National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: June 27, 2007

In reply refer to: H-07-4 through -8

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On September 23, 2005, a 1998 Motor Coach Industries, Inc. (MCI), 54-passenger motorcoach, operated by Global Limo Inc. (Global), of Pharr, Texas, was traveling northbound on Interstate 45 (I-45) near Wilmer, Texas.[1] The motorcoach, en route from Bellaire to Dallas, Texas, as part of the evacuation in anticipation of Hurricane Rita, was carrying 44 assisted living facility residents and nursing staff. The trip had begun about 3:00 p.m. on September 22. Fifteen hours later, about 6:00 a.m. on the following day, a motorist noticed that the right-rear tire hub was glowing red and alerted the motorcoach driver, who stopped in the left traffic lane and then proceeded to the right shoulder of I-45 near milepost 269.5. The driver and nursing staff exited the motorcoach and observed flames emanating from the right-rear wheel well. As they initiated an evacuation of the motorcoach, with assistance from passersby, heavy smoke and fire quickly engulfed the entire vehicle. Twenty-three passengers were fatally injured. Of the 21 passengers who escaped, 2 were seriously injured and 19 received minor injuries; the motorcoach driver also received minor injuries.

The National Transportation Safety Board determined that the probable cause of the accident was insufficient lubrication in the right-side tag axle wheel bearing assembly of the motorcoach, resulting in increased temperatures and subsequent failed wheel bearings, which led to ignition of the tire and the catastrophic fire. Global Limo Inc. had failed to conduct proper vehicle maintenance, to do pretrip inspections, and to complete posttrip driver vehicle inspection reports, thereby allowing the insufficient wheel bearing lubrication to go undetected. Contributing to the accident was the Federal Motor Carrier Safety Administration's ineffective compliance review system, which resulted in inadequate safety oversight of passenger motor carriers. Contributing to the rapid propagation and severity of the fire and subsequent loss of life was the lack of motorcoach fire-retardant construction materials adjacent to the wheel well. Also contributing to the severity of the accident was the limited ability of passengers with special needs to evacuate the motorcoach.

[1] For more information, see <http://www.ntsb.gov/publictn/2007/HAR0701.pdf>. National Transportation Safety Board, *Motorcoach Fire on Interstate 45 During Hurricane Rita Evacuation, Near Wilmer, Texas, September 23, 2005*, Highway Accident Report NTSB/HAR-07/01 (Washington, DC: NTSB, 2007).

When fire burns in a confined space, the heat feedback from surroundings causes the material to burn more intensely. In this accident, the heat radiated by the glowing hub components and the confinement of the rubber tire within the wheel well significantly increased the rate at which the fire burned. From the burning 3R tire, the fire spread to adjacent tires, to other combustible wheel well area components,[2] and to the composite exterior of the motorcoach. In addition, significant amounts of diesel fuel from the fuel delivery system became involved and accelerated the spread of the fire during the incipient stage.

In the accident motorcoach, the fuel lines were routed through a centerline tunnel in the undercarriage. Two small access panels made of a combustible material separated the fuel lines from the wheel well. One access panel was completely consumed by fire, and the other was partially melted and deformed. The thermoplastic fuel lines were completely consumed by fire from the engine compartment to a point within 1 foot of the fuel tank. In motorcoaches, fuel lines located near engine compartments and service tunnels can burn through and provide volatile fuel to an existing fire, causing a significant increase in the fire hazard. In this accident, burnthrough occurred once the tire fire breached the two combustible access panels to the service tunnel and the fuel lines in the engine compartment. Therefore, the Safety Board concludes that, because of the proximity of the combustible access panels to the tire wheel well, where the fire originated, the fuel delivery system contributed to acceleration of the fire.

Replacement of the combustible access panel with a fire-resistant barrier might preclude the early involvement of fuel in a fire in the wheel well area and thereby limit the rate of fire spread. The National Highway Traffic Safety Administration (NHTSA) has developed a fuel system crashworthiness standard (Federal Motor Vehicle Safety Standard [FMVSS] 301) to limit the amount of fuel spill as a result of an accident and thus reduce the chance of a catastrophic postcrash fire. However, this FMVSS does not apply to motorcoaches.

During the Safety Board's public hearing on this accident investigation,[3] August 8–9, 2006, in Washington, D.C., the senior technical advisor for the motorcoach manufacturer MCI noted that body panels on coaches have been made of aluminum, steel, or fiberglass for many years and that both aluminum and fiberglass are combustible materials. The MCI representative further stated, "We provide an interior inner fender barrier between the tire area and the passenger compartment. It is always made out of stainless steel." He explained that the exterior of the vehicle is the most prominent path of fire into the interior as flames travel up the outside and past the windows, superheating the windows and causing them to break, allowing entry into the passenger compartment.

The most likely point of initial entry of a fire into a motorcoach is burnthrough of the combustible exterior composite materials just above the passenger-side rear wheel well area, followed by movement into the passenger compartment via both the heating, ventilating, and air conditioning (HVAC) system and the windows. In the case of a tire fire, the geometry of the

[2] These components include bushings, mud flaps, and suspension system air bags.

[3] "Motorcoach Accident and Selected Federal Motor Carrier Safety Administration Oversight Issues, Wilmer, Texas." The Safety Board may hold a public hearing as part of its investigation into an accident to supplement the factual record. Technical experts are called as witnesses to testify, and Board investigative staff and designated representatives from the parties to the investigation ask questions to obtain additional factual information. A hearing is not intended to analyze factual information for cause.

wheel well and the buoyant nature of fire cause the flames to impinge on the sidewall; this exposure to severe heat is what leads to burnthrough of the combustible sidewall materials. In the accident motorcoach, the panels inside the wheel well area (those facing the roadway) were lined with stainless steel, which acted as a barrier to the fire. However, as the fire intensified above the wheel well, it burned through the exterior composite material and underlying sidewall foam insulation. The HVAC ventilation ductwork that ran along the sides of the motorcoach at the floor level opened a path for the fire and smoke, as evidenced by the destroyed recirculation duct in the right-rear wheel area and the aluminum return ducts and adjoining parts that showed signs of severe heat exposure. The missing sections had been located above the wheel well areas on both sides of the motorcoach.

The burnthrough of the exterior wall allowed the fire's intense heat and smoke—byproducts of the burning tires, foam, and fiberglass—to enter the passenger compartment, where interior components also began to catch on fire. The propagation of the fire into the passenger compartment and the burning of interior components caused an exponential increase in the production of smoke and heat and accelerated the fire. The Safety Board concludes that the tire fire, caused by an overheated right-side tag axle wheel bearing assembly, which ignited the tire, spread up the side of the motorcoach and burnt through the fiberglass sidewall above the wheel well and through the motorcoach windows, creating an entry path for the smoke and fire into the passenger compartment.

The Federal standard for flammability of interior materials, FMVSS 302, does not apply to the exterior of motor vehicles.[4] The standard evaluates a material's capability of resisting ignition and flame spread when exposed to a small ignition source, such as a match or a lit cigarette. It does not represent fire conditions where significant preheating of the material occurs and the ignition source is large. Additionally, the standard only tests materials in the horizontal orientation, which is a far less challenging test than the vertical orientation.

MCI's senior technical advisor stated during the public hearing that MCI uses materials throughout the coach, including exterior sidewall components, that comply with FMVSS 302. However, as is clear from this accident, the compliance of the exterior sidewall materials to this standard was inconsequential to resisting the rapid propagation of the fire, which impeded the passengers' ability to safely evacuate. Therefore, the Safety Board concludes that the exterior of the motorcoach had not been fire-hardened in fire-prone areas, such as around the wheel wells, and was not required to be by regulation, thereby limiting the time available for safe egress in the event of a fire.

As several witnesses at the Safety Board public hearing explained, and as documented during the motorcoach tire fire testing in August 2006, it is extremely difficult, and beyond the capacity of any practical, currently available hand-held chemical extinguisher or automatic fire suppression system, to completely extinguish a burning tire. Although the accident motorcoach driver was not able to unlatch the 5-pound dry chemical fire extinguisher, this type of fire extinguisher, as noted during the public hearing and the tire fire testing, cannot extinguish a tire fire and therefore would not have made a difference in this accident.

[4] Title 49 *Code of Federal Regulations* (CFR) 571.302 applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.

Various manufacturers currently sell automatic fire detection and suppression systems for transit and intercity motorcoaches[5] that target engine compartment and electrical system fires. According to the testimony of an MCI senior technical advisor at the public hearing, the number of MCI motorcoaches being sold with fire suppression systems has increased.[6] These systems generally employ spot heat detectors and a fire suppression agent distribution network with individual nozzles near the heat sensors. However, none of these systems have been specifically designed to protect against and extinguish a tire fire. As the vehicle fire suppression systems product manager with Amerex Corporation stated at the public hearing, one way to prevent a fire may be to use a heat monitoring system to provide the driver with a prefire warning alert to elevated heat in a wheel well. In addition, future wheel well fire suppression systems might be designed to preempt the outbreak of a fire by monitoring the tires to detect dangerously high temperature conditions, at which point a fire suppression agent could be used to cool the tire. Currently, the Federal Motor Carrier Safety Administration is working with the Volpe National Transportation Systems Center to identify ways to prevent, reduce, or mitigate the severity and frequency of motorcoach fires, including the assessment of available fire suppression systems. The Safety Board concludes that because tire fires are difficult to extinguish, early detection of potentially hazardous conditions in a wheel well area is critical, as demonstrated by the sequence of events in this accident, to eliminating the fire hazard.

The Safety Board has investigated accidents involving motorcoaches with emergency windows, such as on the accident motorcoach, that are approximately 7–8 feet from the ground, hinged at the top, and operated by lifting a release bar and pushing outward.[7] In several of these investigations, emergency responders and bystanders had difficulty rescuing passengers because of window height and top-hinge design, just as bystanders reported in the Wilmer accident.

For example, on June 20, 1998, a 1997 MCI motorcoach operated by Greyhound Lines, Inc., was traveling westbound on the Pennsylvania Turnpike near Burnt Cabins, Pennsylvania,[8] when it ran off the right side of the roadway and struck the back of a tractor semitrailer. The entire front of the motorcoach was crushed, and the front loading door was destroyed; the motorcoach driver and 6 passengers were killed, and 16 passengers were injured. The emergency responders reported difficulty in rescuing the trapped passengers and had to set up a ladder to reach the emergency windows. The Safety Board determined that when passersby and emergency responders arrive on scene to rescue trapped passengers and provide medical assistance, any impediment to rapid entry into the accident vehicle can be detrimental to timely treatment of injuries and passenger survival. In the Wilmer accident, witnesses interviewed by the Safety Board reported trying to open the motorcoach windows from the exterior. When two

[5] New Jersey Transit has been using vehicles with fire detection and suppression systems since 1994.

[6] In addition, MCI has introduced the SmarTire pressure temperature monitoring system as an option in its motorcoaches.

[7] (a) National Transportation Safety Board, *Interstate Bus–Automobile Collision, Interstate Route 15, Baker, California, March 7, 1968*, Highway Accident Report NTSB/SS-H-3 (Washington, DC: NTSB, 1968). (b) National Transportation Safety Board, *Greyhound Bus Collision With Concrete Overpass Support Column on Interstate 80, San Juan Pass, Sacramento, California, November 3, 1973*, Highway Accident Report NTSB/HAR-74/05 (Washington, DC: NTSB, 1974). (c) National Transportation Safety Board, Docket No. SRH-96-FH-015.

[8] National Transportation Safety Board, *Greyhound Run-Off-the-Road Accident, Burnt Cabins, Pennsylvania, June 20, 1998*, Highway Accident Report NTSB/HAR-00/01 (Washington, DC: NTSB, 2000).

passersby could not reach high enough to pry open two windows, they broke the windows but were unable to rescue any passengers.

Past Safety Board investigations have involved passengers of diverse ages and physical abilities who reported difficulty in evacuating because the windows were heavy and they could not hold them open while attempting to climb out and descend unassisted 8 feet to the ground. The majority of passengers in the Wilmer accident were persons with special needs, were unable to evacuate on their own, and could not be rescued before the fire destroyed the motorcoach; in other emergency situations, however, window height and design could impede the timely egress of passengers responding to a rapidly propagating fire.

On July 29, 1997, for example, a 1985 TMC motorcoach operated by Rite-Way Transportation, Inc., drifted off the side of Interstate 95 near Stony Creek, Virginia,[9] and down an embankment into the Nottoway River, where it came to rest on its left side, partially submerged in water. The front of the motorcoach was severely damaged, and the vehicle immediately began to fill up with water. Many passengers had to swim to the surface to escape. Some of the passengers, as young as 11, were too small to push the heavy emergency windows open far enough to evacuate. The Safety Board concluded that the strength and height needed to open an emergency window when a motorcoach is not upright pose a problem for some passengers, especially children, senior citizens, and injury victims. The Safety Board recommended that NHTSA

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> 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 that they remain open during an emergency evacuation when a motorcoach is upright or at unusual attitudes.

The Safety Board added this recommendation to the List of Most Wanted Transportation Safety Improvements in 2000,[10] and it is currently classified "Open—Acceptable Response." On October 12, 2006, NHTSA wrote to the Safety Board and stated that, as part of the regular 7-year regulatory review process, it is studying FMVSS 217 and anticipates completion of the review by early 2007.

The rapid propagation of fire and quickly spreading smoke call for prompt, orderly egress of all motorcoach passengers. The circumstances of the Wilmer accident—a rapidly spreading fire, inadequate motorcoach egress systems, and destruction of the vehicle—along with the increasing number of tire fires noted by the industry, highlight the critical need to evaluate the

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

[10] NHTSA originally responded to the Safety Board by letter on April 15, 1999, stating that the agency would research a "hold open" device for all emergency exit windows that are hinged at the top and determine whether the device would satisfy the conditions set forth in the Safety Board's recommendation. If not, NHTSA stated that it intends "to perform research to establish the feasibility of a device that will limit the forces required to open emergency windows and keep emergency exit windows open when the bus its on its side. When the above is complete, NHTSA will then propose changing Standard 217 to require this device on emergency exit windows on buses and school buses."

adequacy of current motorcoach emergency egress design. In any such evaluation, passenger negotiation of the 7–8 foot window drop as a means of escape cannot be ignored. Many motorcoach window exits are 8 feet above ground, a distance higher than the wings of some airplanes, such as the 727, 737, and Canadair regional jet. Federal regulations require an approved means to assist airplane passengers in descending from an exit that is higher than 6 feet above ground; however, no such Federal regulations are in place for motorcoach exit heights. The Safety Board concludes that, in the absence of demonstrated emergency evacuation capabilities for motorcoaches, such as the accident vehicle, the effectiveness of design features in facilitating the safe escape of passengers cannot be determined.

The National Transportation Safety Board therefore makes the following recommendations to the National Highway Traffic Safety Administration:

> Develop a Federal Motor Vehicle Safety Standard to provide enhanced fire protection of the fuel system in areas of motorcoaches and buses where the system may be exposed to the effects of a fire. (H-07-4)
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> Develop a Federal Motor Vehicle Safety Standard to provide fire-hardening of exterior fire-prone materials, such as those in areas around wheel wells, to limit the potential for flame spread into a motorcoach or bus passenger compartment. (H-07-5)
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> Develop detection systems to monitor the temperature of wheel well compartments in motorcoaches and buses to provide early warning of malfunctions that could lead to fires. (H-07-6)
>
> Evaluate the need for a Federal Motor Vehicle Safety Standard that would require installation of fire detection and suppression systems on motorcoaches. (H-07-7)
>
> Evaluate current emergency evacuation designs of motorcoaches and buses by conducting simulation studies and evacuation drills that take into account, at a minimum, acceptable egress times for various postaccident environments, including fire and smoke; unavailable exit situations; and the current above-ground height and design of window exits to be used in emergencies by all potential vehicle occupants. (H-07-8)

The Safety Board also issued safety recommendations to the Federal Motor Carrier Safety Administration, the Pipeline and Hazardous Materials Safety Administration, the Fraternal Order of Police, the International Association of Chiefs of Police, the International Association of Fire Chiefs, the International Association of Fire Fighters, the National Association of State EMS Officials, the National Sheriffs' Association, the National Volunteer Fire Council, Motor Coach Industries, Inc., and other motorcoach manufacturers, the United Motorcoach Association, and the American Bus Association. In addition, the Safety Board reiterated two recommendations to the U.S. Department of Transportation.

Please refer to Safety Recommendations H-07-4 through -8 in your reply. If you need additional information, you may call (202) 314-6177.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred in these recommendations. Member HERSMAN filed a concurring statement, and Member HIGGINS filed a concurring and dissenting statement, both of which are attached to the Accident Report.

[*Original Signed*]

By: Mark V. Rosenker
Chairman