National Transportation Safety Board

Washington, DC 20594

Highway Accident Brief

Accident Number:	HWY-05-MH-006
Accident Type:	Motorcoach run-off-the-road and rollover
Location:	Interstate 55, near Turrell, Arkansas
Date and Time:	October 9, 2004, 5:02 a.m. central standard time
Vehicles:	1988 Motor Coach Industries, Inc., 47-passenger motorcoach
Owners/Operators:	Walters Bus Service, Inc.
Fatalities/Injuries:	15 fatalities 13 serious injuries 2 minor injuries

Accident Description

On October 9, 2004, about 5:02 a.m., a 1988 Motor Coach Industries, Inc. (MCI), 47-passenger motorcoach was southbound on Interstate 55 (I-55) near Turrell, Arkansas, transporting 29 passengers to a casino in Tunica, Mississippi. Witnesses following the motorcoach prior to the accident estimated that it had been traveling about 70 mph. At the exit 23A interchange, the motorcoach veered to the right and entered the grassy area between the exit ramp and the entrance ramp. (See figure 1.) As it rotated in a clockwise direction, the motorcoach struck an exit sign, overturning onto its left side and sliding in a southwesterly direction. The left side of the vehicle struck the westernmost side of a 2-foot-deep earthen drainage ditch, and the motorcoach continued to roll over. As it rolled, the roof opened up, allowing passengers to be thrown from the open top. The motorcoach landed 65 feet from the drainage ditch and came to rest upside down. Its roof was laying on the ground (top side up), still hinged to the right side of the vehicle.

At the time of the accident, it was dark and there was no highway safety lighting. The roadway was wet from a misting rain, but there was no standing water.

Survival Aspects

The rollover and partial detachment of the roof resulted in the ejection of all 30 occupants. The motorcoach driver was not wearing his lap belt; the passenger seats were not equipped with seat belts. In total, 14 passengers and the driver, who was partially trapped under the roof, were killed; 5 of the fatally injured passengers had been trapped under the roof. Thirteen passengers were seriously injured, one of whom had been trapped under the roof; and two passengers received minor injuries. One of the three passengers found under the motorcoach body survived. (See table 1 for fatality and injury information.)

