Motorcoach Roadway Departure and Overturn on Interstate 95 Near Doswell, Virginia May 31, 2011

Accident Report

NTSB/HAR-12/02
PB2012-916202

National Transportation Safety Board

NTSB/HAR-12/02
PB2012-916202
Notation 8333A
Adopted July 31, 2012

Highway Accident Report

Motorcoach Roadway Departure and Overturn on Interstate 95
Near Doswell, Virginia
May 31, 2011

National Transportation Safety Board

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2012. *Motorcoach Roadway Departure and Overturn on Interstate 95 Near Doswell, Virginia, May 31, 2011*. Highway Accident Report NTSB/HAR-12/02. Washington, D.C.

Abstract: On Tuesday, May 31, 2011, approximately 4:55 a.m. eastern daylight time, a 2000 Setra 59-passenger motorcoach operated by Sky Express, Inc., occupied by a driver and 58 passengers, was traveling north on Interstate 95 in the right lane of the three northbound lanes near Doswell, Virginia. The motorcoach drifted from the highway to the right, struck a cable barrier, rotated counterclockwise around its vertical axis, overturned to the right, and rolled onto its roof. As a result of the accident, 4 of the 58 passengers were killed, 14 received serious injuries, and 35 received minor injuries. The driver sustained minor injuries and refused medical treatment.

The accident investigation focused on the issues of driver fatigue, motorcoach deficiencies in roof strength and occupant protection, and the Federal Motor Carrier Safety Administration (FMCSA) failure to exercise adequate safety oversight of the accident motor carrier. As a result of the investigation, the National Transportation Safety Board makes three new recommendations to the FMCSA, reiterates previous recommendations to the FMCSA and the National Highway Traffic Safety Administration (NHTSA), reclassifies a previous recommendation to the FMCSA, and reiterates and reclassifies a previous recommendation to NHTSA.

Contents

Figures

Acronyms and Abbreviations

BASICs	Behavior Analysis and Safety Improvement Categories
BMI	body mass index
CDL	commercial driver's license
CFR	*Code of Federal Regulations*
CMV	commercial motor vehicle
CSA	Compliance, Safety, Accountability (Federal Motor Carrier Safety Administration program)
CVSA	Commercial Vehicle Safety Alliance
DDEC	Detroit Diesel Electronic Control module
DOT	U.S. Department of Transportation
ECE	United Nations Economic Commission for Europe
EDA	evasion detection algorithm
EMS	emergency medical services
FMCSA	Federal Motor Carrier Safety Administration
FMCSRs	*Federal Motor Carrier Safety Regulations*
FMVSSs	*Federal Motor Vehicle Safety Standards*
HOS	hours-of-service
I-95	Interstate 95
MADYMO	MAthematical DYnamic MOdeling software package
MCS-150	Motor Carrier Identification Report (FMCSA form)
NAFMP	North American Fatigue Management Program
NHTSA	National Highway Traffic Safety Administration
NPRM	notice of proposed rulemaking
NTSB	National Transportation Safety Board

psi	pounds per square inch
SafeStat	Safety Status Management System
VSP	Virginia State Police
USDOT number	U.S. Department of Transportation motor carrier number

Executive Summary

On Tuesday, May 31, 2011, approximately 4:55 a.m. eastern daylight time, a 2000 Setra 59-passenger motorcoach operated by Sky Express, Inc., occupied by a driver and 58 passengers, was traveling north on Interstate 95 in the right lane of the three northbound lanes near Doswell, Virginia. The motorcoach drifted from the highway to the right, struck a cable barrier, rotated counterclockwise around its vertical axis, overturned to the right, and rolled onto its roof. As a result of the accident, 4 of the 58 passengers were killed, 14 received serious injuries, and 35 received minor injuries.[1] The driver sustained minor injuries and refused medical treatment.

The National Transportation Safety Board (NTSB) determines that the probable cause of this accident was the failure of the motorcoach driver to maintain control of the vehicle due to his falling asleep while driving because of fatigue resulting from acute sleep loss, poor sleep quality, and circadian disruption and the failure of Sky Express, Inc., management to follow adequate safety practices and to exercise safety oversight of the driver. Contributing to the accident was the Federal Motor Carrier Safety Administration's lack of adequate oversight of Sky Express, Inc., which allowed the company to continue operations despite known safety issues. Contributing to the fatalities and the severity of the injuries was the lack of a comprehensive occupant protection system, including systems for providing passenger restraint and for ensuring sufficient roof strength.

The accident investigation focused on the following safety issues:

- **Driver fatigue.** The motorcoach drifted from the travel lanes because the driver fell asleep while driving. The motorcoach crossed the shoulder, passing over the rumble strip and onto an earthen area before striking the cable barrier. The driver awoke and steered to the left, back toward the travel lanes. Due to the driver's steering overcorrection and the cable barrier deflection, the motorcoach overturned and rolled onto its roof.

- **Motorcoach deficiencies in roof strength and occupant protection.** The accident resulted in four fatalities, all of whom were initially seated on the passenger side of the bus in the region of maximum roof deformation. These four people died as a result of crushing injuries, as the motorcoach rolled over and the roof collapsed. Injuries occurred during the rollover when passengers were thrown from their seats and the survivable space decreased due to the substantial roof crush. Passenger restraints were not available on this motorcoach. The NTSB is concerned about the lack of Federal standards for occupant protection and roof strength on motorcoaches.

- **Federal Motor Carrier Safety Administration (FMCSA) failure to exercise adequate safety oversight of the accident motor carrier.** In 2005, the interstate motor carrier operating this bus service sought operating authority from the

[1] The injury status of five passengers could not be determined due to insufficient information.

FMCSA.[2] The FMCSA passed the carrier in a new entrant safety assurance audit in early 2007, despite having identified deficiencies in the carrier's safety systems. During its 6 years in business as an interstate passenger carrier, the accident carrier was the subject of five FMCSA reviews of its compliance with safety regulations. According to the results of these reviews and additional information uncovered during the investigation, this carrier, Sky Express, Inc., repeatedly failed to fulfill the requirements of Federal safety regulations and did not ensure its drivers complied with safety requirements. Despite its recognizing Sky Express's safety deficiencies, the FMCSA did not remove the carrier's operating authority until the accident occurred.

Parties to the investigation were the FMCSA; the National Highway Traffic Safety Administration (NHTSA); the Virginia Department of Transportation; the Virginia State Police; and Setra North America, the motorcoach manufacturer.

As a result of the investigation, the NTSB makes three new recommendations to the FMCSA, reiterates previous recommendations to the FMCSA and NHTSA, reclassifies a previous recommendation to the FMCSA, and reiterates and reclassifies a previous recommendation to NHTSA.

[2] In 2005, the carrier's name was Lei Shi. It was subsequently changed to Sky Express, Inc.

1. Factual Information

1.1 Accident Narrative

1.1.1 Events Preceding the Accident

The accident motorcoach, operated by the motor carrier Sky Express, Inc., was traveling north from Greensboro, North Carolina, on the night of May 30, 2011, en route to the Chinatown neighborhood in the borough of Manhattan in the city of New York, New York, a trip of about 607 miles. The motorcoach was operated by a 37-year-old male driver and carried 58 passengers, including a child on an adult's lap. The accident motorcoach departed Greensboro at 10:30 p.m. eastern daylight time and had traveled approximately 278 miles at the time of the accident.[1] The driver's service log indicated three driving stops—in Raleigh, North Carolina; Durham, North Carolina; and Warfield, Virginia (to purchase fuel).

According to passenger reports, sometime after departing Durham, the driver made an unscheduled stop at a highway rest stop and left the vehicle without permitting the passengers to exit. The driver left the area where the vehicle was parked, and the passengers did not know where he was for about 30 to 45 minutes. The driver did not log this stop. When the driver returned to the motorcoach, they resumed the northbound trip. About 20 minutes later, the driver again stopped at a highway rest stop and left the vehicle for about 30 to 40 minutes. The driver did not log this stop. The driver next stopped the vehicle for fuel at the Davis Travel Center in Warfield, Virginia. Passengers were allowed to exit the vehicle at this stop. One passenger sent her supervisor in New York an e-mail stating she would probably be late for work, due to the tardiness of the motorcoach.[2] They stayed at the travel center for about 25 to 30 minutes and then continued north on Interstate 85 to Interstate 95 (I-95).

When interviewed, a number of passengers stated that the driver had purchased and consumed several energy drinks and cups of coffee during the trip. One passenger described the driver as leaning over the steering wheel with both arms wrapped around it, with his head "bobbing" up and down while driving. One passenger said she overheard the driver having a cell phone conversation during which he stated he was tired and did not have much turnaround time between trips.

1.1.2 Accident Sequence

Approximately 4:55 a.m. on May 31, the motorcoach was traveling in the right lane northbound on I-95 at a speed of 55 to 60 mph.[3] The road in the vicinity of the accident, approximately 25 miles north of Richmond, Virginia, was a six-lane divided interstate, with three

[1] Unless otherwise indicated, all times given are eastern daylight time.

[2] The National Transportation Safety Board (NTSB) obtained a copy of that e-mail, and it was time-dated as having been sent at 3:25 a.m. The fuel receipt for Davis Travel Center recorded the date of May 31 but did not record the time.

[3] This range was based on simulation and accident reconstruction calculations.

lanes northbound and three lanes southbound.[4] The motorcoach drifted from the highway to the right along a generally level section of road near the end of a 1.2-degree horizontal curve to the left.[5]

The motorcoach drifted from the right-hand travel lane at an angle of about 6 degrees.[6] After crossing the 12-foot-wide shoulder adjacent to the travel lane, the motorcoach entered an earthen area. The slope of the earthen area was approximately 1:7, or about 14 percent.[7] The motorcoach then struck a low-tension, three-cable longitudinal barrier beyond the paved shoulder. Between initial lane departure and barrier impact, the motorcoach traveled 126 feet. The motorcoach struck the cable barrier at a shallow impact angle and traveled along the barrier for 147 feet. Scrape marks began at the front of the bus and ran along its passenger side.[8]

The motorcoach's impact with the low-tension cable barrier system caused a 6-foot cable deflection and displaced 21 cable posts. The maximum cable deflection occurred 273 feet from the location at which the motorcoach drifted from the road. Based on the ground scar evidence, investigators believe that, after striking the barrier, the motorcoach traveled several feet along the barrier while rotating counterclockwise (so its front was turning back toward the road) before overturning onto its passenger side, sliding, overturning onto its roof, and coming to final rest on its roof about 460 feet from where it left the roadway. (See figures 1, 2, and 3.)

Weather conditions at the time of the accident were as follows: calm winds, visibility of 4 miles, mist, clear sky at or below 12,000 feet, and temperature of about 70° F.[9] The roadway held no standing water. The accident took place in predawn darkness; sunrise was due to occur at 5:50 a.m. On-scene investigators found that the road signs, reflective pavement line for the shoulder, and reflective dashed white line dividing the right and center lanes would have been clearly visible.

