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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In reply refer to: H-87-11

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National Highway Traffic
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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 consensus 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 passengers' safety.

Overall, in the cases investigated for this study, the Safety Board found the bodies of poststandard schoolbuses withstood crash forces very well, maintaining structural

integrity even in severe crash forces. This probably helped reduce injuries. However, as a result of this study, the Safety Board did find deficiencies in Federal Motor Vehicle Safety Standard 221, Schoolbus Joint Strength.

FMVSS 221 requires that an inside or outside body panel of a schoolbus be fastened so that the body panel is capable of holding the body panel to the member to which it is joined when subjected to a force of 60 percent of the tensile strength of the weakest joined body panel. The purpose of this standard is to reduce the deaths and injuries resulting from the structural collapse of schoolbus bodies during crashes.

The rule defines the term "body panel" as a body component used on the exterior or interior surface to enclose the schoolbus occupant space, and defines "body panel joint" as the area of contact or close proximity between the edges of a body panel and another body component, excluding spaces designed for ventilation or other functional purpose, and excluding doors, windows, and maintenance access panels.

Maintenance access panels are panels, either on the exterior or interior of the bus, which allow access to mechanical functions (i.e. door opening) and electrical functions (wiring for lights, turn signals, stop arm, etc.) of the bus. The design and placement of maintenance access panels varies. For example, if maintenance access panels are located in the bus interior, they might be located above the windows, below the windows, or both above and below. Methods of enclosing the panel and its attachment to the bus body also differ.

Federal standards do not specify where access panels can be located. More importantly, maintenance access panels in large poststandard schoolbuses are not required to meet Federal schoolbus joint requirements. This omission has been and continues to be a source of concern.

Based on the investigations conducted during this study, the Safety Board believes that the separations of the maintenance access panels from the adjacent interior body panels continue to be a hazard to schoolbus passengers. Maintenance access panels separated in 5 of the 44 schoolbuses in this study. These separations definitely resulted in schoolbus passenger injuries in two accidents. When a maintenance panel separates, sharp edges are exposed not only in the access panel itself but also in the body panels to which it had been joined. Passengers who contact exposed metal edges of the body or maintenance access panels during collisions and overturns can sustain disfiguring and sometimes life-threatening injuries.

The first accident in which separated access panels caused injury occurred when a tractor-trailer rear-ended a stopped schoolbus which then rolled over. The crash took place in Tuba City, Arizona, on April 29, 1985, and involved a 1979 Blue Bird schoolbus. This bus had interior maintenance access panels installed on both sides above the windows. Following the crash, joint separations were noted at the connections joining the left and right maintenance access panels to the interior body side walls at the rear. Above the 13th row of seats, where the separation of the maintenance access panel left the bottom edge of the body panel exposed, a quantity of blood, hair, and human tissue was present on the edges of the body panel. How many students were injured on this sharp metal edge is not known, but the occupant of seat 13A probably sustained his head laceration when he contacted this edge. Other passengers may have been injured as well.

In the St. Louis, Missouri, accident a 1979 Ward schoolbus travelling between 59 and 67 mph struck a sign post head-on. Major impact was to the right front of the bus which was torn open from the side wall to approximately the third window on the right. The front roof was also extensively damaged and collapsed almost down to the seat backs in the front of the bus. Safety Board investigators found a 6-foot-10-inch maintenance access panel, which before the crash, had been installed at the right front of the bus under the side windows, lying across the seat backs on the left side of the bus. (It probably had been moved there by rescuers on the scene, but it had clearly separated.) The joint which the access panel had covered was splattered with blood, hair, and tissue. This indicates that the sharp edges of the exposed joint caused a head injury to one of the schoolbus occupants.

Both of these accidents were extremely severe crashes. However, the body panels subject to FMVSS 221 in the direct impact area did not fail. Some of the maintenance access panel separations, however, were outside the area of direct crush. Even if the access panels in these two crashes had met Federal joint strength standards, they still might have separated since crash forces may have exceeded the standard.

In three other moderate crashes, maintenance access panels separated, but injuries were not attributed to this failure. If access panels had been required to meet Federal joint strength standards, they probably would not have failed in these three cases.

The five cases in this study involving post-1977 schoolbuses with maintenance access panel separations suggest that FMVSS 221 should be revised to include maintenance access panels. If the panels are located within the interior of the schoolbus they should be subject to the same joint strength requirements as the other body panels.

The Safety Board has in the past issued Safety Recommendation H-85-51 to the National Highway Traffic Safety Administration (NHTSA) requesting that the joints of the interior body maintenance access panels meet the standard's requirements. This was done in connection with the Tuba City, Arizona, investigation. NHTSA, however, declined to revise the standard, citing insufficient evidence of a problem. In 1985, the Safety Board classified this recommendation as "Closed--Unacceptable Action," but is issuing a new recommendation based on this study.

The design of schoolbus seats is another area which needs improvement. In 16 of the 43 accidents investigated for the study, bottom 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. In 3 of the 16 cases, passengers received minor injuries from contact with the loose cushions.

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. More than minor injuries could possibly result from any of the above scenarios.

In 1984, the Safety Board issued a Safety Recommendation H-84-75 that recommended that FMVSS 221 be revised to require a more "fail safe" latching device on schoolbus cushions. NHTSA did not agree that a revision in the standard was needed and instead sent a letter in September 1986 alerting the schoolbus industry to the "potential problem" of loose seat cushions.

In January 1987, NHTSA told the Safety Board that three schoolbus manufacturers had responded to NHTSA's letter of information, saying that their new buses will have permanently attached seat cushions. In the same letter, NHTSA reported the results of an informal poll they had conducted of manufacturers who had not responded:

> The six largest schoolbus manufacturers, representing approximately 80 percent of the new schoolbus production, have indicated that their seat cushions will be permanently affixed in future production. The remaining manufacturers could not give a definite answer, but indicated that a positive response, in line with the other manufacturers, was most probable.

The Safety Board is pleased with industry's prompt and positive response. Schoolbus seat cushions should be securely attached and remain attached to their seat frames, even during a crash. In addition to improving crashworthiness, permanent attachment should help circumvent poor maintenance practices which otherwise could negate a well designed attachment system.

The Safety Board is concerned, however, about the 20 percent of new schoolbuses which apparently will not have seat cushions permanently attached. 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 Safety 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.

Permanent cushion attachment is preferred, however. The Safety Board urges the NHTSA to identify each schoolbus body manufacturer who does not have plans to implement permanent attachment for their full production line, starting in 1987, and requests that the NHTSA contact each of these companies to urge them to formulate such plans.

Without a change in FMVSS 222, however, there is nothing to prevent schoolbus manufacturers from switching from a permanent to an impermanent seat attachment in future model years, and nothing to require the schoolbus manufacturers who currently do not have firm plans to switch to permanent attachment to do so. As a result, the Safety Board reiterates Safety Recommendation H-84-75 to the National Highway Traffic Safety Administration:

> For newly manufactured vehicles, revise Federal Motor Vehicle Safety Standard No. 222 to include a requirement that schoolbus seat cushions be installed with fail-safe latching devices which ensure they remain in their latched positions during impacts and rollovers.

The National Transportation Safety Board further recommends that the National Highway Traffic Safety Administration:

> Amend Federal Motor Vehicle Safety Standard 221, Schoolbus Body Joint Strength, to include interior maintenance access panels in the standard's performance requirements. (Class II, Priority Action) (H-87-11)

Also as a result of its investigations, the National Transportation Safety Board issued Safety Recommendations H-87-12 to schoolbus body manufacturers and H-87-13 through -16 to State Directors of Pupil Transportation. The Safety Board also reiterated H-86-57 to Thomas Built Buses, L.P.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in this recommendation.

Patricia A. Goldman for

By: Jim Burnett
Chairman