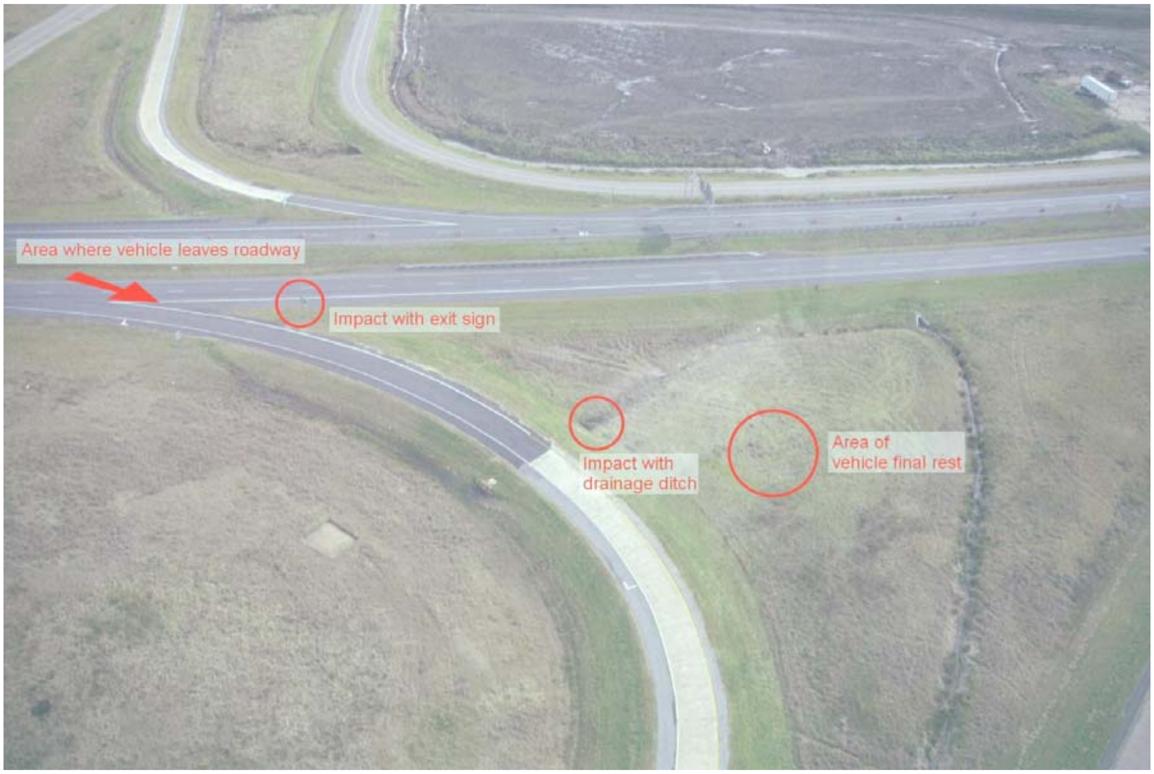

Figure 1. Path of motorcoach from I-55. (Courtesy of Arkansas Highway Police)

Table 1. Injuries.

Injury[A]	Motorcoach driver	Motorcoach passengers	Total
Fatal	1	14	15
Serious	0	13	13
Minor	0	2	2
None	0	0	0
Total	1	29	30

[A]Title 49 *Code of Federal Regulations* (CFR) 830.2 defines fatal injury as any injury that results in death within 30 days of the accident. It defines serious injury as any injury that requires hospitalization for more than 48 hours, commencing within 7 days of the date of injury; results in a fracture of any bone (except simple fractures of the fingers, toes, or nose); causes severe hemorrhages, or nerve, muscle, or tendon damage; involves any internal organ; or involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

The Crittenden County Sheriff's Department Communications Center served as the primary public safety communications center, with the West Memphis Fire Department providing support. Three police agencies, 3 local fire departments, and 18 ambulances (12 were used) responded to the accident.[1] The Crittenden County Sheriff's Department was notified of the accident at 5:04 a.m. and immediately dispatched two deputies, who arrived on scene at 5:12 a.m. with a Crittenden County Game and Fish Conservation officer. The first ambulance from the Crittenden County Ambulance Service was dispatched at 5:13 a.m. and arrived at 5:25 a.m. The West Memphis Fire Department was dispatched at 5:18 a.m. and arrived at 5:35 a.m.

Three months after the accident, a Safety Board investigator met with staff from the Crittenden County Sheriff's Department to review its role in the accident and to examine the related policies and operation of the communications center. On February 22, 2005, Safety Board investigators identified several deficiencies and organizational failures concerning the emergency response to the accident. On April 5, 2005, the Crittenden County sheriff outlined the progress that had been made in improving the emergency response system.

Vehicle

The vehicle involved in the accident was a 1988 MCI 47-passenger motorcoach, model 96-A3. The bus was 11 feet high, 8 feet wide, and 40 feet long. The empty gross vehicle weight was 28,200 pounds. The motorcoach was not equipped with an electronic data recorder.

The motorcoach was equipped with power steering and a TRW/Ross model HFB-70054 integral[2] steering gearbox, which were found to be functional. The vehicle's standard dual circuit air brake system with S-cam drum brakes was in good working condition. All brakes were in adjustment according to standards used by the Commercial Vehicle Safety Alliance. The 2L-outside tire had only 47 psi—rather than the normal full pressure of 95 psi—but was found with grass lodged around the tire and the rim, which most likely occurred during the rollover sequence and resulted in air escaping the tire. The left tag axle tire was bald, and the right-side tire was bald in spots and had a 1/32-inch tread depth. The tread depths of the remaining tires met Federal regulations of 4/32 inch for the steer axle and 2/32 inch for all other tires, as required by 49 CFR 393.75 and 49 CFR appendix G, subchapter B. The air suspension system included eight air bags in good working condition.