Following the accident, while being interviewed by the Virginia State Police (VSP), the driver stated that he had been tired and had fallen asleep while driving. He also stated that when he awoke, he steered the vehicle hard to the left, and it rolled over. The driver made similar statements when interviewed by a representative of the Federal Motor Carrier Safety Administration (FMCSA). One passenger told investigators that, after the accident, she overheard the driver say he was sorry, and he had fallen asleep.

[4] The accident occurred at mile marker 103.5.

[5] The curve extended for about 2,900 feet.

[6] Several passengers stated that the bus had swerved or drifted in and out of its lane during the period before the accident.

[7] A 1:7 slope means that for every 7 feet of horizontal distance, the elevation drops 1 foot.

[8] The passenger side of the motorcoach is the right-hand side, assuming the viewer is in the interior of the bus and facing the windshield; the driver side is the left-hand side under the same circumstances.

[9] These conditions are based on observations made at 4:54 a.m. at the Hanover County Municipal Airport, located about 13 miles south-southeast of the accident site.

Figure 1. View facing the passenger side of the overturned motorcoach at the accident scene. The front of the bus is to the left side of the photograph. (Photograph courtesy of the Federal Motor Carrier Safety Administration.)

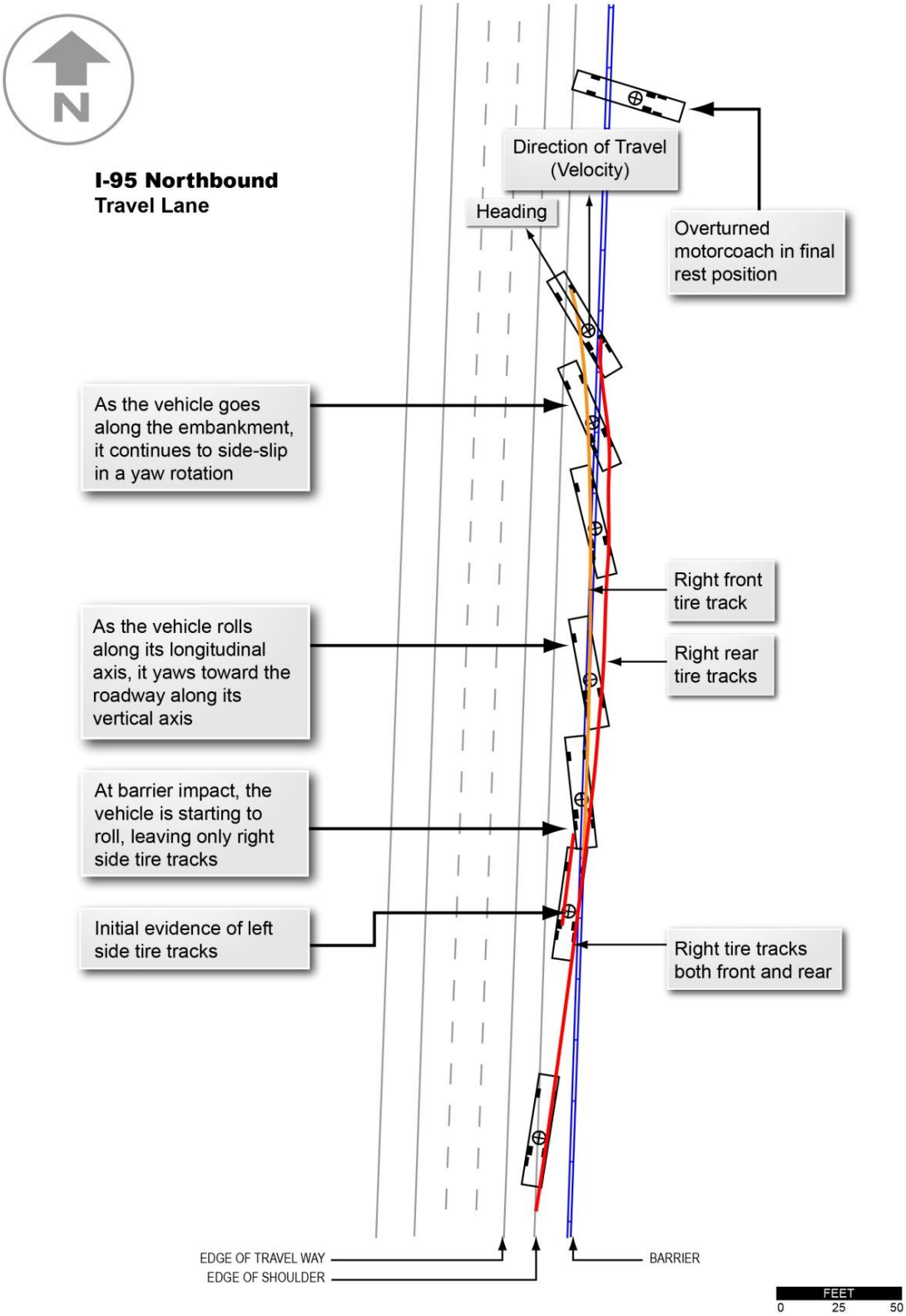

Figure 2. Accident scene diagram.

Figure 3. Map showing the motorcoach's travel area and the accident location.

1.2 Injuries

There were 58 passengers and 1 driver on the motorcoach. The driver, who appears to have used his lap-only seat belt, received minor injuries and refused treatment.

On-scene police records of passengers were incomplete with regard to contact information, gender, and age. Police records identified the names and injury status for 59 passengers. Through passenger interviews, NTSB investigators were able to identify two female passengers occupying two seats each and another passenger with a child on her lap.

Given the discrepancy between police records showing 59 names and passenger interview information establishing 58 passengers, it appeared that two names were associated with one passenger. By cross-checking police records with emergency medical services (EMS) and hospital medical records, and through passenger interviews, investigators determined relevant identifying information for all but five passengers.[10]

[10] The identification information for three male passengers could not be confirmed. These three male passengers occupied seat 7c (row 7, passenger side, aisle seat), seat 8a (row 8, driver side, window seat), and seat 8b (row 8, driver side, aisle seat).

As a result of the accident, 4 of the 58 motorcoach passengers died at the scene. Two of those passengers died of mechanical asphyxiation due to being trapped between the collapsed roof and the tops of seatbacks. The other two passengers died from blunt force trauma after being partially ejected out the passenger side of the motorcoach and becoming trapped between the ground and the collapsed sidewall of the motorcoach.

The types of serious injuries received by 14 passengers included spinal compression fractures, brain contusions, pelvic fractures, and extremity fractures. In addition, 35 passengers received minor injuries that included multiple abrasions, contusions, and lacerations. The injury status for 5 passengers is unknown, because hospital treatment records reflected only 53 of the 58 passengers.[11]

Table 1 summarizes the injuries by level of severity.

Table 1. Injury summary.

Injury Severity[a]	Motorcoach Driver	Passengers	Total
Fatal	0	4	4
Serious	0	14	14
Minor	1	35	36
Unknown	0	5	5
Total	1	58	59

[a]Title 49 *Code of Federal Regulations* (CFR) 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "any injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface."

Through passenger interviews, investigators determined that three passengers were fully ejected.[12] Two other passengers were found partially ejected; they were fatalities. All five of these passengers were seated in window seats on the passenger side of the motorcoach.

Figure 4 shows the seating locations of the motorcoach occupants, their level of injury, and their ejection status. Images of passengers who received fatal injuries are shaded, and those of passengers partially or fully ejected are indicated by callouts ending with "PE" or "E."

[11] The 4 fatalities documented by the medical examiner are included in the count of 53 passengers known from hospital records.

[12] Two of these passengers received serious injuries, and one received minor injuries.

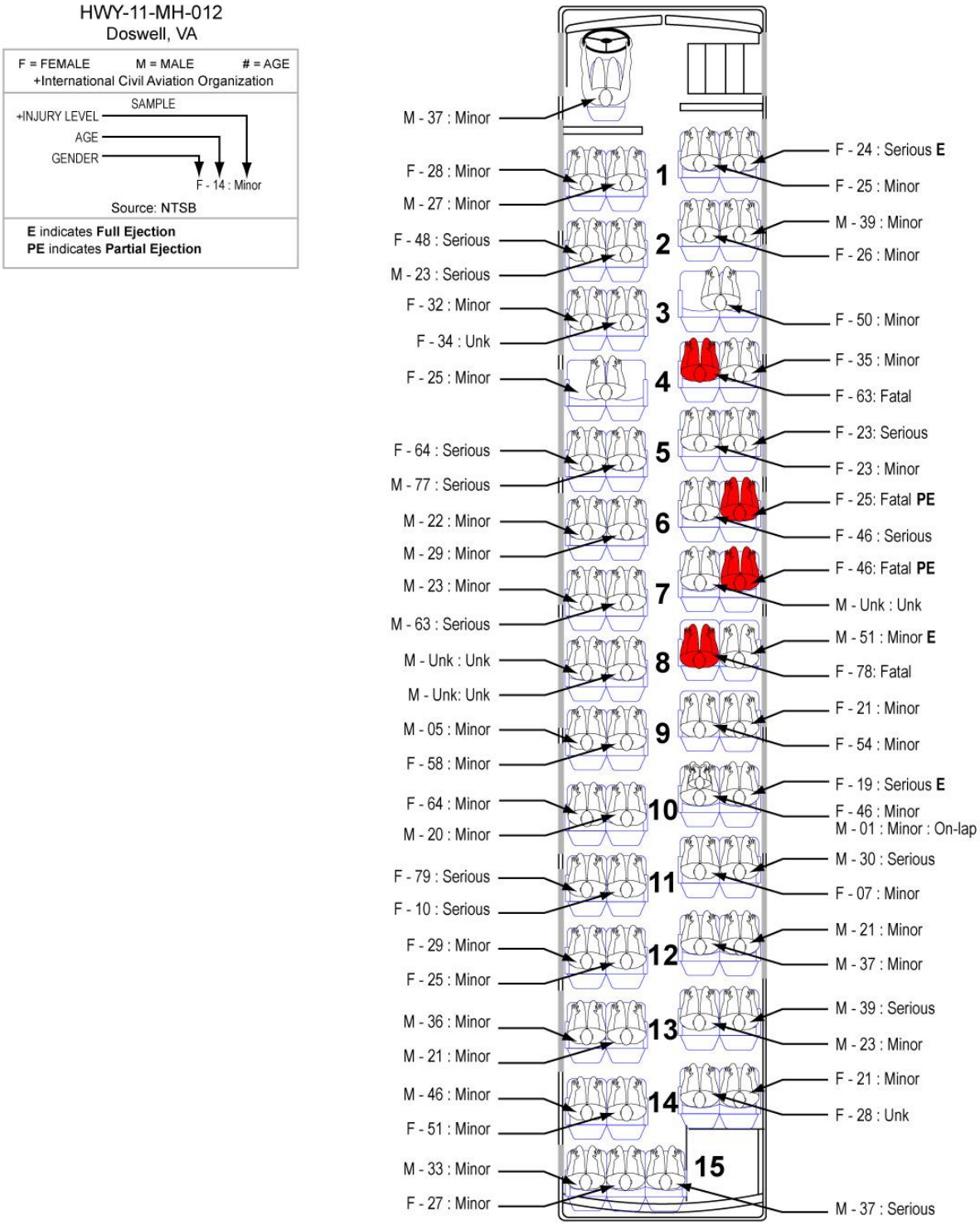

Figure 4. Motorcoach occupant diagram, showing seating location, injury, and ejection information.

