National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 8, 2012

In reply refer to: H-11-36 through -38
H-01-8 and H-08-15
(Reiteration and
Reclassification)
H-01-6 and -7 (Reiteration)

The Honorable David L. Strickland
Administrator
National Highway Traffic Safety Administration
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On Thursday morning, August 5, 2010, in Gray Summit, Missouri, traffic slowed in the approach to an active work zone on eastbound Interstate 44 (I-44), as motor vehicles merged from the closed left lane to the right lane. A 2007 Volvo truck-tractor with no trailer was traveling eastbound in the right lane and had slowed or stopped behind traffic. About 10:11 a.m. central daylight time, a 2007 GMC Sierra extended cab pickup truck merged from the left to the right lane and struck the rear of the Volvo tractor. This collision was the first in a series of three.

A convoy of two school buses from St. James High School, St. James, Missouri, was traveling eastbound in the right lane of I-44, approaching the slowed traffic and the collision ahead. Their destination was the Six Flags St. Louis amusement park in Eureka, Missouri. The lead bus was a 71-passenger school bus, occupied by 23 passengers. Following closely behind the lead bus was a 72-passenger school bus, occupied by 31 passengers. Seconds after the lead bus passed a motorcoach that had pulled over and stopped on the shoulder, it struck the rear of the GMC pickup. This collision—the second in the series—pushed the pickup forward, overturning it onto the back of the Volvo tractor. The front of the lead bus was ramped upward, as it came to rest on top of the GMC pickup and the Volvo tractor. Moments later, the following school bus struck the right rear of the lead bus.

As a result of this accident sequence, the driver of the GMC pickup and one passenger seated in the rear of the lead school bus were killed. A total of 35 passengers from both buses, the

2 bus drivers, and the driver of the Volvo tractor received injuries ranging from minor to serious. Eighteen people were uninjured.[1]

The National Transportation Safety Board (NTSB) determined that the probable cause of the initial Gray Summit collision was distraction, likely due to a text messaging conversation being conducted by the GMC pickup driver, which resulted in his failure to notice and react to a Volvo tractor that had slowed or stopped in response to a queue that had developed in a work zone. The second collision, between the lead school bus and the GMC pickup, was the result of the bus driver's inattention to the forward roadway due to excessive focus on a motorcoach parked on the shoulder of the road. The final collision was due to the driver of the following school bus not maintaining the recommended minimum distance from the lead school bus in the seconds preceding the accident. Contributing to the severity of the accident was the lack of forward collision warning systems on the two school buses.

Emergency Exit Windows

All but one occupant of the lead school bus evacuated through the left rear emergency exit window. One injured passenger who had been entrapped between seats was extricated and removed by emergency responders through the right rear emergency exit window. According to the incident commander, all occupants, except for the one fatality, were removed from the bus by 10:37 a.m., 24 minutes after the first call to 911. Several passengers, and a witness who assisted in the evacuation, stated in postaccident interviews that egress was hindered due to (1) a raised emergency release latch plate at the bottom of the emergency exit window, which snagged clothing; and (2) the failure of the emergency window to independently remain in the open position as occupants climbed out.

According to the School Bus Manufacturers Technical Committee (SBMTC),[2] it has never received negative feedback from end users (buyers) regarding evacuation through emergency exit windows. An SBMTC representative stated that when a school bus is involved in an accident and does not roll over, the front, rear, and side doors are the primary points of egress; when a bus rolls on its side, evacuation occurs primarily through the emergency exit windows or roof hatches. In this accident, the 71-passenger lead school bus remained upright, but the rear-end collision blocked the rear emergency exit door, and the elevated resting position of the bus prevented egress through the loading door and roof hatches. Because the accident bus was not equipped with side emergency exit doors, the emergency exit windows were the only egress option.