The motorcoach body sustained damage to the upper front driver's side corner, right-passenger-side rear corner near the lavatory, and roof. (See figure 2.) During the rollover, the entire left side of the roof, including the front and rear upper structures, became separated from the motorcoach sidewall at the sash rail (lower window sill level). At final rest, the motorcoach was upside down with the roof adjacent to the body (top side up) and still partially attached

[1] Crittenden County Sheriff's Department, Crittenden County Game and Fish Conservation Office, Arkansas State Police, Marion Volunteer Fire Department, West Memphis Fire Department, and Earle Fire Department.

[2] "Integral" refers to the manual steering gear, the hydraulic control valve, and the hydraulic power cylinder all being contained within the steering gearbox.

along the right side by several vertical posts.[3] The motorcoach sustained significant interior damage as a result of the rollover.

Figure 2. Motorcoach postaccident, with roof detached.

During the investigation, it was discovered that—2 years prior to the accident—the motorcoach had sustained fire damage to its roof and interior as a result of a fire in a facility in which it was parked. Postcrash inspection revealed 14 additional panels of sheet metal attached on top of the original 14 panels on both sides of the roof along its curvature.[4] (See figure 3.) The new roof panels were 35 by 60 inches. The panels were glued and riveted using Magna-Lock rivets on top of the original roof panels, which ran horizontally from window line to window line and measured 106.25 inches in length and 62 inches in width. Rivet holes drilled to attach the new roof panels were misaligned with the original rivet holes. The investigation also revealed corrosion of several roof vertical posts, roof rails, roof bows, and sash rails along both sides of the motorcoach. Stick welding (oxyacetylene) found in the right-rear upper structure of the roof was also indicative of previous repairs.

[3] The roof vertical posts were cut by rescue personnel.

[4] A Safety Board metallurgist, along with the MCI director of engineering, inspected the motorcoach roof at the Safety Board's materials laboratory on October 19–20, 2004.

Figure 3. Roof of motorcoach, postaccident.

Although the Inter-Industry Conference on Auto Collision Repair and the National Institute for Automotive Service Excellence have uniform procedures for automobile and light truck roof repair, there are no set standards for buses. Likewise, bus manufacturers and bus repair facilities have no set standards or best practices for repairing motorcoaches. MCI said that this type of repair is not what it would have recommended, though it has no written repair procedures.

There are no roof crush or rollover standards for motorcoaches; however, the Safety Board has recommended that the National Highway Traffic Safety Administration develop performance standards for motorcoach roof strength (Safety Recommendation H-99-50) and then require newly manufactured motorcoaches to meet the standards (Safety Recommendation H-99-51). Both of these recommendations are classified “Open—Acceptable Response.”

Highway

The accident occurred in the southbound lanes of I-55, which is a divided four-lane paved asphalt controlled access highway. The two southbound lanes measured 24 feet across and were constructed with paved shoulders. The left shoulder was 4 feet wide, and the right shoulder was 10 feet wide. The traffic lanes had a 2 percent cross slope, and the shoulders incorporated a cross slope of about 4 percent. The northbound lanes were similarly configured and were separated from the southbound lanes by a 40-foot depressed earthen median.[5] Except

[5] The width of the center median, including both shoulders, was determined by measuring the distance between the yellow edge lines of the left shoulders, northbound and southbound.

for a 1-degree right-hand curve, the southbound approach to the accident location consisted of a tangent section of comparatively flat roadway.

