National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 19, 2009

In reply refer to: H-09-22 through -24
H-99-47, -48, -50, and -51
(Reiterations)

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About 12:45 a.m., central daylight time, on Friday, August 8, 2008, a 2002 56-passenger Motor Coach Industries, Inc. (MCI), motorcoach, operated by Iguala BusMex, Inc., was northbound on U.S. Highway 75 when it was involved in a single-vehicle, multiple-fatality accident in Sherman, Texas. The chartered motorcoach had departed the Vietnamese Martyrs Catholic Church in Houston, Texas, at approximately 8:30 p.m. on August 7, 2008, with a driver and 55 passengers onboard, en route to the Marian Days Festival in Carthage, Missouri. When the accident occurred, the motorcoach had completed about 309 miles of the approximately 600-mile-long trip.

Before the crash, the motorcoach was traveling in the right lane of the four-lane divided highway. As the motorcoach approached the Post Oak Creek bridge at a speed of about 68 mph, its right steer axle tire failed. The motorcoach departed the roadway on an angle of about 4 degrees to the right, overrode a 7-inch-high, 18-inch-wide concrete curb, and struck the metal bridge railing. After riding against the bridge railing for about 120 feet and displacing approximately 136 feet of railing, the motorcoach went through the bridge railing and off the bridge. It fell about 8 feet and slid approximately 24 feet on its right side before coming to rest on the inclined earthen bridge abutment adjacent to Post Oak Creek. As a result of the accident, 17 motorcoach passengers died; 12 passengers were found to be dead at the crash site, and 5 others later died at area hospitals. In addition, the 52-year-old driver received serious injuries, and 38 passengers received minor-to-serious injuries.[1]

[1] See *Motorcoach Run-Off-the-Bridge and Rollover, Sherman, Texas, August 8, 2008*, Highway Accident Report NTSB/HAR-09/02 (Washington, DC: National Transportation Safety Board, 2009), which is available on the NTSB website at http://www.ntsb.gov/publictn/2009/HAR0902.pdf.

The National Transportation Safety Board determined that the probable cause of this accident was the failure of the right steer axle tire, due to an extended period of low-pressure operation, which resulted in sidewall, belting, and body ply separation within the tire, leading to loss of vehicle control. Contributing to the severity of the accident was the failure of the bridge railing to redirect the motorcoach and prevent it from departing the bridge. The lack of an adequate occupant protection system contributed to the severity of the passenger injuries.

Among the issues the National Transportation Safety Board (NTSB) identified during the investigation were the need for tire pressure monitoring systems on commercial vehicles and the lack of motorcoach occupant protection systems. These issues are discussed below.

Need for Tire Pressure Monitoring Systems on Commercial Vehicles

Tire pressure monitoring systems (TPMS) are designed to monitor and inform the driver of tire pressures and are capable of detecting operating temperatures. Direct TPMSs have the advantage of providing actual tire pressures to the driver in real time while the vehicle is in operation.[2] In this accident, a direct TPMS could have detected the decreasing pressure of the right steer axle tire and alerted the driver before the tire's catastrophic failure.

The Transportation Recall Enhancement, Accountability, and Documentation Act (TREAD Act), enacted by Congress on November 1, 2000, directed the Secretary of Transportation to conduct rulemaking to require warning systems in new motor vehicles to indicate to the operator when a tire is significantly underinflated. In 2007, National Highway Traffic Safety Administration (NHTSA) rulemaking at 49 *Code of Federal Regulations* Part 571[3] established Federal Motor Vehicle Safety Standard (FMVSS) 138 for TPMSs to warn the driver when a tire is significantly underinflated. Application of that standard, however, was restricted to light vehicles—specifically to passenger cars, trucks, multipurpose passenger vehicles, and buses with gross vehicle weight ratings of 10,000 pounds or less, except for those vehicles with dual wheels on an axle. Unlike the NHTSA rule, the TREAD Act referred to "new motor vehicles" without restriction regarding vehicle class.[4]

No rule or standard currently requires that large commercial vehicles, including motorcoaches, be equipped with TPMSs. The NTSB notes that the difference between the broad nature of the Congressional language in the TREAD Act and the specific and restrictive regulatory language used in NHTSA's rulemaking leaves large commercial vehicles, including motorcoaches that carry many passengers, unaffected by this important safety requirement. Direct TPMSs have the potential to eliminate failures on commercial vehicles caused by tire underinflation or overloading through their ability to directly measure tire pressure and operating temperatures. Furthermore, direct TPMSs continuously monitor actual tire pressure in real time and can immediately relay information to the operator while the vehicle is en route.