1.3 Emergency Response

The accident occurred in Caroline County, Virginia. The VSP handled the initial investigation of the accident, and fire departments and EMS units were responsible for victim rescue, extrication, and transport. Eleven fire departments and more than two dozen ambulances, rescue squads, and medic units responded to the accident. Surviving passengers were transported to 10 area hospitals. Table 2 shows the response timeline.

Table 2. May 31, 2011, accident emergency response timeline.

Time (a.m.)	Action
4:55:09	Caroline County 911 system dispatcher notified of the accident
4:55:42	First call from the 911 dispatch to the VSP dispatch
4:57	VSP arrived on scene
4:58	Caroline County Fire Department notified
5:05	Hanover County Fire Department notified
5:11	Caroline County Fire Department EMS arrived on scene
5:12	Hanover County Fire Department battalion chief arrived with an ambulance unit and assumed incident command
5:16	I-95 northbound lanes closed
6:30	All seriously injured passengers transported from the accident scene
7:30	Last of the ambulatory passengers with minor injuries transported from the scene
11:57	I-95 lanes reopened to traffic

1.4 Survival Factors and Damage

1.4.1 Survival Factors

On the motorcoach, the driver's seat was equipped with a lap-only seat belt. On-scene evidence indicated the belt had been used. None of the passenger seats were equipped with any form of restraint system nor were they required to be so equipped.

Two passengers had to be extricated from the bus by fire department personnel. Another passenger stated she was initially trapped in the motorcoach, with her right arm stuck between two seats and under a seat, but she was able to extract her arm before the first responders arrived.

By the time the first responders arrived, the majority of passengers had already exited the motorcoach. According to passenger interview information, most passengers made their way out through the driver-side windows; a few exited via the passenger-side windows. Some evacuated through the broken windshield under their own power or were carried out by first responders. One passenger stated he and another passenger opened the emergency exit window on the driver side of the motorcoach and exited that way.

Responders located two deceased passengers trapped between the roof and the tops of seatbacks. Two other deceased passengers were found partially ejected out the passenger side of the bus. Postaccident photographs show evidence indicating that the sidewall structure at the base of the windows caused the fatal blunt force trauma to the head of one of these two passengers and to the head and chest of the other when the motorcoach roof shifted laterally and collapsed during the rollover.

The roof of the accident bus was deformed laterally toward the driver side of the vehicle and displaced vertically toward the tops of the seatbacks. In the center of the bus, in the area of maximum roof crush, the interior luggage rack and bus roof were resting on top of the seats. Due to the roof crush, the bottom panel of the overhead luggage rack on the passenger side fractured away from the roof mountings and rested on top of the seatbacks, angling from row 3 on the passenger side to row 10 on the driver side.

Inspection of the vehicle's interior revealed several points of occupant contact and some contact evidence, primarily to the underside of the luggage rack and roof on the passenger side. Considerable contact evidence was found on the luggage rack in the first row on the passenger side. Several of the seat armrests along the driver-side aisle were bent outward into the aisle. The metal tubular frames of the passenger-side seatbacks for seven rows (rows 3 through 7, row 8, and row 10) were fractured; the broken metal frames were poking through the seatback cushions and material. (Figures 5 and 6 show the extent of the interior damage to the motorcoach caused by the rollover.)

Figure 5. Passenger seats in rows 6 to 8 of the motorcoach after the vehicle was righted following the accident, showing the extent of the roof crush. (Note: The maximum roof crush, or roof deformation, was greater than seen here. It is common for a vehicle structure to "spring back" somewhat after an impact.)

Figure 6. Damage to the aisle seat in row 4 on the passenger side of the motorcoach, showing that the collapse of the roof was so forceful it broke the seat structure.

1.4.2 Motorcoach Damage

The accident bus was damaged over the extent of its front and passenger side; it also had significant roof deformation as a result of the rollover. The vehicle's initial impact with the three-strand cable barrier resulted in damage to the front end and passenger side. The direct contact damage extended from the vehicle's passenger-side front bumper corner to and along its passenger side. The approximate maximum crush to the bumper was 15.5 inches aft. Two deep parallel gouges, spaced 3 inches apart and measuring 129 inches long, were located on the passenger side of the bus, oriented at an angle of about 15 to 17 degrees counterclockwise from horizontal. Three external luggage bay compartment doors were detached from the passenger side of the bus. The boarding door located at the front passenger side of the bus retained only its bottom half; it also was only partially attached and hanging from the door frame. The rear and driver side of the bus had less damage, showing some body cracks and deformation induced from the damage to the side of the bus body. (See figure 7.)

Figure 7. Motorcoach postaccident, showing overall accident damage.

All windshield glazing, the upper boarding door glazing, and all passenger window glazing on the passenger side of the motorcoach were missing.[13] The glazing from three of the seven passenger windows on the driver side of the vehicle was also missing. The driver's side window glazing was intact, and the window was found partially open at the time of initial postaccident inspection. (See figures 8 and 9 for additional damage information.)

[13] Glazing is the clear part of a vehicle window, which may be made of tempered glass, laminated glass, polycarbonate, or other materials.

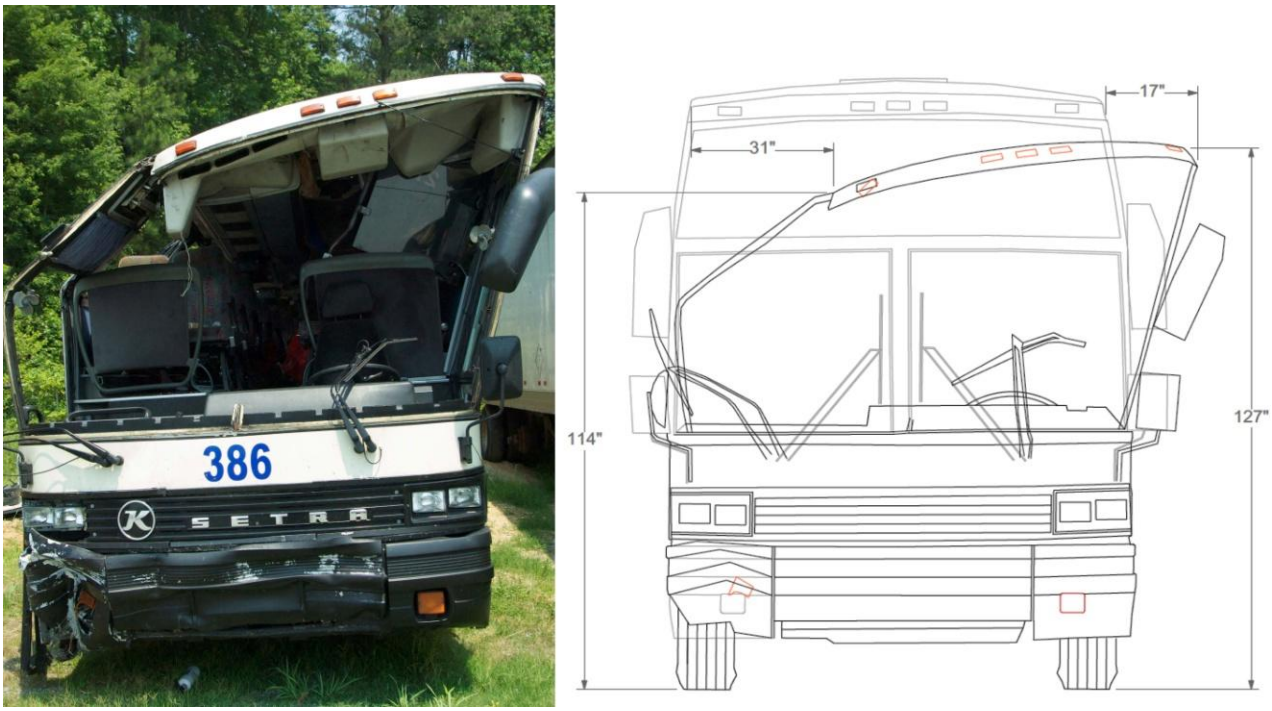

Figure 8. Side-by-side images of structural deformation of the accident motorcoach viewed from the front. (The photograph on the left shows the front view of the motorcoach postaccident. The drawing on the right shows the postaccident front profile of the accident motorcoach, superimposed over the profile of an undamaged exemplar motorcoach.)

Figure 9. Damage to the passenger side of the motorcoach.

The driver's seating area and controls remained intact and mostly undamaged. The driver's seat was intact and in place in the motorcoach.

When NTSB investigators examined the vehicle, they found a hole punched in both sides of the motorcoach, above and behind the front axle. They learned that, during postaccident recovery operations, responders had run a chain through the motorcoach to stabilize it so the deceased could be removed. The chain was also used to lift and right the motorcoach.

1.5 Driver Information

1.5.1 License, Fitness, Training, and Driving History

License. The 37-year-old driver held a New York class "B" commercial driver's license (CDL), which was issued in June 2010 and expired in May 2012.[14] The license had a passenger "P" endorsement with no restrictions.

Fitness. The driver's most recent commercial driver fitness examination had been conducted in May 2010 by a doctor in New York City. The driver was medically qualified for 2 years, and his medical certificate would expire in May 2012. According to records of the fitness examination, the driver stated he did not have any of the medical conditions listed on the exam form, and the examining physician indicated he observed no notable medical conditions. The driver's height was recorded at 66 inches and his weight at 160 pounds. His uncorrected Snellen distant visual acuity was recorded as 20/25 with the left, right, and both eyes.[15]

Following the accident, police arrested the driver, and the in-take process at the Pamunkey Regional Jail included a medical screening.[16] Records from that screening indicated the driver stated he did not take any medications, alcohol, or illicit drugs. The driver also stated he had not been hospitalized or treated by a physician in the past year.