The traffic lanes were divided by 4-inch-wide diamond-patterned retroreflective thermoplastic white lines approximately 10 feet in length and spaced 30 feet apart. The left lane was separated from the shoulder by a 4-inch-wide profiled[6] yellow edge line, while the right lane was separated from the shoulder by a combination of a 4-inch-wide profiled and a 7-inch-wide smooth white edge line. Sixteen-inch-wide milled rumble strips were installed on the left and right shoulders about 5 inches from the edge line. In addition to the thermoplastic lane markings, lanes were further delineated by retroreflectorized pavement markers spaced about 81 feet apart. These markers were also incorporated at the gore areas between the traffic lane and exit ramps, where they were spaced every 10 feet and placed adjacent to the edge lines of both the main travel lane and the exit ramp.

Semirigid roadside barriers were used along the southbound approach to shield errant traffic from bridge structures and other fixtures adjacent to the roadway. The center median did not include the use of a barrier, nor was one warranted by guidelines of the American Association of State Highway and Transportation Officials. However, in addition to the roadside barriers, a nondirective crash cushion system—consisting of sand-filled plastic modules—was positioned in the center median to shield the bridge columns.

The exit 23A interchange, the scene of the accident, is a four-leg partial cloverleaf, incorporating two looped ramps in diagonally opposite quadrants. (See figure 4.) Entrance and exit maneuvers are restricted to the right side of I-55. Southbound motorists approaching the interchange encounter a diagonal exit ramp before the crossroad’s overpass. A looped exit ramp is located on the other side of the overpass, and a diagonal entrance ramp is located beyond the first two exit ramps.

[6] The thermoplastic material was embossed with a continuous series of perpendicular ribs. This material was first used by the Arkansas State Highway and Transportation Department in 1994 on an all-weather pavement marking demonstration project. It has been used regularly by the State since 1997 as a means of increasing edge line retroreflectivity on wet pavement during nighttime hours.