The accident vehicle's tires were substantially underinflated on the tag axle and slightly overinflated on the drive axle. These conditions could have been detected either by a pretrip

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[2] Advanced TPMSs are equipped with central inflation systems that automatically maintain proper tire inflation pressures.

[3] *Federal Register*, vol. 72, no. 133 (July 12, 2007), p. 38017.

[4] See section 13 of Public Law 106-414.

inspection using a tire gauge or by a TPMS. Moreover, the right steer axle tire experienced a slow leak from a puncture that may have occurred during the accident trip. A TPMS would have detected this critical safety problem en route. The NTSB concluded that if the driver had been aware of the motorcoach's tire pressures, particularly the dangerously low pressure in the damaged right steer axle tire, then he would have had an opportunity to take corrective action, which might have prevented this accident. A direct TPMS could have provided such a warning. Therefore, the NTSB recommends that NHTSA require all new motor vehicles weighing over 10,000 pounds to be equipped with direct TPMSs to inform drivers of the actual tire pressures on their vehicles.

Lack of Motorcoach Occupant Protection Systems

Safety Standards. Seventeen people died and 25 were seriously injured in this accident. In the event of an accident, the vehicle's occupant protection system serves to mitigate the crash forces that cause injury. A comprehensive occupant protection system considers many aspects of the vehicle, including roof strength, window glazing, seat strength, and restraint systems and their anchorage strengths—all working together to protect occupants should a crash occur. Generally, the NTSB has found that passengers who remain in their seating compartments sustain fewer injuries, while ejected passengers are more likely to be killed. NHTSA motorcoach testing using crash test dummies has confirmed NTSB findings, showing that a lap/shoulder-belted dummy on the far side of an impact had a much lower risk of sustaining injuries than an unrestrained dummy on the far side of an impact.

In February 2008, NHTSA conducted roof strength tests on four motorcoaches, comparing U.S. school bus and European motorcoach roof strength requirements. An MCI motorcoach and a Prevost motorcoach were tested under both the FMVSS 220 school bus rollover protection standard and the United Nations Economic Commission for Europe Regulation 66 (ECE R66), "Rollover Protection Strength and Structural Integrity," requirements. The motorcoaches failed both the FMVSS 220 and the ECE R66 tests. An additional ECE R66 test of a 2000 MCI motorcoach was performed in July 2009. Of the two standards, the ECE R66 test is considered a more "real-world" test because it is a dynamic fall onto a hard surface from an 800-millimeter (about 2.6-foot) step. In this test, the motorcoach is equipped with templates representing the residual space. No object outside of the residual space at the start of the test, including the luggage racks, may intrude upon this space during the test; however, those racks are unloaded.[5] In the February 2008 ECE R66 test of the MCI motorcoach, the left side luggage rack inboard hangers (supports) rearward of the two front hangers broke, exposing sharp metal edges.[6] In this test, contact was documented between the back of an unrestrained crash test dummy's head and the bottom of the luggage rack. The lap/shoulder-belted dummies on the far side showed much lower risk for injury than the unrestrained dummies. In addition, during a

[5] NHTSA Motorcoach Roof Crush/Rollover Testing presentation, February 2009 Government Industry Meeting <http://www.nhtsa.gov/staticfiles/DOT/NHTSA/NRD/Multimedia/PDFs/Public%20Paper/SAE/2009/Hott%20200%20SAE.pdf>, accessed September 21, 2009.

[6] *NHTSA ECE Regulation 66-Based Research Test of Motorcoach Roof Strength*, Final Report, ECE66-MGA2007-001, May 2008.