The Federal standard for bus emergency exits and window retention and release, Federal Motor Vehicle Safety Standard (FMVSS) 217 (at 49 *Code of Federal Regulations* 571.217), was established to minimize the likelihood of occupants being thrown from a bus and to provide a

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[1] For additional information, see *Multivehicle Collision, Interstate 44 Eastbound, Gray Summit, Missouri, August 5, 2010*, Highway Accident Report NTSB/HAR-11/03 (Washington, DC: National Transportation Safety Board, 2011), which is available on the NTSB website at <http://www.ntsb.gov/>.

[2] The SBMTC—a committee within the National Association of State Directors of Pupil Transportation Services—comprises school bus and chassis manufacturers, such as Freightliner, Blue Bird, Ford Motor Company, and Thomas Built Buses.

means of readily accessible emergency egress. FMVSS 217 specifies the minimum number of emergency exit windows, minimum window size, designation as emergency exit windows, and maximum force allowed to push the window out, among other characteristics. To assist manufacturers in meeting the requirements, the National Highway Traffic Safety Administration (NHTSA) published laboratory test procedures for school bus emergency exits and window retention and release.[3]

The NTSB reviewed the test procedures for side emergency exit windows and found separate procedures for determining the maximum force requirements to push the window out and the minimum size requirements for egress. However, the procedures do not address scenarios in which an occupant would need to push the window out and maintain it in the open position while attempting egress. On the lead school bus, one person was needed to hold the emergency window open while another attempted egress. Although the opening size of the emergency exit window met Federal standards, this opening could not be maintained by a single occupant while simultaneously exiting from the window. Both FMVSS 217 and the associated NHTSA laboratory test procedures require that each emergency exit be manually extendable by a single occupant to admit unobstructed passage, but neither directive then specifies that the same occupant be able to egress while manually extending the window.

The National Congress on School Transportation (NCST) publishes specifications and procedures to supplement FMVSS 217.[4] For rear emergency exit on school buses with a rear engine, large windows are used in lieu of emergency exit doors, and the NCST specifies that a lifting assistance device be in place to aid in lifting and holding the window open. However, no such specification is provided for side emergency exit windows during evacuation.

According to Blue Bird Corporation, in 2005, after the last state removed its requirement for horizontally hinged windows, the company redesigned all side emergency exit windows. The emergency exit windows now offered are vertically hinged, with release latch tabs that present less intrusion into the area of egress. Although a vertically hinged side emergency exit window may be an improvement, accident scenarios are still possible in which the window may have to be held in place so as not to hinder evacuation. The NTSB concluded that the situation of a single occupant having to manually hold open the emergency exit window could delay school bus evacuation. Therefore, the NTSB recommends that NHTSA modify FMVSS 217 to require that all emergency exits on school buses be easily opened and remain open during an emergency evacuation.

The NTSB has previously addressed potential hindrances due to emergency exits that fail to stay in the open position during evacuation. As the result of an accident field investigation of a

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[3] *Laboratory Test Procedures for FMVSS 217: School Bus Emergency Exits and Window Retention and Release*, TP-217-06 (Washington, DC: National Highway Traffic Safety Administration, December 1996).

[4] *National School Transportation Specifications and Procedures* (Warrensburg, Missouri: Fifteenth National Congress on School Transportation, 2010). This document serves as the national guideline for school bus design specifications, inspection procedures, and out-of-service criteria.

pickup and a tour bus collision in Laredo, Texas, in 1984,[5] the NTSB issued the following recommendation to NHTSA:

> Revise Federal Motor Vehicle Safety Standard 217 to require a locking mechanism that would hold open side window emergency exits on intercity-type buses during use. (H-86-61)

Because NHTSA indicated that no rulemaking was planned for this recommendation, it was classified "Closed—Unacceptable Action" in 1987.

In 1999, the NTSB completed a special investigation on selective motorcoach issues based on two motorcoach accidents—one of which occurred in Stony Creek, Virginia, in 1997.[6] It involved a motorcoach that drifted off the road and into the Nottoway River, resulting in 2 people killed and 39 injured. Several passengers reported difficulty evacuating the bus because the emergency window would not remain open. As a result, the NTSB issued the following recommendation to NHTSA:

> Revise the Federal Motor Vehicle Safety Standard 217, "Bus Window Retention and Release," to require that other than floor-level emergency exits can be easily opened and remain open during an emergency evacuation when a motorcoach is upright or at unusual attitudes. (H-99-9)

In November 2009, the U.S. Department of Transportation (DOT) published its Motorcoach Safety Action Plan and identified as a priority safety initiative enhancing the ability of passengers to evacuate a motorcoach in a crash. The NTSB was pleased that progress was being made to improve motorcoach safety but expressed concern that decisions on regulatory action were not forthcoming. Accordingly, the NTSB classified Safety Recommendation H-99-9 "Open—Unacceptable Response" in 2010.

FMVSS 217 and the accompanying test procedures also fail to address other emergency exit design characteristics that could affect egress safety, such as the latch plate protrusion found on the lead school bus. The Gray Summit accident did not require an expedited evacuation because the spilled fuel from the GMC pickup was managed by first responders and did not catch fire, and because several people assisted in the evacuation. Although, in this case, the latch plate only snagged clothing, the NTSB is concerned that any protrusion into a space of egress may act as an injury source and delay egress, especially during more urgent evacuation scenarios.

The NTSB concluded that components of emergency exit windows, such as protruding latch plates, could cause delays or injuries during school bus evacuation. Therefore, the NTSB recommends that NHTSA modify FMVSS 217 or the corresponding laboratory test procedure to eliminate the potential for objects such as latch plates to protrude into the emergency exit window opening space even when that protrusion still allows the exit window to meet the

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[5] *1982 Eagle Charter Coach Head-on Collision With 1983 Ford Pickup Truck, Near Laredo, Texas, October 20, 1984*, Highway Field Report NTSB FTW-85-H-FR02 (Washington, DC: National Transportation Safety Board, 1986).

[6] *Selective Motorcoach Issues*, Highway Special Investigation Report NTSB/SIR-99/01 (Washington, DC: National Transportation Safety Board, 1999).

opening size requirements. To cover the interim period until FMVSS 217 is modified, the NTSB also recommends that NHTSA provide the states with guidance on how to minimize potential evacuation delays that could be caused by protruding latch mechanisms on emergency exit windows and by exit windows that require additional manual assistance to remain open during egress.

Forward Collision Avoidance Systems

The Gray Summit accident consisted of three rear-end collisions involving a passenger vehicle and two large buses. Forward collision warning (FCW) systems are currently available as options from nearly all major manufacturers of passenger vehicles as well as heavy commercial motor vehicles. Collision warning systems are vehicle-based systems that monitor the roadway in front of the host vehicle, and in some applications to the side, and warn the driver of potential collision risks. These systems use radar technology, camera technology, or both, typically mounted within the front bumper assembly. Additionally, NHTSA is evaluating FCW systems based on radio communications between vehicles (vehicle-to-vehicle) equipped with global positioning system technology. When other vehicles or stationary objects are within predefined distances or closing speeds in the forward path of the host vehicle, an in-cab display unit provides audible and visual alerts to the driver. An add-on to this system is adaptive cruise control (ACC), which uses the same technology to adjust or disengage conventional cruise control when a collision risk is detected. Collision warning systems can also be designed to engage the foundation and engine brakes of the vehicle when an imminent hazard is detected, which is referred to as active braking;[7] this technology combined with FCW is another collision mitigation option.

When a heavy vehicle equipped with an FCW system approaches a slower moving vehicle or stationary object, the system issues progressively more urgent warnings according to preset thresholds.[8] Some currently available systems can detect and display warnings at a distance of 350 feet or a following distance period of up to 3 seconds. If the following distance closes to less than 0.5 second or if the radar detects slow-moving or stopped traffic within 350 feet of the vehicle, the system alerts the driver with visual indicators and an audible tone. FCW systems significantly reduce the risk of rear-end collisions by allowing more time for the driver to react to fast-closing situations. Commercial vehicles equipped with FCW generally begin braking earlier, thereby reducing the risk of accidents. Additionally, when using FCW systems, drivers usually adopt longer following-distance driving behaviors.

For over a decade, the NTSB has advocated technological solutions to reduce the occurrence of rear-end collisions for both passenger and commercial vehicles. In 2001, the NTSB made the following recommendations to the DOT:[9]

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[7] Some active braking systems on the market claim to generate decelerations of up to 0.35 g in commercial vehicles.

[8] *Analysis of Benefits and Costs of Forward Collision Warning Systems for the Trucking Industry*, FMCSA-RRT-09-021 (Washington, DC: Federal Motor Carrier Safety Administration, 2009), p. v.

[9] *Vehicle- and Infrastructure-Based Technology for the Prevention of Rear-End Collisions,* Special Investigation Report NTSB/SIR-01/01 (Washington, DC: National Transportation Safety Board, 2001).

> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new commercial vehicles. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-6)
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> After promulgating performance standards for collision warning systems for commercial vehicles, require that all new commercial vehicles be equipped with a collision warning system. (H-01-7)
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> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new passenger cars. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-8)

Following its investigation of a 2005 multifatality accident involving a motorcoach and an overturned truck-tractor semitrailer combination unit on Interstate 94 near Osseo, Wisconsin, the NTSB issued a recommendation to NHTSA requiring FCW systems on commercial vehicles:[10]

> Determine whether equipping commercial vehicles with collision warning systems with active braking and electronic stability control systems will reduce commercial vehicle accidents. If these technologies are determined to be effective in reducing accidents, require their use on commercial vehicles. (H-08-15)

Following the investigation of a 10-fatality accident, when a truck-tractor semitrailer combination unit rear-ended and overrode several passenger vehicles on I-44 near Miami, Oklahoma, the NTSB reiterated Safety Recommendations H-01-6 and -7 to NHTSA[11] and reclassified their status to "Open—Unacceptable Response."[12] The Miami report also reiterated Safety Recommendation H-08-15 to NHTSA, and its status is "Open—Acceptable Response." Safety Recommendation H-01-8 is currently classified "Open—Acceptable Response."

The DOT has sponsored a variety of research into collision avoidance systems. Much of the passenger vehicle research has been conducted as part of the NHTSA crash avoidance research program in the area of integrated vehicle-based safety systems. Commercial vehicle research has found that 21 percent of rear-end crashes could be prevented with FCW systems alone, and 28 percent of rear-end crashes could be prevented with a combination of FCW and ACC. If all 1.8 million commercial trucks in the United States were equipped with FCW

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[10] *Truck-Tractor Semitrailer Rollover and Motorcoach Collision With Overturned Truck, Interstate Highway 94, Near Osseo, Wisconsin, October 16, 2005*, Highway Accident Report NTSB/HAR-08/02 (Washington, DC: National Transportation Safety Board, 2008).

[11] Safety Recommendations H-01-6, -7, and -8 were originally assigned to the Federal Motor Carrier Safety Administration, in 2001; the DOT subsequently transferred them to NHTSA.

[12] *Truck-Tractor Semitrailer Rear-End Collision Into Passenger Vehicles on Interstate 44 Near Miami, Oklahoma, June 26, 2009*, Highway Accident Report NTSB/HAR-10/02 (Washington, DC: National Transportation Safety Board, 2010).

systems, the DOT estimates that 4,700 rear-end crashes, 2,500 injuries, and 96 fatalities could be prevented each year.[13]

NTSB investigators were unable to determine whether FCW and ACC could have prevented or mitigated the initial Gray Summit collision because of insufficient information about the actions of the GMC pickup driver. Had the pickup entered the right lane several hundred feet behind the Volvo tractor, an FCW system might have warned the driver in time for him to take evasive action and avoid the collision. Unfortunately, it is not possible to determine from the available evidence when the pickup entered the right lane and how soon after that the initial collision occurred.

Had the lead school bus been equipped with an FCW system, it is possible that the driver would have been alerted far enough in advance to take action to avoid the GMC pickup–Volvo tractor collision. An FCW system would have alerted the bus driver to the accident 350 feet ahead. Although the ruptured brake line of the lead bus would not have allowed the driver to stop her vehicle in time, the FCW alert might have given her enough time to swerve to avoid a frontal collision, or at least to mitigate the severity of the impact. Moreover, the activation of brake lights on the rear of the lead bus would have given the driver of the following school bus a readily recognizable cue to initiate braking, and more time and distance to decelerate her vehicle. Had the following bus also been equipped with an FCW system, the bus driver would have been alerted to the slowing or stopped vehicles ahead. The braking cues of the lead bus and the FCW alerts might have allowed her to avoid the collisions ahead, regardless of the involvement of the lead bus.

The NTSB concluded that FCW systems on the two accident buses—and possibly on the GMC pickup—could have prevented the accident or at least mitigated its severity. Because NHTSA has not yet completed rulemaking requiring FCW systems on private and commercial vehicles, and because the NTSB continues to investigate serious accidents that could have been prevented or mitigated with FCW systems, the NTSB reiterates Safety Recommendations H-01-8 and H-08-15 to NHTSA and reclassifies each recommendation "Open—Unacceptable Response." The NTSB also reiterates Safety Recommendations H-01-6 and -7 to NHTSA.

To summarize, as a result of its investigation of the Gray Summit accident, the National Transportation Safety Board makes the following safety recommendations to the National Highway Traffic Safety Administration:

> Modify Federal Motor Vehicle Safety Standard 217 to require that all emergency exits on school buses be easily opened and remain open during an emergency evacuation. (H-11-36)
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> Modify Federal Motor Vehicle Safety Standard 217 or the corresponding laboratory test procedure to eliminate the potential for objects such as latch plates to protrude into the emergency exit window opening space even when that protrusion still allows the exit window to meet the opening size requirements. (H-11-37)

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[13] *Volvo Trucks Field Operational Tests: Evaluation of Advanced Safety Systems for Heavy Truck Tractors* (Washington, DC: U.S. Department of Transportation, February 2005).

> To cover the interim period until Federal Motor Vehicle Safety Standard 217 is modified as specified in Safety Recommendations H-11-36 and -37, provide the states with guidance on how to minimize potential evacuation delays that could be caused by protruding latch mechanisms on emergency exit windows and by exit windows that require additional manual assistance to remain open during egress. (H-11-38)

In addition, as discussed in this letter and in the Gray Summit accident investigation report, the National Transportation Safety Board reiterates and reclassifies the following previously issued recommendations to the National Highway Traffic Safety Administration:

> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new passenger cars. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-8)

> Determine whether equipping commercial vehicles with collision warning systems with active braking and electronic stability control systems will reduce commercial vehicle accidents. If these technologies are determined to be effective in reducing accidents, require their use on commercial vehicles. (H-08-15)

Safety Recommendations H-01-8 and H-08-15 are reclassified "Open—Unacceptable Response."

The National Transportation Safety Board also reiterates the following previously issued recommendations to the National Highway Traffic Safety Administration:

> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new commercial vehicles. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-6)

> After promulgating performance standards for collision warning systems for commercial vehicles, require that all new commercial vehicles be equipped with a collision warning system. (H-01-7)

The NTSB also issued new safety recommendations to the 50 states and the District of Columbia, the state of Missouri, the Missouri Department of Elementary and Secondary Education, CTIA–The Wireless Association and the Consumer Electronics Association, and the National Association of State Directors of Pupil Transportation Services, the National Association for Pupil Transportation, and the National School Transportation Association. The NTSB reiterated previously issued recommendations to the Federal Motor Carrier Safety Administration and the American Association of Motor Vehicle Administrators.

In response to this letter, please refer to Safety Recommendations H-11-36 through -38; Safety Recommendations H-01-6, -7, and -8; and Safety Recommendation H-08-15. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our secure mailbox.

To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in these recommendations. Chairman Hersman, Vice Chairman Hart, and Member Sumwalt each filed concurring statements, which are appended to the accident report.

[Original Signed]

By: Deborah A.P. Hersman
Chairman