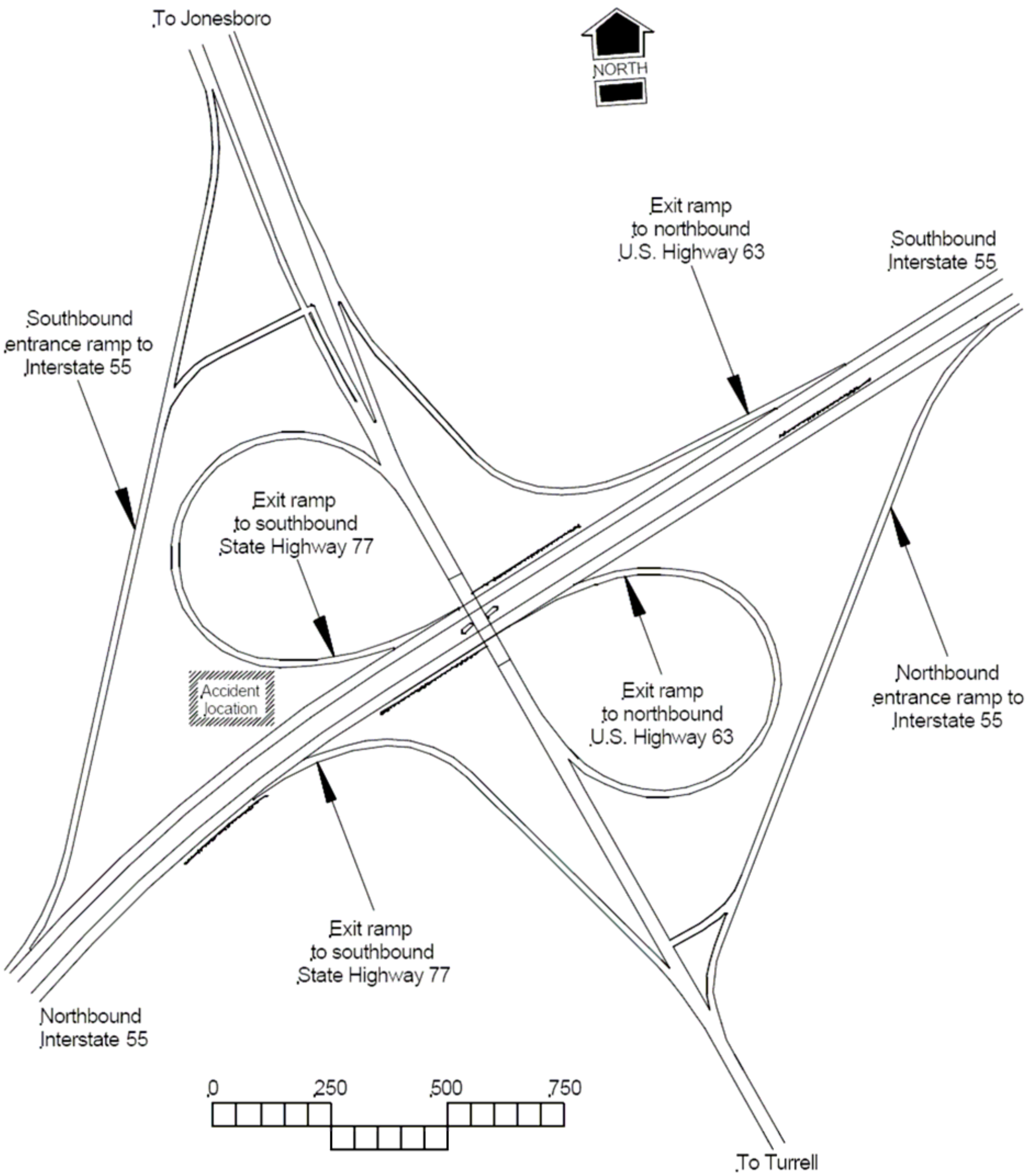

Figure 4. Layout of I-55 accident interchange.

Physical Evidence

Four tire marks about 71 feet long were located along the southbound shoulder adjacent to the right traffic lane. These marks ended at the edge of the pavement, where furrow marks continued for a distance of 55 feet to the exit 23A sign. Contact damage was observed along the right edge of the exit sign panel, 9 feet above the ground. (See figure 5.) Another tire mark—beginning about 41 feet south of the origin of the four tire marks—was observed along the left side of the exit ramp.

Figure 5. Gore area with furrow marks.

The furrow marks continued for an additional 97 feet until they went across a pair of posts supporting a right arrow sign. The accident motorcoach had overrun the sign, bent the posts forward until they became detached, and then traversed a drainage ditch, leaving a 6- by 8-foot scar. A debris field extended across both sides of the drainage ditch. The motorcoach came to rest about 65 feet south of the ditch. (See figure 6.)

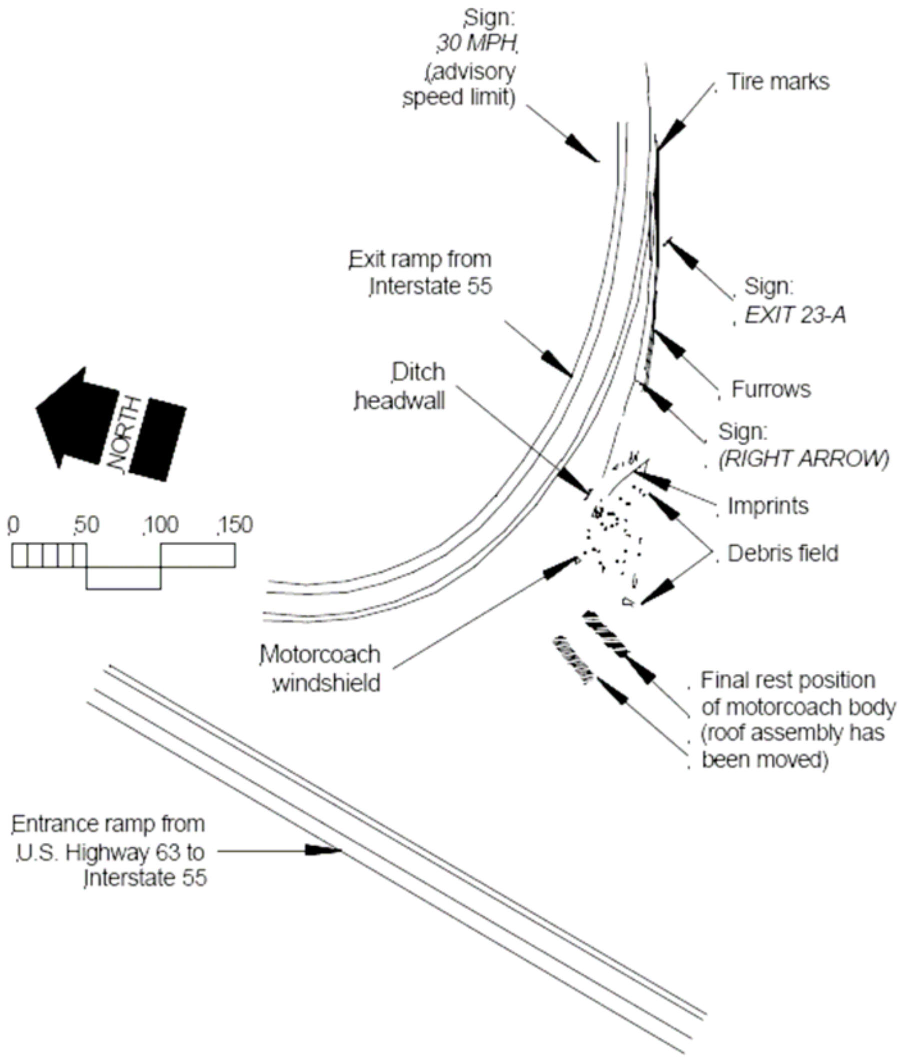

Figure 6. Accident scene diagram.

Accident Reconstruction

The precrash lane position of the motorcoach was unknown because no pavement evidence was found on the main travel lanes of the interstate, and the passengers were asleep prior to the accident event. However, analysis of the vehicle's approach based on the tire marks and furrow marks suggests that, prior to leaving the roadway, the motorcoach had been traveling in the left southbound lane. Possible interaction with the rumble strips was also considered when determining the precrash lane position. Evidence indicated that the motorcoach traveled in a curved path and, based on the degree of curvature, the vehicle would have just come into contact with the rumble strips and then started a directional change to the right. The motorcoach departed the road at an 11-degree angle. As the vehicle continued forward and over the right arrow sign, it began to roll longitudinally onto its left side. At final rest, the motorcoach had rotated about 540 degrees, or about one and one-half times over.

Motor Carrier

Walters Bus Service, Inc. (Walters), was an interstate "for-hire" carrier of passengers. Walters operated one motorcoach and had one driver. Annual mileage reported for 2002 was 30,000 miles. The company operated passenger charter tours throughout the continental United States as well as shuttle service for events in the Chicago and Detroit areas. At the time of the accident, Walters had had no reported driver or vehicle inspections or reportable accidents in the 30 previous months for which data were available.

Walters was rated "satisfactory" on October 15, 1987, following its only Federal Motor Carrier Safety Administration compliance review in 19 years of operation. A postaccident compliance review resulted in an unsatisfactory rating. Walters was found to be noncompliant with requirements for drug/alcohol random testing, driver qualification files, driver logs, maintenance and inspection programs, and periodic inspection of commercial motor vehicles. Walters lost its only commercial vehicle in this accident and elected to cease operation by accepting the unsatisfactory safety rating.

Driver Information

The 67-year-old motorcoach driver possessed an Illinois class B commercial driver's license (CDL) with a P endorsement for passenger-carrying vehicles and an F restriction, which required the use of a left outside mirror.[7] The CDL was issued on August 8, 2001, and expired on September 14, 2005. According to the driver's wife, he had over 30 years of experience driving school buses, motorcoaches, a flat-bed truck, and a dump truck. The accident driver had no recorded accidents or traffic violations. Toxicological tests were negative for the presence of illicit drugs and alcohol.

The driver had a valid medical certificate. Medical records and reports from his wife indicate that he had undergone surgery for glaucoma in June 2004; had seen the ophthalmologist regularly; and, as indicated by records, was progressing well, without complications. He had a history of asthma, which was triggered by cigarette smoke and diesel fumes; he took two prescription medications and carried an inhaler to avoid acute flare-ups. His wife said he had not had an acute attack in nearly 6 years. The driver was also taking medication for high cholesterol, and his wife said he had not experienced any side effects.

The accident driver's log for this trip was limited to entries for October 8, 2004. There were no logbook entries for October 9, but his activities were reconstructed based on distance traveled and witness interviews. Figure 7 outlines the truck driver's activities for October 7–9, 2004.

[7] This restriction is normally issued to persons who have limited mobility to turn, hearing deficiencies, or sight-related impediments such as restricted peripheral vision. The motorcoach was equipped with external mirrors as required by the license restriction, which would have helped to mitigate existing limitations in the driver's horizontal visual field.

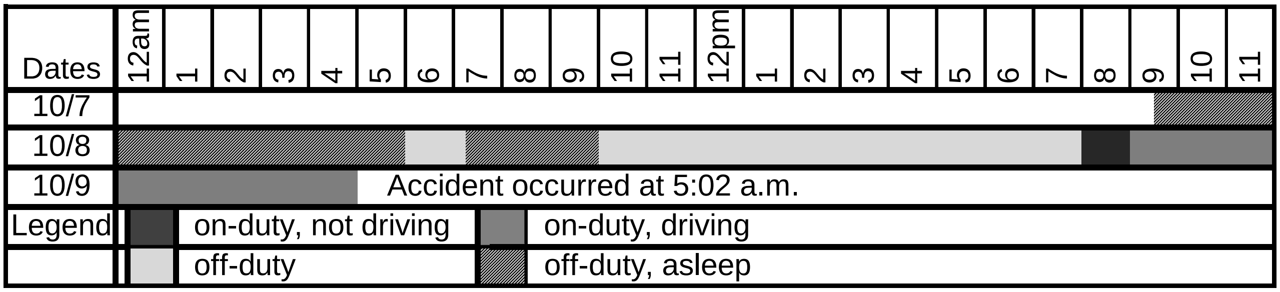

Figure 7. Duty status for motorcoach driver, October 7–9, 2004.

The driver's wife provided additional information on her husband's activities. He typically drove her to work about 6:15 a.m. and went to bed about 10:00–10:30 p.m. On October 7, he went to bed about 9:30 p.m.; the following morning he drove his wife to work as usual. She thought he returned home and slept until 10:00 a.m. At 2:00 p.m., she came home and they left to run errands, returning home about 4:30 p.m. After dinner, the driver rested in his recliner with his eyes closed until 6:00 p.m. They left the house about 6:50 p.m. to pick up the bus at the garage.

Surviving passengers said they were still boarding the bus at 8:45 p.m. and departed Chicago at 9:00 p.m. The driver had made two stops for restroom breaks; typically, he stopped at Effingham, Illinois, and then every 3 or 4 hours thereafter. None of the passengers could recall the time or location of the second stop. The driver's wife said she spoke to him about 10:00 p.m.

The driver had been awake for nearly 19 hours at the time of the accident. He had been on duty for 9 hours, of which the last 8 hours were spent driving. He had made two brief stops, the first one about 3 hours into the trip. The accident occurred on October 9 about 5:02 a.m., a time at which he usually was not driving but asleep—and a time of maximal sleepiness. Although the driver had obtained a full night's sleep on October 7 and had taken a nap during the day, the scheduling of the trip deprived him of his customary nighttime sleep period. He normally went to bed between 10:00–10:30 p.m., but on October 8 he left Chicago at 9:00 p.m. for an estimated 10-hour trip.

Research has revealed an association between time on task and increased risk of crash involvement.[8] A North Carolina study showed that drivers in sleep-related crashes had been driving for longer periods of time compared to those who were in nonsleep-related crashes. Driving between midnight and 6:00 a.m. and driving after being awake for more than 15 hours significantly increased a driver's risk of being involved in a sleep-related motor vehicle accident.[9] The accident driver took two restroom breaks, but it is unlikely that they provided

[8] (a) W. Harris, R. Mackie, and others, *A Study of Relationships Among Fatigue, Hours of Service, and Safety Operations of Truck and Bus Drivers*, Report No. BMCS-RD-71-2 (Washington, DC: U.S. Department of Transportation, 1972). (b) I. S. Jones and H. S. Stein, *Effect of Driver Hours of Service on Tractor-Trailer Crash Involvement* (Washington, DC: Insurance Institute for Highway Safety, 1987).

[9] J. C. Stutts, J. W. Wilkins, J. S. Osberg, and B. V. Vaughn, "Driver Risk Factors for Sleep-Related Crashes," *Accident Analysis and Prevention* Vol. 35 (2003): 321–331.

much benefit from fatigue. Research has shown that such breaks provide only a short-term benefit for drivers who are already tired.[10]

The accident occurred about 5:02 a.m. Studies have shown that crashes caused by drivers falling asleep at the wheel are far more likely to occur at night. For example, an analysis of interstate truck crashes found that about twice as many occurred between midnight–8:00 a.m. as compared to other times, and about half of all single-vehicle crashes occurred in the early morning hours.[11] Research has shown that maximal sleepiness occurs between 3:00–5:00 a.m., with a lower peak in sleepiness between 3:00–5:00 p.m. Drivers working through the night are awake at a time when their body is programmed to sleep.[12]

Based on reconstructed vehicle dynamics, the motorcoach made a directional change to the right, most likely after contacting the milled rumble strips adjacent to the left pavement edge lane. Rumble strips are designed to provide tactile or auditory alerts for the driver. In most situations, rumble strips are effective in reducing the number and severity of run-off-the-road accidents.[13] However, in this case, the vibration and noise made by the tires on the rumble strips may have startled the driver, causing him to steer abruptly and excessively (as evidenced by the vehicle's path) and sending the motorcoach off the right side of the road, which likely initiated the rotation of the vehicle.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the motorcoach driver's fatigued condition, which led him to drift from the left side of the roadway, contact rumble strips, oversteer to the right, and then move off the roadway. The detachment of the motorcoach roof was a contributing cause to the severity of injuries and the number of ejections.

Adopted: August 22, 2008

[10] N. Haworth, "The Role of Fatigue in Setting Driving Hour Regulations," *Fatigue and Driving: Driver Impairment, Driver Fatigue, and Driving Simulation*, ed., L. Hartley (Bristol, PA: Taylor & Francis, 1995).

[11] W. Harris, "Fatigue, Circadian Rhythm, and Traffic Accidents," *Vigilance Theory, Operational Performance, and Physiological Correlates*, ed., R. R. Mackie (New York: Plenum, 1977) 133–146.

[12] T. Roth, T. A. Roehrs, M. A. Carskadon, and W. C. Dement, "Daytime Sleepiness and Alertness," *Principles and Practice of Sleep Medicine*, eds., M. H. Kryger, T. Roth, and W. C. Dement (Philadelphia, PA: Sanders, 1994).

[13] (a) J. J. Hickey, "Shoulder Rumble Strip Effectiveness: Drift-Off-Road Accident Reductions on the Pennsylvania Turnpike," *Transportation Research Record*, 1573 (Washington, DC: National Research Council/Transportation Research Board, 1997). (b) D. A. Morena, "Rumbling Towards Safety," *Public Roads* Vol. 67, No. 2 (2003). (c) R. R. Marvin and D. J. Clark, *An Evaluation of Shoulder Rumble Strips in Montana*, FHWA/MT-03-008/8157 (Washington, DC: Federal Highway Administration, 2003).