2007 frontal crash test, several unrestrained crash dummies experienced their highest resultant head accelerations during head contact with the luggage racks.[7]

Differences in the drop heights between the ECE R66 test (800 millimeters or about 2.6 feet) and the Sherman accident (8 feet) most likely would not change the improved injury results seen with lap/shoulder belts. If the energy is properly managed, passengers can survive an 8-foot fall, and in this accident, many passengers, especially those on the far side of the impact, survived the fall. A simplified analysis[8] showed that the vertical impact velocity in this accident scenario would be less than two times the impact velocity in the ECE R66 crash test. In the Sherman accident, the motorcoach also had some forward velocity (29 mph) at the time of the fall from the bridge. This forward velocity would enable an occupant in a shoulder belt to engage the belt, providing better occupant restraint for a lap/shoulder-belted passenger than was seen for the restrained dummies in the ECE R66 test. Although the ECE R66 test requires a drop from only about 2.6 feet, similar improved results for lap/shoulder-belted passengers would be expected in an 8-foot drop, as experienced by the accident motorcoach passengers.

With respect to this accident, interviews with first responders and passengers confirmed that some passengers in the accident motorcoach were ejected as a result of the accident. However, due to the circumstances of the accident, the NTSB could not determine the exact number of fully and partially ejected passengers.[9]

The FMVSSs contain 22 standards on vehicle crashworthiness. Most of these standards exempt motorcoaches with gross vehicle weight ratings over 10,000 pounds, and no Federal regulations require that motorcoaches in the United States be equipped with an occupant protection system for passengers. Although motorcoaches must comply with FMVSS 217, which establishes minimum requirements for motorcoach window retention and release; FMVSS 205, which covers windshields and glazing; and FMVSS 302, which establishes standards for the flammability of interior materials,[10] motorcoaches do not have to comply with the many other FMVSSs concerning occupant protection standards that apply to school buses[11] and passenger cars.

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[7] In December 2007, NHTSA conducted its first motorcoach crash test. That frontal crash test, and subsequent sled tests, looked at crash forces under different velocities, impact angles, and restraint conditions. In the frontal crash test, the luggage rack failed.

[8] The analysis is simplified in that it assumes the same motorcoach mass, but it neglects the longitudinal velocity, the roll velocity, and the asymmetry in the impact configuration.

[9] Some of those passengers who were partially ejected were trapped under the vehicle, making it difficult for witnesses to identify how many passengers had been ejected. Also, first responders' records of ejections were inconclusive because other passengers rendered immediate assistance to the injured, who were moved away from the motorcoach as quickly as possible due to passengers' fears of a postcrash fire.

[10] FMVSS 208, "Occupant Crash Protection"; FMVSS 209, "Seat Belt Assemblies"; and FMVSS 210, "Seat Belt Assembly Anchorages" currently apply to the driver's seat only.

[11] Title 49 *United States Code* §30125 defines a "school bus" as any vehicle that is designed for carrying a driver and more than 10 passengers and which, as NHTSA determines, is likely to be "used significantly" to transport "preprimary, primary, and secondary" students to or from school or related events (which include school-sponsored field trips and athletic events). This definition was enacted in 1974, as part of a comprehensive effort by Congress to enhance school bus safety. In 2007, Texas enacted legislation requiring school buses to be equipped with 3-point lap/shoulder seat belts.

In 1994, the ECE initiated a project to improve safety by fitting seat belts on motorcoaches.[12] That study found that passenger ejection is a major cause of death and injury and that, although seat belts can significantly reduce or prevent passenger ejection, the whole system—seats, seat belts, and all anchorages—must be considered to ensure effectiveness. A more recent European Union (EU) study, by TNO-Automotive in the Netherlands,[13] concluded that wearing either a lap or a lap/shoulder belt is safer than not wearing a seat belt and that the main advantage of wearing seat belts in a motorcoach is to prevent ejection during rollover accidents, as well as during frontal accidents. Since 1997, EU member states have required 2-point lap belts and energy-absorbing seats or 3-point lap/shoulder belts on all M3 motorcoaches.[14]

Australia applies a set of design rules in addition to ECE requirements.[15] The Federal Office of Road Safety in Canberra conducted a 5-year study (1988 to 1993) of 23 motorcoach accidents to identify occupant protection issues involving long-distance coaches.[16] Since 1994, Australian Design Rule 68/00 has required that all newly manufactured motorcoaches have lap/shoulder belt systems.

Despite the lack of U.S. Federal requirements, manufacturers are proceeding to introduce lap/shoulder belt seats into the U.S. market,[17] and states such as Texas are beginning to require lap/shoulder belt-equipped seats for motorcoach transport of students.[18]

In 1999, the NTSB conducted a bus crashworthiness special investigation and issued a series of safety recommendations to improve occupant protection in the event of an accident.[19] In that report, the NTSB concluded that one of the primary causes of preventable injury in motorcoach accidents involving a rollover, ejection, or both, is occupant motion out of the seat during a collision when no intrusion into the seating area occurs. Safety Recommendations H-99-47, 48, -50, and -51 asked NHTSA to take the following actions:

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[12] D. Kecman and others, *Study of the Technical Requirements for Fitment of Seat Belts on Minibuses and Coaches*, Cranfield Impact Centre Report to European Commission, DGIII, Contract No. ETD/94/B5–3000/MI/05 (1994-1995).

[13] C.G. Huijskens, M. Schrooten, and P. de Coo, "Frontal Occupant Safety Simulation for Coach and Bus Passengers," *Proceedings: 18th International Technical Conference on the Enhanced Safety of Vehicles, Nagoya, Japan, May 19 through 22, 2003,* Paper No. 284 (2003).

[14] Within the EU, the M-definition of buses provides a common classification of coaches based on weight. M3 coaches are defined as weighing more than 5 tons. The M-definitions are further separated into classes I through III based on application. ECE Regulation 80 specifies the strength of seats on large passenger buses (16 or more passengers), requiring passengers to remain in the predetermined zone in cases of a 30-kilometer-per-hour impact.

[15] Australia requires 3-point seat belts and 20-g seats.

[16] K.B. Smith, "Fatal and Serious Injury Bus Crashes," Working Document WD117 (Canberra, Australia: Federal Office of Road Safety, November 1993).

[17] In January 2009, American Seating and SafeGuard introduced lap/shoulder belt-equipped seats on Prevost motorcoaches. In April 2009, Greyhound ordered 140 Prevost X3-45 motorcoaches with lap/shoulder belt-equipped seats.

[18] The state of Texas has required that, by September 1, 2014, all charter (motorcoach) buses used by Texas schools to transport school children be equipped with 3-point lap/shoulder belts for passengers.

[19] *Bus Crashworthiness Issues*, Highway Special Investigation Report NTSB/SIR-99/04 (Washington, DC: National Transportation Safety Board, 1999).

> In 2 years, develop performance standards for motorcoach occupant protection systems that account for frontal impact collisions, side impact collisions, rear impact collisions, and rollovers. (H-99-47)
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> Once pertinent standards have been developed for motorcoach occupant protection systems, require newly manufactured motorcoaches to have an occupant crash protection system that meets the newly developed performance standards and retains passengers, including those in child safety restraint systems, within the seating compartment throughout the accident sequence for all accident scenarios. (H-99-48)
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> In 2 years, develop performance standards for motorcoach roof strength that provide maximum survival space for all seating positions and that take into account current typical motorcoach window dimensions. (H-99-50)
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> Once performance standards have been developed for motorcoach roof strength, require newly manufactured motorcoaches to meet those standards. (H-99-51)

All of these recommendations are classified "Open—Unacceptable Response." Safety Recommendations H-99-47 and -50 are on the NTSB Most Wanted List of Transportation Safety Improvements.

All four recommendations have been reiterated to NHTSA as a result of several motorcoach accident investigations over the last decade and as recently as this year in conjunction with the NTSB's investigation of a motorcoach rollover accident near Mexican Hat, Utah.[20] The Sherman accident motorcoach experienced multiple collisions, including a rollover with an 8-foot drop. Previous NTSB motorcoach investigations concluded that passengers would be safer with an occupant protection system and sufficient roof strength. Recent NHTSA crash testing showed that injury risk was much lower for lap/shoulder-belted dummies than for unrestrained dummies. The NTSB concluded that if NHTSA had implemented the requirements for motorcoach occupant protection systems following the issuance of Safety Recommendations H-99-47, -48, -50, and -51, fewer injuries and fatalities might have occurred because more occupants might have been retained within the accident motorcoach. Once again, the NTSB reiterates these safety recommendations to NHTSA, and they remain classified "Open--Unacceptable Response."

Luggage Rack Failure. The 36-foot-long right side luggage rack on the Sherman motorcoach was attached to the ceiling and sidewall by nine cast aluminum brackets. Each bracket was secured to the ceiling using two 1/2-inch bolts and secured to the sidewall using two inline 1/2-inch bolts. The overhead luggage rack on the right side of the motorcoach sustained failure damage at the anchorage points, became completely detached, and fell diagonally across the aisle onto the passengers. The fallen structure blocked the aisle near rows 3 and 4 as well as the right side emergency window exits. The fallen overhead luggage rack obstructed the

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[20] (a) *Motorcoach Rollover Near Mexican Hat, Utah, January 6, 2008,* Highway Accident Report NTSB/HAR-09/01 (Washington, DC: National Transportation Safety Board, 2009); (b) *Motorcoach Override of Elevated Exit Ramp, Interstate 75, Atlanta, Georgia, March 2, 2007,* Highway Accident Report NTSB/HAR-08/01 (Washington, DC: National Transportation Safety Board, 2008); (c) *Motorcoach Run-Off-The-Road and Overturn, Victor, New York, June 23, 2002*, Highway Accident Report NTSB/HAR-04/03 (Washington, DC: National Transportation Safety Board, 2004).

evacuation route of those who were ambulatory and, based on interview evidence, impeded the efforts of first responders to evacuate injured passengers. The NTSB concluded that the failure of the luggage rack on the accident motorcoach impeded egress and rescue efforts. The NTSB recommends that NHTSA develop performance standards for newly manufactured motorcoaches to require that overhead luggage racks remain anchored during an accident sequence.

The majority of the seriously and fatally injured passengers incurred blunt force trauma to the head, neck, chest, and spine. There was evidence that several passengers' heads contacted the luggage rack and, although investigators were unable to determine exactly when in the accident sequence passenger injuries took place, it is possible that serious head or neck injury resulted from the interactions between the passengers and the luggage rack. In addition, recent motorcoach rollover testing performed by NHTSA using crash test dummies has demonstrated the potential for serious head injury to unrestrained dummies due to passenger interactions with luggage racks. Lap/shoulder-belted dummies showed low risk for head injury and were retained within the seating compartment. Currently, there are no U.S. standards for luggage rack design that would help to reduce potential injuries during a motorcoach crash sequence. The NTSB concluded that the Sherman accident and recent motorcoach testing indicate that the lack of standards for overhead luggage racks on motorcoaches leaves passengers at risk of serious injury from interaction with luggage racks in case of a crash. The NTSB recommends that NHTSA develop performance standards for newly manufactured motorcoaches that prevent head and neck injuries from overhead luggage racks.

As a result of the investigation, the NTSB makes the following recommendations to the National Highway Traffic Safety Administration:

> Require all new motor vehicles weighing over 10,000 pounds to be equipped with direct tire pressure monitoring systems to inform drivers of the actual tire pressures on their vehicles. (H-09-22)
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> Develop performance standards for newly manufactured motorcoaches to require that overhead luggage racks remain anchored during an accident sequence. (H-09-23)
>
> Develop performance standards for newly manufactured motorcoaches that prevent head and neck injuries from overhead luggage racks. (H-09-24)

Further, the NTSB reiterates Safety Recommendations H-99-47, -48, -50, and -51 to the National Highway Traffic Safety Administration:

> In 2 years, develop performance standards for motorcoach occupant protection systems that account for frontal impact collisions, side impact collisions, rear impact collisions, and rollovers. (H-99-47)
>
> Once pertinent standards have been developed for motorcoach occupant protection systems, require newly manufactured motorcoaches to have an occupant crash protection system that meets the newly developed performance standards and retains passengers, including those in child safety restraint systems, within the seating compartment throughout the accident sequence for all accident scenarios. (H-99-48)

> In 2 years, develop performance standards for motorcoach roof strength that provide maximum survival space for all seating positions and that take into account current typical motorcoach window dimensions. (H-99-50)
>
> Once performance standards have been developed for motorcoach roof strength, require newly manufactured motorcoaches to meet those standards. (H-99-51)

The NTSB also issued safety recommendations to the Federal Highway Administration, the Federal Motor Carrier Safety Administration (FMCSA), the American Association of State Highway and Transportation Officials, the American Association of Motor Vehicle Administrators, and Motor Coach Industries, Inc. The NTSB also reiterated a previous recommendation to the FMCSA.

In response to the recommendations in this letter, please refer to Safety Recommendations H-09-22 through -24 and Safety Recommendations H-99-47, -48, -50, and -51. 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 Member SUMWALT concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman