National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-44 through -46

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The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address initiatives to enhance school bus and passive grade crossing safety and the safety consequences of large longitudinal distances between lap/shoulder belt anchor points. The recommendations are derived from the Safety Board's investigation of the Safety Board's investigation of the collision of a CSX Transportation, Inc., (CSXT) freight train and Murray County, Georgia, district school bus at a railroad/highway grade crossing in Conasauga, Tennessee, on March 28, 2000,[1] and are consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued reiterated 1 safety recommendation and issued 10 new safety recommendations, 3 of which are addressed to the National Association of State Directors of Pupil Transportation Services (NASDPTS). Information supporting the recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On March 28, 2000, about 6:40 a.m., a CSXT freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee. The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

During its investigation of the Conasauga accident, the Safety Board determined, after reviewing documents pertaining to Murray County school bus routes, that route hazards, including grade crossings, apparently were not identified, nor were busdrivers told (other than through annual training) what actions to take in the area of potential hazards. As a result of a previous accident investigation involving similar issues,[2] the Safety Board recommended that the NASDPTS:

> H-96-52
> Encourage your members to develop and implement a program for the identification of school bus route hazards and to routinely monitor and evaluate all regular and substitute school bus drivers.

In June 1998, the NASDPTS, in cooperation with the National Highway Traffic Safety Administration, published guidance on school bus routing and distributed the guidance to States and localities. The Safety Board classified Safety Recommendation H-96-52 "Closed—Acceptable Action" on November 7, 1997. The guidance is also now part of the *National School Transportation Specifications and Procedures.*

To further assist the States in assessing grade crossing safety, the Federal Railroad Administration (FRA) compiles and maintains the U.S. Department of Transportation's (DOT's) Highway Rail Crossing Inventory.[3] States often use information from the inventory to develop a hazard index for railroad/highway grade crossings. The FRA developed a Web-based Accident Prediction System (WBAPS) that is based, in part, on information from the inventory, and on data such as the type of warning device at the grade crossing, the exposure index,[4] and the number of accidents at the location in the past 5 years. A private company, under contract to the FRA, completed an analysis of the WBAPS in June 1999, comparing the performance of the FRA model to other models used to predict accidents. The study found that differences were minimal and that no model retained a substantial edge over another.[5] The public can use the WBAPS to help determine where best to direct highway grade crossing resources.[6] Law enforcement personnel can use the system to target unsafe crossings for monitoring.

According to an FRA official, about half the States have devised their own hazard indexes for evaluating grade crossings. Tennessee uses the DOT's *Rail Highway Crossing*

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[2] For more information, read: National Transportation Safety Board, *Collision of Northeast Illinois Regional Commuter Railroad Corporation (METRA) Train and Transportation Joint Agreement School District 47/155 School Bus at Railroad/Highway Grade Crossing in Fox River Grove, Illinois, on October 25, 1995,* Highway/Railroad Accident Report NTSB/HAR-96/02 (Washington, DC: NTSB, 1996).

[3] Database intended to document every grade crossing in the United States <http://safetydata.fra.dot.gov/officeofsafety/Crossing/Default.asp>.

[4] The exposure index includes the number of trains per day, the number of cars traversing the grade crossing, and the fastest train speed on the track.

[5] May 8, 2000, letter from the Secretary of Transportation to the Chairman of the National Transportation Safety Board.

[6] U.S. Department of Transportation, Federal Railroad Administration, "Using Data Produced by WBAPS Disclaimer."

Resource Allocation Procedure User's Guide[7] to prioritize crossings for upgrade. To determine the hazard index of crossings, the guide applies the FRA accident prediction formula, which is similar to the WBAPS. Under 23 *Code of Federal Regulations* 924, States are required to incorporate the relative hazard of railroad/highway grade crossings into their highway safety improvement program based on a hazard index formula.

Although the WBAPS, the FRA's Web-based accident prediction system, is primarily a tool for States to use in determining funding authority, law enforcement agencies also use it to identify and monitor unsafe grade crossings. If the crossing inventory in the WBAPS were accurate, school districts could also find the WBAPS helpful in establishing school bus routes and identifying hazardous crossings. While the inventory is not up-to-date, it represents the most comprehensive source of data available and does permit hazard identification. Ideally, school bus routes should exclude passive grade crossings; when that is not possible, the WBAPS or the State's own grade crossing index could help school districts determine the least hazardous crossing. The Safety Board concluded that the FRA's WBAPS or a State's grade crossing hazard index, as part of the school bus routing hazard identification program, could help school districts select the safest school bus routes.

Despite the Safety Board's efforts to improve school bus and grade crossing safety, needless accidents, such as this one at Conasauga, continue to occur. Following the accident, the Safety Board developed the initiatives discussed below, based on previous safety recommendations that, if implemented by each State, could reduce the number of grade crossing accidents involving school buses. These initiatives include installing warning devices at passive grade crossings, strengthening the criteria for the installation of active warning devices, installing noise-reducing switches in school buses, improving school bus driver performance and routing, and strengthening the State commercial driver's license manual and exam to include questions related to passive grade crossings.

Passive grade crossing warning devices

In its 1998 study on safety at passive grade crossings,[8] the Safety Board recommended that all passive grade crossings be equipped with highway stop signs, at a minimum. Only Idaho and Hawaii have taken the initiative to install stop signs at all passive grade crossings.

While eliminating railroad/highway grade crossings or activating them with lights and gates is ideal, the Safety Board understands that activating crossings can be expensive; installing stop signs is a less costly solution. Had the accident driver stopped the school bus at the crossing and looked for the train, she would have been able to see it and probably would not have crossed in front of it. The sight distance along the tracks for a vehicle 15 feet from the crossing was sufficient to allow a stopped driver to see a train approaching. While State laws already require that school bus drivers stop at all grade crossings, drivers can benefit from being reminded about this requirement, and a stop sign provides that reinforcement. Moreover, passengers riding the bus are unlikely to know that all school buses are supposed to stop at grade crossings. If a stop

[7] U.S. Department of Transportation, Federal Railroad Administration, *Rail Highway Crossing Resource Allocation Procedure User's Guide*, DOT/FRA/OS-87/10.

[8] National Transportation Safety Board, *Safety at Passive Grade Crossings*, Volume 1: Analysis, Safety Study NTSB/SS-98/02 (Washington, DC: NTSB, 1998).

sign is present, it is possible that passengers may question a driver if he or she does not stop or may tell their parents or teachers that the busdriver failed to stop, providing another means of oversight. The Safety Board concluded that had a stop sign been present at the Conasauga accident crossing, it would have reinforced to the driver the need to stop before crossing the tracks, likely prompting her to stop and not attempt to cross in front of the train.

Hazard index

About half the States use their own hazard index (as opposed to the FRA's hazard index) to determine priorities for upgrading passive grade crossings to active crossings. Some, such as North Carolina, plan to factor school buses into their formula. North Carolina has indicated that it will not only consider whether school buses use a crossing but will also rank passive crossings according to number of school bus trips over them and load data. Including such factors assigns higher priority to school bus crossings and results in upgrading the safety of these crossings more quickly than if the standard hazard index is used. At the time of the accident, two school buses used the Liberty Church Road crossing daily. The Safety Board concluded that had Tennessee factored school bus use into its grade crossing hazard index, the accident crossing may have had a higher priority for receiving funds to install active warning devices.

Noise reduction

Locomotive event recorder data from the train involved in the Conasauga accident indicate that the train horn was activated for about 3 seconds when the train was 952 feet from the crossing and then continuously for 9 seconds (a minimum of 574 feet) before the collision. The busdriver had the radio and overhead speaker on. Additionally, the two panels above the driver's head were covered with sound attenuation material.[9] To be identified, a sound must be 3 to 9 decibels above the threshold of detection;[10] to reach the alerting level, it must be at least 10 decibels above the ambient noise level.[11]

With the door closed and the radio on (the conditions at the time of the accident), but with the bus stopped, audibility testing revealed that the sound of the horn was only 4 decibels greater than the ambient noise when the train was just visible from the crossing; the horn was barely detectable to the volunteer busdriver. With the radio on and the door and window closed, the audio portion of the videotape did not pick up the sound of the horn over the ambient noise. Under similar conditions, but with the radio off and the door open, the sound level of the horn was 25 decibels above that of the ambient noise, and a driver would probably be able to detect the sound and be alerted to the approaching train. Therefore, the Safety Board concluded that the driver did not stop, had the radio on, and the door closed; thus she had difficulty detecting the train horn and was probably unaware of the presence of the train.

[9] While it is unclear how much this material contributed to the driver's inability to hear the train horn, it may have absorbed some of the horn sound. The Safety Board remains concerned about the effects of sound attenuation material on a driver's ability to hear an alerting signal. As explained in the Fox River Grove report, sound attenuation material reduced the volume of both the train horn and the warnings shouted by bus passengers in that accident. For more information, read: NTSB/HAR-96/02.

[10] The "threshold of detection" is the level at which a person is aware of a sound.

[11] Stanley C. Skeiber, Robert L. Mason, and R. C. Potter "Effectiveness of Audible Warning Devices on Emergency Vehicles, Sound and Vibration," February 1978, pp. 14-22.

The Safety Board made two recommendations concerning bus speakers to the NASDPTS in the 1996 Fox River Grove, Illinois, highway accident report:[12]

> H-96-50
> Develop guidelines for the appropriate placement of radio speakers and use of radios on school buses and disseminate these guidelines to your members.
>
> H-96-51
> Advise your members to check their school district buses and disable any radio speakers located immediately adjacent to the school bus drivers' heads.

The NASDPTS informed the Safety Board that it had surveyed the States and found that a majority of the States had prohibited, or had legislation pending that prohibited, radio speakers in the driver's compartment. The remaining States reviewed their policies on use of radios and radio speakers in school buses and stated that the policies were adequate to ensure that drivers can hear critical auditory information. Georgia informed its local school districts of the need to follow proper procedures, including turning off speakers, when crossing railroad tracks. The State did not require school districts to disconnect the speakers adjacent to the driver's head; Georgia left that decision to the local school districts. In October 1998, the National Safety Council revised its "Recommended Procedures for School Bus Drivers at Railroad Grade Crossings" to remind drivers of the importance of turning off radios at railroad/highway grade crossings; the revision was incorporated in the *2000 National School Transportation Specifications and Procedures*. Based on the NASDPTS survey and the association's efforts to inform its members of the hazards of not turning off the radio at grade crossings, Safety Recommendations H-96-50 and –51 were classified "Closed—Acceptable Alternate Action"[13] on February 19, 1999.

Despite the NASDPTS' efforts, the 1-year-old school bus involved in this accident was equipped with a radio speaker adjacent to the driver's head. In addition, to exacerbate the audibility problem, the driver in the Conasauga accident did not follow prescribed policy to turn down the volume at railroad/highway grade crossings. The Safety Board understands from the NASDPTS' response to Safety Recommendations H-96-50 and -51 that the speakers can also be used to transmit important information to the driver via two-way radio from the school district dispatcher. While the Safety Board agrees that information from the dispatcher is important, use of the speakers for music or entertainment broadcasts is not critical and can hamper the driver's ability to hear external auditory alerts.

Speakers adjacent to a school bus driver's head probably contribute the most to masking exterior sounds, such as train horns, but air conditioning, heaters, defrosters, wiper motors, and other sounds also help mask exterior sounds. Therefore, Florida and Kentucky have begun to install noise-canceling switches in school buses. The interrupt-type switches are spring-loaded to prevent drivers from permanently overriding normal operation of noise-producing equipment. When pressed, noise in the driver's area is reduced, improving the driver's ability to listen for

[12] NTSB/HAR-96/02.

[13] The recommendations received this classification because the actions taken met the intent of the recommendations, even though formal guidelines were not developed and school districts were reminded of the hazards of speaker use when approaching railroad tracks, but were not specifically told to disable the speakers.

audible warnings. The Safety Board concluded that if activated prior to a grade crossing, a switch that turns off all nonessential noise-making components, including, but not limited to, the radio, can help drivers hear train horns and stop as necessary.

School bus driver performance and training

Georgia and Tennessee law require that school bus drivers stop the bus before crossing railroad tracks, open the door and window, turn off the radio, look both ways, and proceed when clear. An analysis of the videotape found on the accident bus showed that the school bus was traveling about 25 mph to 30 mph down Liberty Church Road and had reduced its speed to about 15 mph prior to the crossing. The videotape recorded the driver's failure to stop. The window and door were not visible on the videotape, but no sounds associated with opening either one were audible. Had the busdriver stopped 15 feet from the crossing, as required, she would have been able to see 1,268 feet down the tracks and to observe the approaching train. Had the busdriver turned off the radio and opened the door and window, as required, she probably would have heard the train horn. The Safety Board therefore concluded that if the busdriver had followed the required procedures at the grade crossing, that is, if she had stopped at least 15 feet from the nearest rail, turned off her radio, and opened the door and window, she would have seen and heard the train and avoided the accident.

In a postaccident interview, the busdriver stated that she stopped, looked both ways, opened the door, looked in her rear view mirror to make sure the passengers were seated, then looked both ways down the track and proceeded. However, the school bus videotape contradicts this statement. Nor was the busdriver's behavior on this occasion an isolated incident; her actions were indicative of complacency at grade crossings. As recorded on the accident bus videotapes, the driver drove over the same railroad crossing, without stopping, eight other times in the previous 2 weeks. Another train engineer reported seeing a female school bus driver cross the railroad tracks in front of his train at the same location on a previous occasion, although he did not report the incident at the time that he witnessed it. The accident driver was the only female school bus driver to regularly traverse the Liberty Church Road crossing.

The Murray County School District provides annual recertification training for all busdrivers. This training, which the accident driver had received on August 12, 1999, includes information on what drivers are required to do at railroad/highway grade crossings. The driver also received training on the same subject from her previous employer and was reprimanded for talking during the lesson. The fact that the driver told police investigators that she stopped and opened the door shows that she knew the regulations for school buses crossing railroad tracks. The Safety Board concluded that although the driver had been educated on and knew the mandatory safety precautions at railroad/highway grade crossings, she disregarded the required procedures and crossed the railroad tracks without stopping on the day of the accident and at least eight other times before the accident.

The accident driver crossed the Liberty Church Road railroad tracks daily when operating over her regular route. In its 1998 study on safety at passive grade crossings,[14] the Safety Board concluded:

[14] NTSB/SS-98/02, p. 61.

> A driver's decision to look for a train may be adversely affected by the driver's familiarity with and expectations at a specific passive grade crossing and the driver's experience with passive crossings in general.

The accident busdriver may have become complacent; she had not stopped at the crossing on at least eight other occasions and, therefore, even though trains passed this crossing daily between 6:00 a.m. and 7:00 a.m., may not have perceived the danger associated with railroad/highway grade crossings. The annual training she had received apparently was insufficient to reinforce to the driver the hazards associated with grade crossings.

On January 25, 1985, the Safety Board issued a recommendation on monitoring school bus driver compliance at grade crossings to the State directors of pupil transportation for the 50 States and the District of Columbia:

> H-85-4
> Encourage local school jurisdictions to establish and enforce procedures to systematically monitor schoolbus driver compliance with railroad crossing stop requirements and routing requirements which include on scene observations of driver performance.

Georgia responded that the superintendent or staff monitored each school bus route annually and that drivers were encouraged to report any unsafe crossings. The recommendation was classified "Closed—Acceptable Action" for Georgia on November 18, 1993.[15] The NASDPTS *National School Transportation Specifications and Procedures* recommends that pupil transportation directors monitor and evaluate school bus drivers in the performance of their duties.

Based on a review of the Murray County School District files, neither the accident driver nor any other driver had been monitored or received a performance evaluation. Observing and evaluating drivers allows problems to be detected and addressed before an accident occurs. In this case, in which the driver had frequently ignored proper procedures at passive grade crossings by crossing the tracks without stopping, ample opportunity existed for the transportation director (or a representative) to have observed the driver's behavior, reviewed the videotapes,[16] or both, and taken corrective action.

Without an evaluation program in place, the school district had no proactive means of identifying drivers who were operating their buses in an unsafe manner. The Safety Board concluded that the Murray County School District did not monitor drivers nor identify and correct improper behavior, thus missing the opportunity to observe this driver's behavior at railroad/highway grade crossings. Since the accident, Murray County has implemented a program under which supervisors follow drivers who are operating school buses to evaluate their

[15] Safety Recommendation H-85-4 is classified "Closed—Acceptable Action" for 48 States and the District of Columbia and "Closed—No Longer Applicable" for 2 States.

[16] While the videotapes are intended to monitor passenger behavior, they can also be used to observe driver behavior and to educate drivers on proper actions, as necessary.

performance. The county has also been working more closely with Operation Lifesaver[17] to provide mandatory driver training about grade crossing safety.

Commercial driver knowledge of passive grade crossing safety

In addition to providing feedback to currently licensed school bus drivers, the States can incorporate knowledge of passive grade crossing safety into the driver certification process. The Safety Board recommended in its 1998 study on passive grade crossing safety[18] that the States include questions on safety at passive grade crossings in every version of the States' written commercial driver's license examinations. This would reinforce the actions that commercial drivers, including school bus drivers, should take when encountering grade crossings.

In addition to examining school bus and passive grade crossing safety, this investigation also examined the safety consequences of large longitudinal distances between lap/shoulder belt anchor points. In this accident, the upper anchorage (D-ring) and emergency retractor of the driver's continuous lap/shoulder belt were mounted to the bus body side panels approximately 16 inches behind the driver's seat. The lower anchorages were mounted to the seat and attached to the floor with tethers directly under the driver's seat. When the body separated, the driver's seat, the seat-mounted lap belt components, and part of the lap/shoulder belt remained with the chassis, while the D-ring mounted on the sidewall and part of the shoulder belt remained with the bus body. The body separation resulted in high forces exerted on the belt webbing system, which tore, and the driver was ejected from the separating vehicle components. The driver sustained minor injuries.

Because the driver's lap/shoulder belt was attached to both the bus body floor and the sidewall, with one anchor point remaining with the body and the others with the chassis, great forces were exerted on the belt. When the distance between anchor points is broad and the body separates anywhere between these points, the webbing may cause injury to the driver because of forces exerted on the webbing as the two components separate. In this accident, the webbing failed, and the driver was ejected before the belt exerted serious or fatal forces on her. While the Safety Board has not seen body separations in this location before, it is concerned that drivers can sustain serious or fatal injuries if the lap/shoulder belt anchor points are sufficiently far apart that a vehicle separation between the points results in extreme forces exerted on the driver by the webbing during an accident. The Safety Board concluded that the driver's lap/shoulder belt webbing failed due to the high forces applied to the webbing as the two parts of the school bus separated and due to the large distance between the lap belt anchor points. In the Safety Board's opinion, those responsible for pupil transportation should be aware of the potential consequences associated with lap belt anchor points that are far apart. If the anchor points are closer together,

[17] Operation Lifesaver is a nonprofit nationwide effort to educate the public and increase public awareness of the hazards at railroad-highway grade crossings and to develop proper driver behavior patterns at grade crossings. Operation Lifesaver participants include State and local officials, civic groups, safety organizations, transportation industry groups, labor groups, public information media, and private citizens.

[18] Safety Recommendation H-98-37 requests that the States "ensure that questions on safety at passive grade crossings are included in every version of the State's written drivers examination." This recommendation has been classified "Closed—Acceptable Action" for 3 States, "Closed—Acceptable Alternate Action" for 10 States, "Open—Acceptable Response" for 12 States, and "Open—Unacceptable Response" for 1 State. The Safety Board has yet to receive a response from 24 States, including Georgia and Tennessee. For more information, read: NTSB/SS-98/02.

the likelihood of a body separation occurring between them can be reduced, thereby lessening the risk of injury.

Manufacturers should be aware of the potential consequences associated with lap belt anchor points that are far apart. If the anchor points are closer together, the likelihood of a body separation occurring between them can be reduced, thereby lessening the risk of injury. The NASDPTS School Bus Manufacturers Technical Council functions as an industry advisor to school bus manufacturers and the Safety Board believes that it should notify its members of how and why the driver's lap/shoulder belt tore in this accident and of the potential consequences of large longitudinal distances between lap/shoulder belt anchor points.

Although the Safety Board has issued numerous recommendations, as previously cited, to improve school bus and grade crossing safety, needless accidents, such as this one at Conasauga, continue to occur. Following the accident, the Safety Board developed a set of initiatives, based on previous safety recommendations that, if implemented by the States, could reduce the number of grade crossing accidents involving school buses. Therefore, the National Transportation Safety Board recommends that the National Association of State Directors of Pupil Transportation Services:

> Encourage your members to use the Federal Railroad Administration's Web-based accident prediction system or the States' hazard indexes for grade crossings when developing school bus routes. (H-01-44)

> In cooperation with the States, develop and implement a program of initiatives for passive grade crossings and school buses that includes (1) installation of stop signs at passive crossings that are traversed by school buses except where an engineering study shows their installation would create a greater hazard; (2) use of information about whether school buses routinely cross passive grade crossings as a factor in selecting crossings to upgrade with active warning devices; (3) a requirement that all newly purchased and in-service school buses be equipped with noise-reducing switches; (4) enhanced school bus driver training and evaluation, including periodic reviews of on-board videotapes where available, especially with regard to driver performance at grade crossings; and (5) incorporation of questions on passive grade crossings in the commercial driver's license manual and examination. (H-01-45)

> Notify your members of how and why the driver's lap/shoulder belt tore in this accident and of the potential consequences of large longitudinal distances between lap/shoulder belt anchor points. (H-01-46)

The Safety Board also issued safety recommendations to the States, the National Highway Traffic Safety Administration, the Federal Highway Administration, the Georgia Department of Education, and the school bus manufacturers. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation. In your response to the recommendations in this letter, please refer to H-01-44 through -46. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman