



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: JUN 27 2007

In reply refer to: I-07-1 and -2

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On September 23, 2005, a 1998 Motor Coach Industries, Inc., 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.nts.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).

The director of risk management for Sunrise Senior Living Services, Inc., stated in a Safety Board interview that employees of the Brighton Gardens senior assisted living center placed medical oxygen cylinders both inside the passenger compartment and inside the luggage bay during passenger loading of the motorcoach. Initially, two cylinders were hooked up to nasal canulas and used to provide medical oxygen to two passengers inside the motorcoach. Fifteen cylinders, contained in metal racks, were placed in the luggage bay in the lower portion of the coach, along with passenger wheelchairs. During the trip, the oxygen within the cylinders in the passenger compartment was depleted, and the nursing staff requested that the driver pull over to retrieve additional cylinders from the luggage bay.

To avoid dangerous rupture or explosion, a pressure relief device in oxygen cylinders, such as a burst disk, is designed to actuate when the internal pressure in the cylinder reaches 3,025–3,360 pounds per square inch gage (psig). As designed, when a fully pressurized cylinder is heated to 260°–315° Fahrenheit (F), its internal pressure exceeds the actuation pressure (3,025–3,360 psig) of the burst disk, and a controlled release of oxygen occurs to prevent cylinder rupture. Representatives of aluminum cylinder manufacturers stated to Safety Board investigators that, though aluminum melts at 1,020°–1,206° F, the exposure of the cylinders to temperatures well below the melting range will weaken the aluminum. A fully pressurized aluminum cylinder without a burst disk will maintain its integrity for only minutes at temperatures above 600° F because of the increased pressure levels acting on the now heated and structurally weakened aluminum cylinder.

Federal hazardous materials (HM) regulations on pressure relief devices are designed for the transportation of full cylinders. The regulations require that a pressure relief device prevent the failure of a fully pressurized cylinder in a fire; however, they do not consider cylinders that are partially pressurized. Prior to 1981, this omission was not a problem because all specification cylinders permitted for the transportation of compressed gas were manufactured of steel, which is not as sensitive as aluminum to material strength loss when exposed to heat. In 1981, the HM regulations were amended to permit aluminum cylinders for use in transporting compressed gases. Because of the potential loss of material strength, the Safety Board is concerned that an aluminum cylinder might rupture at an internal pressure well below the actuation pressure of the burst disk.

The Safety Board's analysis indicated that, though the burst disk on a heated, fully pressurized cylinder actuates as designed before failure of the cylinder (that is, before the aluminum weakens and loses integrity), a partially pressurized heated cylinder can fail before the burst disk actuates. Specifically, when a cylinder containing less than 78 percent of its full charge (1,570 psig at room temperature) is heated to a temperature exceeding 400° F, it will structurally fail before its internal pressure actuates the burst disk. Thus, partially pressurized aluminum cylinders exposed to heat are more likely to rupture before the internal pressure is high enough to actuate the burst disk. When the aluminum weakens and the cylinder loses integrity (the cylinder wall fails), though the internal pressure is *not* high enough to actuate the burst disk, it causes the cylinder to fail, releasing the oxygen and causing the fragmented pieces of the cylinder to become hazardous projectiles.

During this accident investigation, three aluminum cylinders retrieved from the motorcoach were found with intact valves, even though two cylinders displayed evidence of

melting, and one had fractured and burst. Upon examination of the burst disks for these three cylinders, the Safety Board determined that two cylinders failed before the burst disks actuated. Such failures would have rapidly released large quantities of oxygen into the fire and may have propelled portions of the cylinders some distance from the point of origin. In fact, the intense burst of fire shown in a still photograph from video footage of the motorcoach fire was likely caused by the failure of one of these two cylinders. Emergency responders and passersby described these bursts of fire as "explosions."

The Safety Board considered what effect, if any, the venting and failure of these cylinders had on the attempted rescue of passengers remaining in the motorcoach. According to the Safety Board's study, the first cylinder failure, which likely caused a burst of fire, would not have occurred until the temperature of the cylinder was at least 400° F. First responders and passersby who were attempting to rescue passengers reported ceasing their efforts just before, or just as, these bursts began to occur.

By the time the temperature levels were high enough to cause the two aluminum cylinders to fail, the heat from the fire in the rear of the motorcoach prevented rescuers from safely reaching the passengers seated there. Further, heavy, black smoke from the fire inside the motorcoach was reported to have been overwhelming within only a few minutes of the passenger evacuation and prevented rescue attempts beyond the first few rows of seats. The Safety Board concludes that the smoke and heat from the fire prevented rescuers from safely proceeding further into the motorcoach within minutes of their arrival on scene and that the aluminum cylinders failed, releasing oxygen to the fire, after successful rescue attempts were no longer possible.

The rupture of aluminum cylinders caused by internal pressure exceeding the strength of the cylinder wall poses a significant hazard to emergency responders and others. Aluminum cylinders can be transported as cargo in any mode of transportation, and the presence of aluminum cylinders containing any compressed gas may pose a significant hazard in transportation fires.

The Pipeline and Hazardous Materials Safety Administration recommends limiting the number of cylinders to the extent practicable and limiting the total weight of cylinders to 99 pounds per vehicle;² however, these limitations may not be practicable in an emergency evacuation, such as in advance of a hurricane. Should aluminum cylinders be an issue for emergency responders in any mode of transportation, the safety of the vehicle occupants and the responders is of the utmost priority. The Safety Board concludes that the possibility of structural failure in partially pressurized aluminum cylinders when exposed to heat and fire, as occurred on the accident motorcoach, poses a danger to the general public and emergency responders.

The National Transportation Safety Board therefore makes the following recommendations to the Pipeline and Hazardous Materials Safety Administration:

² U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, *Guidance for the Safe Transportation of Medical Oxygen for Personal Use on Buses and Trains* (Washington, DC: PHMSA, 2005).

Develop standards for the safe transportation of partially pressurized aluminum cylinders by, for example, requiring the addition of temperature-actuated pressure relief devices or the reduction of residual pressure to safe limits, to ensure that such cylinders do not experience overpressure failure when exposed to a fire.

(I-07-1)

Issue guidance to, at a minimum, the Fraternal Order of Police, International Association of Chiefs of Police, International Association of Fire Chiefs, International Association of Fire Fighters, National Association of State EMS Officials, National Sheriffs' Association, and National Volunteer Fire Council, describing the risk of overpressure failure of partially pressurized aluminum cylinders and the steps that should be taken to protect responders and the general public from a vehicle fire when aluminum cylinders are present. (I-07-2)

The Safety Board also issued safety recommendations to the Federal Motor Carrier Safety Administration, the National Highway Traffic 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 I-07-1 and -2 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.



By: Mark V. Rosenker
Chairman