Training. The driver had attended a commercial vehicle driving school in Brooklyn, New York.[17] His training consisted of 13 hours of one-on-one instruction, studying the *New York CDL Manual*, and listening to a Chinese/English audio compact disc describing how to conduct pre- and post-trip vehicle inspections.[18] He had about 2 hours of behind-the-wheel training driving a school bus. He took his written examination at a New York Department of Motor Vehicles office and his driving test in a 35-passenger school bus. He was issued his CDL permit

[14] The driver and his family declined to be interviewed by NTSB investigators, so the information concerning the driver is based on available records and statements made by the driver to entities other than the NTSB.

[15] Snellen fractions are measures of sight ability; the first number represents the test distance (20 feet), and the second number represents the distance that a person with perfect vision would see in comparison to the test performance. In this case, a person with perfect vision could see at 25 feet what the accident driver could see at 20 feet.

[16] The VSP charged the driver with involuntary manslaughter and reckless driving.

[17] This training school is under Federal investigation in New York for conspiracy to commit fraud concerning allegations that the school engaged in a long-term scam by which it illegally provided CDL applicants the answers to the state's written driving test.

[18] The driver had emigrated from Hong Kong in August 1995. He became a U.S. citizen on May 27, 2005.

on May 11, 2010, and his full CDL on June 21, 2010, upon passing the CDL testing requirements.

The driver applied for a position with Sky Express on July 1, 2010. His previous employment had been as a delivery driver for two restaurants in Virginia. He had no commercial motor vehicle (CMV) driving experience prior to 2010. As part of the hiring procedures, the driver was given a road test on July 1, 2010, in a Van Hool T2145 motorcoach. The test consisted of approximately 30 miles of driving and was conducted by the president of Sky Express.

Driving History. Table 3 below summarizes the known driving violation history for the accident driver.

Table 3. Accident driver's violation history.

Date	Violations
December 8, 1995	Failure to stop for stop sign
February 22, 1997	Right turn against red light
1999	Speeding
2000	Speeding
2004	Failure to obey traffic sign
February 7, 2004	Speeding
2006	Speeding
January 3, 2008	Speeding and nonuse of seat belt
August 5, 2008	Accident (following too closely), noninjury
March 31, 2011	Roadside inspection: violation of 10-hour driving rule (CMV violation)
April 4, 2011	Roadside inspection: false logbook entry and inoperative right turn signal (CMV violation)
May 31, 2011	Reckless driving, failure to maintain control, driver fell asleep, record of duty status not current (CMV violation in Doswell)

1.5.2 Toxicology

After the accident, the driver was transported to Air Park Medical and Occupational Health Services, Inc., in Ashland, Virginia, for postaccident testing. The alcohol test was administered as a breath test at 10:52 a.m.[19] and resulted in a reading of 0.0000.[20] A urine specimen collected at 10:37 a.m. was sent to the clinical laboratory and testing network LabCorp for analysis.[21] Toxicology analysis of the urine was negative for amphetamines, cocaine, opiates,

[19] According to 49 CFR 382.303(a), postaccident alcohol testing shall be done as soon as practicable following an occurrence and, according to 49 CFR 382.303(d)(1), if the alcohol test is not administered within 2 hours of the accident, the employer shall prepare and maintain a record stating why the test was not administered promptly. If the alcohol test is not administered within 8 hours of the accident, attempts to administer it shall cease.

[20] The test equipment was a Lifelock Technologies Phoenix 6.0 v 1.11a.

[21] Title 49 CFR 382.303(d)(2) requires the urine specimen to be collected within 32 hours of the accident.

6-acetyl morphine, cannabinoids, phencyclidine, and MDMA (the illegal drug commonly known as Ecstasy). At the request of the NTSB, a portion of the urine specimen was sent to the Civil Aerospace Medical Institute, which recorded negative results for all the tests it conducted.[22]

1.5.3 Driver's Work/Sleep/Wake History

The accident motorcoach driver's logbook showed he was off duty Saturday, May 28, 2011. On Sunday, May 29, he logged on duty at 8:45 p.m. for a pretrip inspection in the Chinatown neighborhood of New York City. At 9:00 p.m., the driver began a night trip from New York City to Durham, North Carolina, a distance of 531 miles, with an estimated travel time of 9 hours 52 minutes. His logbook recorded two 15-minute on-duty, not driving, stops; the first took place at midnight in Riverside, Maryland, and the second in Warfield, Virginia, at 3:45 a.m. (the Warfield stop was for fueling). The driver placed or received 36 cell phone calls while his duty status was recorded as "driving" between the departure from New York City at 9:00 p.m. on May 29 and his arrival in Durham at 5:45 a.m. on May 30.

According to the driver's postaccident statement to the FMCSA, once he was off duty on Monday morning, May 30, he took a company car to travel from Durham to Greensboro, North Carolina, a distance of approximately 55 miles, to sleep at a company apartment. His logbook indicates he was off duty from 5:45 a.m. until 10:15 p.m. on May 30. Postaccident, the driver told the VSP he awoke at 6:00 p.m. and began work about 10:00 p.m.

Cell phone records showed that after going off duty at 5:45 a.m., the driver continued to make and receive cell phone calls until approximately 6:45 a.m.[23] His cell phone was inactive for about 1 hour, until 7:57 a.m. After this call, his cellular activity ceased for approximately 2.5 hours, until he received an incoming call at 10:27 a.m. His last cell phone activity that morning was an incoming call at 11:29 a.m. The driver's cell phone records show that, in all, he made or received 12 calls on the morning of May 30. His next phone activity for May 30 began at 7:23 p.m., about 3 hours before he went on duty at 10:15 p.m.

The driver's logbook indicates that, following a pretrip inspection of the vehicle, his driving time began at 10:30 p.m. in Greensboro.[24] During the accident trip, the driver logged three 15-minute on-duty, not driving, stops. The log showed these stops as taking place from midnight to 12:15 a.m. in Raleigh, North Carolina; from 12:45 a.m. to 1:00 a.m. in Durham, North Carolina; and from 2:30 a.m. to 2:45 a.m. in Warfield, Virginia (this stop was indicated as for refueling). According to passenger reports, however, the logbook did not accurately reflect the stops that took place during the preaccident journey because it did not include the two additional stops at highway rest areas. (See section 1.1.1, "Events Preceding the Accident" for additional information.)

[22] The laboratory tested for alcohol and a number of drugs, including amphetamines, opiates, cannabinoids, cocaine and cocaine metabolites, phencyclidine, benzodiazepines, barbiturates, antidepressants, and antihistamines.

[23] Investigators requested cell phone tower location information for the driver's cellular activity; the service provider declined to provide tower information, citing 18 *United States Code* 2703(d).

[24] The driver picked up the motorcoach at a gas station approximately 0.10 mile from the company apartment in Greensboro.

The driver's cell phone records showed that, from 10:15 p.m. on May 30 until the time of the accident, he made or received 21 calls. Eighteen calls occurred that night during the timeframe when the logbook recorded his duty status as "driving," with the last call occurring at 3:46 a.m., about 1 hour 11 minutes before the accident. (See figure 10 for more information on the driver's work/sleep/wake history. The figure indicates calls made or received in any 15-minute interval.)

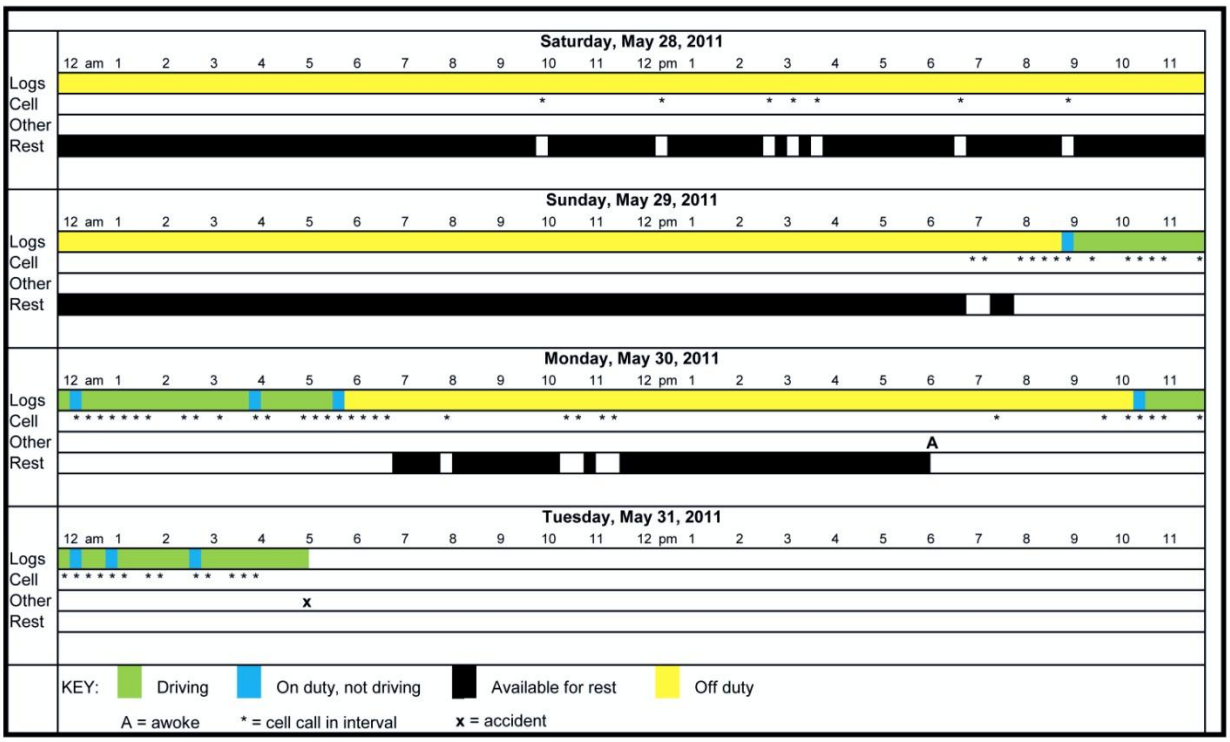

Figure 10. Motorcoach driver's work/sleep/wake history. (Note: Investigators were unable to interview the driver or his wife. Activities preceding the accident were generated using the driver's logbook, his statements to FMCSA investigators and the VSP, and his cellular provider's records.)

1.6 Vehicle Information

The vehicle involved in the accident was a 2000 Setra S-217-HDH 59-passenger motorcoach. The vehicle odometer reading postaccident was 687,362 miles. The engine was a Detroit Diesel Series 60, serial number 06RE117380. The motorcoach had received and passed its most recent required annual inspection on April 11, 2011, at the Carolina Auto Truck and Coach Service, Inc., in Charlotte, North Carolina.

1.6.1 Recording Equipment

The motorcoach engine was equipped with a Detroit Diesel Electronic Control (DDEC) module, series IV, which, postaccident, was in good condition in the engine compartment. Trip report, calibration, and audit trail data were downloaded using Detroit Diesel's Diagnostic Link

software. When examined, the DDEC was found to contain no information associated with the accident trip.[25]

The vehicle was also equipped with a tachograph; however, the system had not been maintained, and it provided no useful accident-related data.[26]

Investigators found no cameras or other video recording system components during the examination of the accident bus.

1.6.2 Steering System

The steering wheel was concentric and not deformed. No damage was noted to any steering system components. All connections were solid and free of wear or excessive play. The steering gear was shipped to the manufacturer's facility, where it was given hydraulic function and pressure tests. The sector shaft turned smoothly from stop to stop, and there were no signs of leaking from the seals.

1.6.3 Braking System

The motorcoach was equipped with Lucas D-3 air disc brakes on the steer axle, and air-operated S-cam drum brakes on the drive and tag axles. In evaluating the brake system, investigators took pushrod stroke measurements for all the brakes. No audible leaks were noted during the measurement tests. The pushrod stroke measurement for the right steer axle was 1/4 inch over the adjustment limit for a type 20 long-stroke brake chamber. The pushrod stroke for the right drive axle was 1/8 inch over the adjustment limit for a type 24 brake chamber.[27]

Investigators examined and measured the brake system rotors and pads. The steer axle brake pads met the minimum thickness requirement per 49 CFR 393.47(d)(1). The steer axle disc brake rotors were found to be slightly heat-checked, but they had no visible grooves or ridges and were of adequate thickness.[28] The drive and tag axle brake shoes met the minimum thickness requirement for drum-type brakes per 49 CFR 393.47(d)(2).

With respect to the Bosch antilock brake system, investigators observed that all sensors were connected and in place on the steer and drive axles.

[25] The DDEC is not designed to serve as an event recorder; it is intended to control engine timing and fuel injection based on various engine and sensor inputs. The DDEC is capable of storing engine and sensor fault codes and data associated with hard brake or last stop events. In this case, past ignition system work to the vehicle changed the engine start mechanism from a vehicle key to a button start switch. The work resulted in a reset of the DDEC-recorded information when the power went off.

[26] The tachograph recording paper had not been changed, resulting in continual overwriting with each trip.

[27] None of the pushrod conditions constituted out-of-service violations.

[28] The manufacturer's operating manual stated that the minimum thickness is 1.378 inches; measurements for the two rotors were 1.734 and 1.732 inches.

1.6.4 Suspension

The conventional suspension system components on the steer axle were undamaged and functional. The drive and tag axle suspension included six air suspension springs, as well as four conventional shock absorbers. The six air suspension springs were located on both the driver and passenger sides of the bus, forward of the drive axle, between the drive and tag axles, and to the rear of the tag axle. At the time of the inspection, the forward air suspension spring on the driver side was found to be damaged and folded over. All three air suspension springs on the passenger side were detached from the top mounting. Investigators considered that the damage was most likely the result of the towing and recovery process. Inspection personnel from the VSP and the FMCSA, who inspected the bus at the accident scene, told NTSB investigators that the system had no obvious air leaks at the time of their inspection, and the bus was maintaining a pressure level of approximately 105 pounds per square inch (psi).[29]

1.6.5 Tires

The bus was equipped with 315/80R22.5 tires mounted on 22.5- by 8.25-inch rims for all axles, in accordance with manufacturer specifications. All the tires remained inflated following the accident. The pressure in both steer axle tires measured 95 psi; the pressure in the drive axle tires measured 100 psi, 99 psi, 83 psi, and 82 psi; and the pressure in both tag axle tires measured 106 psi.[30] The tires did not fail or become separated from the rims as a result of the accident.

Tread depth was measured for each tire; all had tread depths greater than required. Rims were inspected for cracks, welds, and elongated lug nut holes; none were found.

[29] Damaged and detached air suspension springs would have indicated a loss of system pressure.

[30] To provide enough weight capacity to satisfy the gross axle weight ratings, the tires on the accident bus should have been inflated to 115 psi for the steering axle tires, 90 psi for the drive axle tires, and 85 psi for the tag axle tires. The Commercial Vehicle Safety Alliance (CVSA) is an international organization made up of motor carrier safety officials at local, state, and Federal levels, as well as trucking industry representatives in Canada, Mexico, and the United States. CVSA guidelines call for tire pressure to be checked when tires are visibly low; these tires were not visibly low.

1.6.6 Maintenance

Sky Express provided the maintenance records for the accident bus. The records included the last two annual vehicle inspection reports, a Motor Coach Inspection Report form documenting inspection of the motorcoach emergency exits, and maintenance records dating back approximately 13 months prior to the accident. The vehicle passed the annual inspections performed on April 23, 2010, and April 11, 2011. The Motor Coach Inspection Report indicated the pushout windows, emergency doors, and emergency door marking lights were all "OK" when last inspected on April 29, 2011.

1.7 Highway Information

I-95 in the area of the accident is a six-lane highway, with three lanes in each direction separated by a wooded, depressed earthen median. Rumble strips are located on the shoulders on both sides of the travel lanes. The annual average daily traffic for I-95 along the 6-mile segment nearest the accident site was 91,000 vehicles in 2009. The annual average daily traffic for the northbound direction was 48,000 vehicles. Trucks and motorcoaches accounted for approximately 13 percent of the traffic on this part of I-95. The design speed and the posted speed limit designation for I-95 is 70 mph; recorded traffic data indicated that, for vehicles greater than 45 feet in length, the 85th percentile speed was 72 mph, and the average running speed was 66 mph.

Tire marks at the accident scene indicated the motorcoach drifted from the right shoulder at an angle of about 6 degrees. The maximum engagement with the low-tension, three-strand cable barrier system occurred 147 feet after the initial impact and 273 feet after the motorcoach left the road.[31] The barrier was located approximately 14.5 feet from the edge of the paved shoulder and 26.5 feet from the travel lane; it extended over a lateral distance of 806 feet. (See figure 11.) The motorcoach initially struck the 10th post from the south end of the installation and overran 21 posts. Evidence of tire furrows in the earthen roadside embankment began 20.5 feet from the pavement. The wire cables remained intact.

[31] The cables were installed on 30-inch-tall posts that were nominally spaced 15.5 to 16.0 feet apart.

Figure 11. Three-strand cable barrier near accident site.

1.8 Motor Carrier Information

1.8.1 Sky Express, Inc.

Background. Beginning in 2002, two of the owners of Sky Express operated a company called Wah Hun, which operated four 15-passenger vans and provided a shuttle service from Durham, North Carolina, to the pickup location for Horse Run Tours (also known as H&W Tours) at exit 175 on Interstate 85. Horse Run Tours operated a line run from North Carolina to New York, and its fleet consisted of the four Wah Hun 15-passenger vans and three of its own buses. The two companies merged in 2004, using the company name Lei Shi.

The company operation was headquartered in New York City; however, it had no central terminal or office location. The Charlotte, North Carolina, address that appeared on the compliance review paperwork and MCS-150 forms[32] was the home address of the secretary of the company.

[32] An MCS-150 is an FMCSA Motor Carrier Identification Report containing general company information. The form must be filed by all motor carriers operating in interstate or foreign commerce. A new motor carrier must file a form MCS-150 before beginning operations, and all motor carriers are required to file an updated form at least every 2 years.

In April 2005, the company applied for interstate operating authority from the U.S. Department of Transportation (DOT), and the FMCSA issued it a USDOT number and entered it into the new entrant safety assurance program.[33] All new entrant carriers are subject to an 18-month safety-monitoring period. Sometime before the new entrant completes 18 months of operation, the FMCSA is to conduct a safety audit of the carrier and evaluate its accident and roadside inspection data. According to the FMCSA, the safety audit should cover the following areas: driver qualifications, driver duty status, vehicle maintenance, accident register, and controlled substance and alcohol use testing requirements. If the FMCSA identifies deficiencies, the carrier must provide evidence that it is correcting the faults found during the audit.

In February 2007 (about 22 months after applying for operating authority), after the firm had not responded to repeated FMCSA requests to schedule a safety audit, the FMCSA informed new entrant Lei Shi by letter that its authority would be revoked if it did not respond and schedule a safety audit. The company responded, and the FMCSA conducted a safety audit on February 27, 2007. The company passed the audit, although the FMCSA documented three areas needing improvement: driver qualification files, driving/employment histories, and vehicle maintenance files. At this time, the carrier had six drivers.

In 2009, the motor carrier, now named Sky Express,[34] began providing roundtrip service from New York City to two casinos—the Foxwoods Resort Casino in Mashantucket, Connecticut, and the Sands Casino Resort in Bethlehem, Pennsylvania. Sky Express conducted 11 roundtrips per day for Foxwoods and 7 roundtrips per day for the Sands. By 2010, Sky Express had added more routes (two roundtrips per day between Virginia Beach, Virginia, and Washington, D.C.; and eight roundtrips per day between New York City and southern cities). Sky Express purchased more motorcoaches to cover the new routes and hired additional drivers. During its April 2011 compliance review, Sky Express indicated that it operated 31 motorcoaches, two 15-passenger vans, and one 33-passenger minibus and that it employed 53 drivers.

Sky Express used a variety of ticketing mechanisms, depending on the routes of travel. Transportation arrangements between the Sands Casino Resort and Sky Express were handled by the broker Full House, located in Brooklyn, New York. For the arrangement between Foxwoods Resort Casino and Sky Express, Foxwoods contracted with Tiffany Entertainment in New York City and Safeway Travel in Brooklyn to sell tickets and provide a tour guide to accompany customers on the trips. Tickets for the southern routes operated by Sky Express were sold at pickup locations by the bus drivers or as e-tickets over the Web, either through the Sky Express website[35] or online ticketing services, such as www.gotobus, www.taketours, and www.2001bus.

The motor carrier dispatched its drivers from New York City for the southbound routes and from Charlotte, North Carolina, for the northbound routes. The company switched drivers in

[33] All motor carrier new entrants must obtain a USDOT number. This number serves as the DOT's unique identifier for the carrier when collecting and monitoring its safety information acquired during audits, compliance reviews, accident investigations, and inspections.

[34] Sometime between 2007 and 2009, the carrier Lei Shi changed its name to Sky Express. The name change was identified during a May 2009 compliance review.

[35] The Sky Express website is no longer active.

and out along these routes, with designated stops to allow for change of drivers at Battleboro, Durham, and Greensboro, North Carolina; at Florence, South Carolina; and at each of the final destination stops. Drivers were housed in apartments or motels arranged and paid for by the company on long-term agreements.

Operating Practices. Sky Express had no written safety policies, including having no driver's handbook or drug and alcohol, seat belt, cell phone, discipline, or other safety publications, until it employed a safety consultant in April 2011 following a compliance review that resulted in a proposed unsatisfactory rating. The company conducted no in-service training and had no program for monitoring its regular drivers' on-road driving actions. In April 2011, after it had worked with the safety consultant, the company distributed two training/policy publications: "Drivers Hours of Service" and "Driver Safety and Operating Policies."

According to Sky Express, its only hiring criteria were that the applicant be over 21 years of age and have the appropriate class CDL, with a passenger endorsement. The company preferred Chinese-speaking drivers because the majority of its customers were Chinese-speaking. Drivers were expected to learn sufficient English to satisfy the FMCSA requirement for English proficiency as specified at 40 CFR 391.11(b)(2). The company president stated that when new drivers were hired, he monitored them for 3 weeks by periodically riding along in their buses to ensure they drove safely.

As required by Federal regulation, Sky Express required its drivers to pass a preemployment drug and alcohol screening before they started driving for the carrier. Before April 2011, the company was in a drug and alcohol pool covered by the National Testing Association, located in Mooresville, North Carolina. During an April 2011 compliance review, the reviewer noted that only four of Sky Express's drivers had been assigned to the random testing pool. In addition, the company was found to be in violation of most of the testing requirements at 49 CFR Part 382 "Controlled Substances and Alcohol Use and Testing." The safety consultant Sky Express employed following this compliance review removed the carrier from the National Testing Association and enrolled it with USA Testing in Tampa, Florida. All drivers were tested, and all tests were negative. No company officials were trained in "reasonable suspicion" drug and alcohol recognition per 49 CFR 382.603.[36]

Carrier Records on the Accident Driver. When the accident occurred, the driver had been employed with Sky Express for approximately 11 months (July 2010 to May 2011). The company could provide NTSB investigators with only limited driver's logbook pages for 3 months and portions of another 2 months; other logbook pages were not available.[37] Investigators examined these records for August 2010, December 2010, and February 2011, and for portions of April and May 2011.[38] The available records showed the driver had violated the

[36] Title 49 CFR Part 382 includes four categories for drug/alcohol testing: preemployment, random, postaccident, and reasonable suspicion.

[37] Title 49 CFR 395.8 requires drivers to maintain a record of their status, in duplicate, either by using an approved log grid or an automatic on-board recording device, and to keep the records current. Carriers are required to maintain records of duty status and all supporting documents for each driver they employ for a period of 6 months from the date of receipt.

[38] The driver's logs were missing for September, October, and November 2010; and for January, March, and portions of April and May 2011.

hours-of-service (HOS) rules at least 85 times, including the 10-hour, 15-hour, and 60-hour rules. The driver worked every day in August 2010, was assigned short trips, and had no HOS violations. In December 2010, the next documented period, the driver was assigned a longer route, and investigators identified 14 HOS violations. For February 2011, the logs showed 71 HOS violations. Partial records for April and May 2011 showed no HOS violations. The driver had the required 7 days of logs in his vehicle at the time of the accident.

Investigators examined the accident driver's payroll records. The driver received the same pay during every 2-week pay period even though he was logged off duty for differing amounts of time. During a postaccident interview with Sky Express, its management told investigators that drivers were paid by the trip; the longer the trip, the greater the pay. The company offered no explanation for the apparent discrepancy between the accident driver's pay records and the company's stated policy.

Sky Express indicated it required drivers to turn in their logbooks every 15 days.[39] The company had no process for reviewing logbooks for HOS compliance, nor did it systematically store the records, which were kept in cardboard boxes.

Vehicle Maintenance. At the time of the accident, the company's vehicle fleet consisted of 32 motorcoaches, as follows: 1 Freightliner (model year 2009), 4 Setra (model years 1999, 2000, and two 2009s), and 27 Van Hool (ranging from model year 2001 to 2010) motorcoaches.[40] All the vehicles were equipped with E-ZPass devices for automated toll deduction. None of the vehicles were equipped with an on-board camera, electronic on-board recorder, or global positioning system navigation device.

Sky Express vehicles were housed in a rented parking lot in Brooklyn and maintained at various repair shops in the New York City area. The carrier had no scheduled vehicle maintenance program. Vehicles were repaired when a defect was noted on a pre- or post-trip inspection report. The Daily Vehicle Inspection Reports were completed on the backs of the drivers' daily logbooks; the records were completed sporadically and often incorrectly. Sky Express had no formal procedures for reporting defects; drivers were to notify the company vice president by telephone when a defect was discovered. The vice president would then direct the driver to take the vehicle to a local repair facility or, if it were disabled during a trip, repair facility personnel would be sent to the vehicle.

1.8.2 FMCSA Oversight of Sky Express

Roadside Inspections. Certified vehicle inspectors and Motor Carrier Safety Assistance Program officers conduct roadside inspections of CMVs at weigh stations and roadside locations. They examine vehicles and drivers to ensure compliance with Federal regulations and state

[39] Title 49 CFR 395.8(i) requires drivers to submit their logbook pages to the motor carrier within 13 days of completing the form. The driver is also required to maintain a copy of the previous 7 days of the logbook pages for inspection by law enforcement.

[40] Six of the fleet motorcoaches were owned by the company and 26 were under finance arrangements.

statutes concerning driver qualifications and HOS, vehicle equipment, load securement, and other requirements. The CVSA has established levels for roadside inspections.[41]

During his employment with Sky Express, the accident driver had been subject to the following roadside inspections:

- March 31, 2011: level II inspection—Found to be in violation of the 10-hour driving rule (49 CFR 395.5[a][1])
- April 4, 2011 (at 6:28 a.m.): level III inspection—No violations noted
- April 4, 2011 (at 8:22 a.m.): level II inspection—Found to be in violation because of maintaining false logs (49 CFR 395.8[e]) and having an inoperative right turn signal (49 CFR 393.11)

As a result of the May 2011 accident, a level I roadside inspection was conducted on the accident driver and vehicle, resulting in the following violations:

- Reckless driving
- Records of duty status not current (49 CFR 395.8[f][1])
- Right steer brake chamber out of adjustment (49 CFR 393.47[e])
- Automatic brake adjustment failed to work properly (49 CFR 393.53[b])

Between June 27, 2010, and May 31, 2011, Sky Express vehicles were subject to 94 roadside inspections that resulted in a relatively high total of 204 violations. The violations fell into the following general categories:

- HOS or logbook: 48 violations
- Driver or driver license-related: 22 violations
- Equipment: 112 violations
- Other: 22 violations

Compliance Reviews. A compliance review is an on-site examination by the FMCSA (or designate) of a motor carrier's operation, which includes examination of the carrier's HOS practices, vehicle maintenance and inspection, driver qualifications, CDL requirements, financial responsibility, accidents, hazardous materials compliance, and other safety and transportation-related records. The purpose of the compliance review is to determine whether the motor carrier is operating in accordance with the *Federal Motor Carrier Safety Regulations* (FMCSRs) and to evaluate its safety culture.

[41] A level I inspection is a comprehensive look at the driver, the driver's paperwork, and the vehicle (including under-vehicle examination); a level II inspection reviews those same areas but looks less vigorously at the vehicle (no under-vehicle examination); a level III inspection focuses on driver credentials and paperwork; a level IV inspection is a focused, special inspection; a level V inspection is a vehicle-only review; a level VI inspection is for radiological shipments; and a level VII inspection is a jurisdictionally mandated inspection.

Sky Express received five compliance reviews between 2008 and the accident date. The first took place on May 6, 2008. The FMCSA conducted the review because of the carrier's poor safety evaluation area scores in the Safety Status Management System (SafeStat)—74 for driver and 58 for vehicle.[42] At that time, the carrier's fleet consisted of four motorcoaches, and its routes went into South Carolina, North Carolina, Virginia, Maryland, Pennsylvania, New Jersey, Delaware, and New York. As a result of the 2008 compliance review, the FMCSA found the carrier deficient in some of its record-keeping but rated it satisfactory overall.

The company's next compliance review was conducted on May 12, 2009. The reason for the review was again its poor SafeStat safety evaluation area scores—69 for accident, 74 for driver, 67 for vehicle, and 63 for safety management. During the compliance review, it was noted the carrier had changed its name from Lei Shi to Sky Express and had purchased an additional motorcoach (making a fleet total of five). The compliance review rated Sky Express unsatisfactory in factor 2, driver (Parts 382, 383, and 391), and factor 3, operational (Parts 392 and 395); it gave the carrier a conditional rating in factor 4, vehicle (Parts 393 and 396).[43] On May 18, 2009, the FMCSA gave the carrier notice of a proposed unsatisfactory overall rating and informed Sky Express it had 45 days to submit a plan to improve the deficient areas.[44] The motor carrier employed a safety consultant, who helped it to develop and submit a safety improvement plan that was ultimately accepted by the FMCSA. The FMCSA upgraded the overall rating for Sky Express to conditional on July 14, 2009, and required the carrier to pay a fine of $2,160.[45] Sky Express then terminated the safety consultant.

On April 12, 2010, the FMCSA conducted another compliance review of Sky Express because of the conditional rating the carrier had received in July 2009. In this review, the company was found conditional in factor 4, vehicle. Sky Express had one recordable accident in the 12 months prior to the compliance review. The FMCSA gave the carrier an overall rating of satisfactory.

Sky Express was subject to another compliance review on April 7, 2011, because of its poor Safety Measurement System scores under the FMCSA's new Compliance, Safety,

[42] In 2008, the FMCSA was using SafeStat for carrier oversight. SafeStat used available motor carrier safety data to measure the relative safety status of motor carriers in four safety evaluation areas—accident, driver, vehicle, and safety management. The safety evaluation area values ranged from 0 (best) to 100 (worst). For example, the driver safety evaluation area score of 74 in this case indicated that approximately 74 percent of carriers (with sufficient data) demonstrated better performance than Sky Express with respect to driver-related safety; put another way, Sky Express was in the lowest 26 percent of the industry in this safety area.

[43] Compliance review factors are the following: factor 1, general; factor 2, driver; factor 3, operational; factor 4, vehicle; factor 5, hazardous materials; and factor 6, accident rate.

[44] When a carrier receives a proposed or final rating determination of conditional or unsatisfactory from the FMCSA, it has an opportunity to appeal the rating via an administrative review process outlined in 49 CFR 385.15. The carrier may also submit a corrective action plan to the regional service center to indicate it is taking steps to correct those deficiencies found in the compliance review, as outlined in 49 CFR 385.17.

[45] Under 49 *United States Code* 13905(f)(1)(B) and 31144, and 49 CFR 385.13, a motor carrier that receives an unsatisfactory rating shall have its registration revoked. According to the FMCSA, it issued the carrier an out-of-service order on July 13, 2009, because the carrier had not by then provided an adequate safety improvement plan. The order was rescinded on July 14, 2009, when the FMCSA issued the conditional rating.

Accountability (CSA) program.[46] Thresholds for the Safety Measurement System values are determined through a mathematical formula that includes vehicle miles driven, number of vehicles/drivers in the fleet, and time. Violations are time-weighted, so older violations have less significance than more recent ones. The Sky Express scores exceeded the acceptable threshold level in the following four BASIC areas: unsafe driving, 62.9 percent (threshold 50 percent); fatigued driving, 86.2 percent (threshold 50 percent); driver fitness, 99.6 percent (threshold 65 percent); and crash indicator, 90.3 percent (threshold 65 percent).

In the April 2011 compliance review, the FMCSA found the company unsatisfactory in factor 2, driver, and factor 3, operational; it found the carrier conditional in factor 4, vehicle. The FMCSA issued Sky Express a proposed overall rating of unsatisfactory. On April 12, 2011, the FMCSA sent a letter to the carrier indicating the proposed unsatisfactory rating and inviting Sky Express to submit a corrective action plan within 45 days. The 45-day appeals period began on April 13 and was due to expire on May 28. To address the opportunity to submit a corrective action plan, the carrier employed a safety consultant on or about April 15. On April 22, the FMCSA notified the carrier of an enforcement case against it, with a $33,290 civil penalty.

On May 11, Sky Express notified the FMCSA that it had obtained the services of a safety consultant in April and submitted its corrective action plan. On May 12, the FMCSA responded that the proposed plan was insufficient and that it would conduct another compliance review sometime before June 7. On May 13, the FMCSA again notified the carrier of the 45-day period it had in which to show improvement, due to expire on May 28. However, in that same letter, the FMCSA indicated it would hold the final rating in abeyance and granted a 10-day extension to the corrective action period, making the expiration date June 7, 2011.[47]

On May 23, 2011, the FMCSA began another compliance review of Sky Express, during which the carrier submitted another safety improvement plan. The review was conducted on May 23 to 26, and its results were under review when the accident occurred on May 31. The FMCSA had no further contact with Sky Express until May 31, after the accident, when it notified the carrier that the 10-day extension was being rescinded and that it was prohibited from operating in interstate and intrastate commerce. On June 3, the FMCSA issued an order for Sky Express to "cease and desist" all operations, effective immediately. During June 13, 2011, testimony before the U.S. House of Representatives Committee on Transportation and Infrastructure, the FMCSA administrator stated, "We have revised our enforcement policies to eliminate 10-day extensions on out of service orders and are putting carriers out of service as

[46] In December 2010, the FMCSA replaced its SafeStat system with the Safety Measurement System within the CSA program. The Safety Measurement System is organized by six Behavior Analysis and Safety Improvement Categories (BASICs) plus a Crash Indicator. Each BASIC has a threshold percentage; if a motor carrier receives a score for that BASIC above the threshold, the FMCSA sends it a warning notice. Based on the data in each of the motor carrier's BASIC categories, the FMCSA may prioritize it for further monitoring.

[47] Title 49 CFR 385.17(f) states the following: "The filing of a request for change to a proposed or final safety rating under this section does not stay the 45-day period specified in §385.13(a)(1) for motor carriers transporting passengers or hazardous materials. If the motor carrier has submitted evidence that corrective actions have been taken pursuant to this section and the FMCSA cannot make a final determination within the 45-day period, the period before the proposed safety rating becomes final may be extended for up to 10 days at the discretion of the FMCSA."

quickly as our authority permits."[48] On June 7, 2012, the FMCSA administrator told an NTSB staff member that the FMCSA had revised its internal policy to formalize this decision.

On July 6, 2011, the FMCSA released the final results from the Sky Express compliance review that began on May 23. The FMCSA categorized the compliance review as "not rated."[49]

Overall, with respect to the violations identified in the course of the Sky Express compliance reviews, the carrier was cited for 63 violations of the FMCSRs. Of these 63 violations, 24 (38 percent) were classified as critical or acute. Of those 24 violations, 18 were considered in the carrier's compliance rating.

1.9 Accident Simulation

In this accident, the roof collapsed under the weight of the overturned motorcoach, causing intrusion into the passenger compartment near the center of the vehicle. A simulation was created (using TruckSim)[50] to develop the vehicle dynamics representative of the accident sequence and was then used as input to the occupant simulation. An occupant simulation (using MADYMO, release 7.2),[51] representing a small number of occupants seated in the area of maximum roof crush, evaluated the forces and motion for each occupant relative to the seatbacks, the intruding roof structure, and other occupants. The evaluation was performed in both the unrestrained and restrained conditions. Injury causation was evaluated for the head, neck, and chest of each simulated occupant. The results of the simulation showed that unrestrained occupants were vulnerable to injury during the motorcoach overturn due to impacts with other occupants and with interior surfaces. As the motorcoach overturned onto its roof, and the roof shifted laterally and collapsed onto the seats, occupants were thrown toward the roof and were vulnerable to crushing injuries, especially between the intruding roof and the seatbacks.

Although passenger restraints were not available on the accident motorcoach, simulated occupants restrained with lap/shoulder belts were contained within their seating compartments. This containment reduced injuries due to contacts with other occupants and with interior surfaces. Nevertheless, the extent of the roof crush into the passenger compartment placed even these restrained occupants in a position vulnerable to head and neck injury due to the loss of vertical survivable space.

[48] For more information on the testimony provided by the FMCSA administrator to the Committee, see http://transportation.house.gov/hearings/hearingdetail.aspx?NewsID=1295, accessed June 7, 2012.

[49] According to the entry for "not rated" in the FMCSA's *Motor Carrier Safety Fact Sheet Glossary of Terms*, "An unrated carrier means that a safety rating, as a result of a Compliance Review, has not been assigned to the motor carrier by the FMCSA."

[50] TruckSim is a software tool for simulating and analyzing the dynamic behavior of medium-to-heavy trucks, buses, and articulated vehicles.

[51] MADYMO is a MAthematical DYnamic MOdeling software package used to understand crash engineering problems.

1.10 Other Information

1.10.1 Motorcoach Safety Standards

General. The *Federal Motor Vehicle Safety Standards* (FMVSSs) at 49 CFR Part 571 contain 22 standards on vehicle crashworthiness. Most of these standards exempt buses (except school buses) 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.[52]

The NTSB 1999 special investigation on bus crashworthiness included statistics on 36 motorcoach accidents investigated from 1968 through 1997.[53] Since 1997, the NTSB has investigated more than three dozen additional motorcoach accidents (major accidents, field investigations, and incidents). In 2007, the National Highway Traffic Safety Administration (NHTSA) published a plan to improve motorcoach safety.[54] NHTSA developed the plan partially in response to a number of NTSB reports concerning bus accidents.[55]

Following NTSB investigations of motorcoach accidents in Atlanta, Georgia; Mexican Hat, Utah; and Sherman, Texas;[56] on April 30, 2009, the Secretary of Transportation directed the DOT agencies with responsibility for highway, vehicle, and transit safety to conduct a full departmental review of motorcoach safety. The findings from that review resulted in a DOT Motorcoach Safety Action Plan, which was released on November 16, 2009.[57]

---

[52] Motorcoaches fall under the category of buses in the FMVSSs. FMVSS No. 217, "Bus emergency exits and window retention and release," specifies a series of dimensional and physical requirements for bus emergency exits and windows. The window retention testing required for this standard is a quasi-static test. This standard became effective on September 1, 1973, for all new buses. In addition to FMVSS No. 217, motorcoaches must comply with the following crashworthiness standards: FMVSS No. 208, "Occupant crash protection"; FMVSS No. 209, "Seat belt assemblies"; FMVSS No. 210, "Seat belt assembly anchorages"; and FMVSS No. 302, "Flammability of interior materials"; among others. FMVSS Nos. 208, 209, and 210 currently apply to the driver's seat only.

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

[54] See docket no. NHTSA-2007-28793, "NHTSA's Approach to Motorcoach Safety."

[55] (a) *Collision Between Mission Consolidated Independent School District School Bus and Valley Coca-Cola Bottling Company, Inc., Tractor-Semitrailer, Intersection of Bryan Road and Texas Farm-To-Market Road 676, Alton, Texas, September 21, 1989*, Highway Accident Report NTSB/HAR-90/02 (Washington, D.C.: National Transportation Safety Board, 1990). (b) *Greyhound Motorcoach Run-Off-The-Road Accident, Burnt Cabins, Pennsylvania, June 20, 1998*, Highway Accident Report NTSB/HAR-00/01 (Washington, D.C.: National Transportation Safety Board, 2000). (c) *Motorcoach Run-Off-The-Road Accident, Tallulah, Louisiana, October 13, 2003*, Highway Accident Report NTSB/HAR-05/01 (Washington, D.C.: National Transportation Safety Board, 2005). (d) *Motorcoach Fire on Interstate 45 During Hurricane Rita Evacuation, Near Wilmer, Texas, September 23, 2005*, Highway Accident Report NTSB/HAR-07/01 (Washington, D.C.: National Transportation Safety Board, 2007). All these reports fall under the Bus Occupant Safety issue on the NTSB Most Wanted List.

[56] (a) *Motorcoach Override of Elevated Exit Ramp, Interstate 75, Atlanta, Georgia, March 2, 2007*, Highway Accident Report NTSB/HAR-08/01 (Washington, D.C.: National Transportation Safety Board, 2008). (b) NTSB/HAR-09/01. (c) *Motorcoach Run-Off-the-Bridge and Rollover, Sherman, Texas, August 8, 2008*, Highway Accident Report NTSB/HAR-09/02 (Washington, D.C.: National Transportation Safety Board, 2009).

[57] For additional information, the complete 2009 DOT Motorcoach Safety Action Plan is available at http://www.fmcsa.dot.gov/documents/safety-security/MotorcoachSafetyactionPlan_finalreport-508.pdf, accessed June 12, 2012.

Seat Belt Rulemaking. On August 18, 2010, NHTSA published at 72 *Federal Register* 50958 a notice of proposed rulemaking (NPRM) titled "Federal Motor Vehicle Safety Standards; Motorcoach Definition; Occupant Crash Protection."[58] The NPRM proposes to amend FMVSS No. 208 on occupant crash protection to require lap/shoulder belts for each passenger seating position in new motorcoaches. The notice also proposes to require a lap/shoulder belt for the motorcoach and large school bus drivers' seating positions, which currently can have either a lap-only belt or a lap/shoulder belt.[59] The notice also proposes a motorcoach definition. On October 18, 2010, the NTSB commented on this rulemaking, indicating support for the improvements to occupant protection for both motorcoach passengers and drivers. A final rule from this NPRM has not yet been issued.

Motorcoach Roof Strength Testing and Standards. In March 2009, NHTSA issued a discussion paper on motorcoach roof crush/rollover testing.[60] The paper reviewed roof crush/rollover testing performed on two motorcoach models as part of the August 2007 comprehensive plan on motorcoach safety. The testing was performed to evaluate two roof crush/rollover test procedures—FMVSS No. 220 and United Nations Economic Commission for Europe (ECE) Regulation No. 66—to determine the feasibility of establishing a roof crush performance requirement for motorcoaches sold in the United States. The Prevost and MCI motorcoaches NHTSA tested had roof displacements of more than five times the FMVSS No. 220 test limit.[61] The Prevost and MCI motorcoaches also failed the ECE Regulation No. 66 test due to intrusion into the passenger compartment. Because the tested motorcoaches did not meet either FMVSS No. 220 or ECE Regulation No. 66, a quantitative analysis of the test protocols was not possible. NHTSA stated the FMVSS No. 220 test protocol appeared to be more stringent because both buses failed to support their unloaded vehicle weight. But the ECE Regulation No. 66 test seemed more representative of a motorcoach rollover event and was better for assessing whether emergency exits come unlatched during rollovers.

1.10.2 Fatigue Management Programs

A fatigue management program is a comprehensive system designed to manage fatigue within a specific industry, such as commercial motor transportation, and to address how fatigue affects that operational environment. Some motor carriers have established such programs on a voluntary basis. An effective fatigue management program for a motor carrier could include testing of employees for sleep disorders and adoption of treatment options for detected disorders; evaluation of drivers' sleep when off duty; distribution to all carrier personnel of informational brochures/training on fatigue, including its consequences and countermeasures; provision of

[58] See docket no. NHTSA-2010-0112.

[59] Investigators determined that the accident driver was wearing his seat belt. The NTSB has a longstanding recommendation (Safety Recommendation H-90-75 "Open—Acceptable Response") calling for NHTSA to revise FMVSS No. 208 to require that lap/shoulder belt systems for the driver position be installed in all newly manufactured buses, including city, intercity, small, and large buses. The rulemaking proposed in the August 2010 NPRM appears to address the intent of this recommendation.

[60] Motorcoach Roof Crush/Rollover Discussion Paper, NHTSA docket no. NHTSA-2007-28793-0019, March 2009.

[61] The FMVSS No. 220 test applies a uniformly distributed compressive load (equivalent to 1.5 times the unloaded vehicle weight of the bus) to the roof of the bus along its longitudinal centerline.

training for dispatchers and management personnel on improving scheduling to consider driver sleep needs; imposition by management of consequences for HOS violations; implementation of non-punitive reporting systems; and use of fatigue management technologies.

Since 1999, the North American Fatigue Management Program (NAFMP)—an effort jointly sponsored by the FMCSA and Transport Canada—has been studying driver fatigue with the goal of developing a comprehensive, integrated fatigue management program that could be implemented by motor carriers to reduce the safety risks associated with fatigue. The NAFMP has undertaken a four-phase effort to develop a fatigue management program specifically designed for use by motor carriers. The first three phases of the project have been completed. They involved the following steps: (1) identifying fatigue management requirements and developing a comprehensive approach designed to include drivers, dispatchers, and company managers; (2) developing educational and training materials and procedures for field testing the draft program; and (3) conducting a field operational test involving companies in Alberta, Quebec, and California. The field test had the following elements:

- Collecting baseline data during drivers' regular routes
- Assessing and treating sleep disorders
- Conducting educational workshops on fatigue for drivers, their families, dispatchers, and management
- Providing ongoing support and consultation to help companies develop policies and implement practices consistent with a fatigue management program (scheduling, etc.)
- Collecting data following implementation of the fatigue management program during drivers' regular routes

With the completion of phase three of the project, efforts are now moving to phase four, in which the draft program will be revised as necessary, based on field test results, and the recommended practice guidelines, manuals, and other training materials will be developed and finalized. Transport Canada has indicated that the NAFMP will be implemented by the end of 2012. The final product will be a set of 10 Web modules that comprise a curriculum for a fatigue management training program. The American Transport Research Institute has been contracted to host the website.

1.10.3 Safety Management Cycle

The FMCSA's "Safety Management Cycle" is an important tool for investigators to use to diagnose a breakdown in safety practices. The Safety Management Cycle provides a structured view of the safety practices a carrier should have in place to ensure compliance with safety regulations. During a new entrant safety assurance audit and during compliance reviews, the FMCSA considers a carrier's safety management practices. Most carriers' safety programs are quite basic. The FMCSA has been promoting the use of the Safety Management Cycle but does not currently require carriers to have safety practices that are implemented and continuously

carried out for every phase of their operations. The six processes of the Safety Management Cycle may be briefly described as follows:

- **Policies and procedures**—Establish the safety policies and procedures to be followed

- **Roles and responsibilities**—Define and assign the duties and tasks to be performed by managers and staff

- **Qualification and hiring**—Set standards for the managers and staff who will fulfill the defined roles and responsibilities

- **Training and communication**—Ensure that managers and staff receive adequate training and information with which to carry out their assigned roles and fulfill their responsibilities

- **Monitoring and tracking**—Keep watch over operations to determine whether the policies and procedures are being fulfilled and to ensure they are having the intended safety result

- **Meaningful action**—Use the monitoring system to identify problem areas and take steps to address areas where safety shortfalls are apparent

Because this system functions as a cycle, after the carrier takes the final step, "meaningful action," for any operation, it should return to the first element of re-establishing safety policies/procedures and then repeat the entire rotation. The Safety Management Cycle is designed to serve as a continuous means of determining where the carrier may have safety problems and of resolving them once identified.

2. Analysis

2.1 Introduction

Based on a review of the dynamics of the accident, which involved the motorcoach's departing the roadway at a shallow angle without evasive braking or steering correction, as well as a review of the driver's work and rest history, cell phone records, and passenger observations, the investigation determined that the driver fell asleep while driving due to fatigue resulting from acute sleep loss, poor sleep quality, and circadian disruption. Investigators conducted an analysis of possible fatigue countermeasures, such as vehicle technologies, fatigue management programs, and HOS for passenger-carrying drivers. (Driver fatigue is discussed further in section 2.2.)

The motorcoach overturned and its roof collapsed, causing intrusion into the passenger compartment near the center of the vehicle. This intrusion resulted in fatal crushing injuries to four passengers. Additionally, 14 passengers sustained serious injuries, and many of the unrestrained passengers were thrown from their seats during the accident sequence. Investigators developed a computer simulation study to assess motorcoach roof strength integrity and whether passenger seat belts would have mitigated the injuries. The simulations indicated that a restraint system in combination with enhanced roof strength would have helped prevent a number of the serious injuries and fatalities. (Motorcoach roof strength and occupant protection are discussed further in section 2.3.)

In a review of the motor carrier operations, the investigation examined the safety management and driver oversight practices of Sky Express, Inc., and determined that the company failed to exercise oversight of the accident driver's work and rest activities, which enabled him to operate the motorcoach while dangerously fatigued. By examining the Sky Express company history, the investigation determined that the interstate motor carrier entered into the new entrant safety assurance program in 2005. In early 2007, although the FMCSA identified several safety deficiencies in the carrier's operation, it passed Sky Express during the new entrant safety audit. The investigation reviewed the FMCSA new entrant safety assurance program and determined that the new entrant audit process is not keeping unsafe carriers from entering the motor carrier industry. The investigation addressed the importance of safety management and the need to assess a carrier's safety culture during new entrant safety audits.

During its 6 years in business, Sky Express was the subject of five FMCSA reviews of its compliance with safety regulations. The results of these reviews and additional information uncovered during the investigation showed that Sky Express repeatedly failed to fulfill the requirements of Federal safety regulations. In its April 2011 compliance review, the FMCSA found the company unsatisfactory in two major areas and conditional in another; the FMCSA issued Sky Express a proposed overall rating of unsatisfactory and invited it to submit a corrective action plan within 45 days. The 45-day appeals period began on April 13 and was due to expire on May 28. The FMCSA later granted a 10-day extension, making the expiration date June 7, 2011. Although the FMCSA had repeatedly detected safety problems with Sky Express's

operation, it did not remove the carrier's operating authority until after the May 31, 2011, accident. (Motor carrier oversight is discussed further in section 2.4.)

The remainder of this "Introduction" section addresses those factors the NTSB investigated and determined did not significantly influence the accident or the extent of its outcome.

The motorcoach driver was 37 years old and held a medical fitness certificate expiring in May 2012. He had passed a commercial driver fitness examination about 13 months prior to the accident, and the examining physician recorded no notable medical conditions affecting the driver.[62] The driver's tested uncorrected vision was 20/25.

VSP officers, who were on the scene less than 5 minutes after the accident and who are trained to recognize the signs of intoxication in such situations, did not have reasonable suspicion that the driver had been drinking alcohol. Investigators interviewed passengers following the accident and, although many stated that the driver showed signs of fatigue, none indicated that the driver had been drinking alcohol. Between 5.5 and 6 hours after the accident, the driver was given a breath test for alcohol and provided a urine specimen, which was tested for illegal drugs. Results of these tests were negative. At the request of the NTSB, a portion of the urine specimen was also tested by the Civil Aerospace Medical Institute, which found no evidence of alcohol or drugs.

The driver held a valid class "B" CDL with passenger endorsement issued in June 2010 and was operating under its provisions at the time of the accident.

The cell phone records from the driver's cellular provider indicated the last activity on the driver's cell phone took place at 3:46 a.m., more than an hour before the accident occurred.

At the time of the accident, the roadway was dry, the sky was clear, and the temperature was about 70° F. Although sunrise would not occur for nearly an hour, postaccident observation indicated that illumination from the motorcoach's headlights should have provided adequate visibility of the roadway.

During the postaccident inspection of the motorcoach, no significant steering, suspension, or braking system defects were found. Investigators observed no tire conditions that would have played a role in the accident.

Using simulations and accident reconstruction calculations, the investigation determined that the motorcoach was traveling 55 to 60 mph, below the posted speed limit of 70 mph, when it left the highway.[63] The accident motorcoach was engaged by the roadside barrier and, due to the

[62] The driver's personal medical history was sparse. Investigators found indications he went to the doctor only rarely, to address a specific need; investigators found records from three doctors as well as the physician who conducted the CDL fitness examination. The driver's most recent visit to a physician had taken place about 5 months prior to the accident.

[63] It was necessary to derive a speed range, given the uncertainties and assumptions that affect vehicle deceleration; these include, for example, the friction of the tires traveling on the earthen area beyond the shoulder, the unknown contribution of forces associated with interaction with the roadside barrier, and the effect of weight shift on the tires as the vehicle side-slipped on the embankment.

barrier and driver steering input, the vehicle was prevented from traversing a wooded slope adjacent to the roadway.

On this basis, the NTSB concludes that the following were not factors in this accident: (1) driver health, (2) alcohol or drug use, (3) cell phone use by the driver, (4) weather, (5) preexisting mechanical defects or deficiencies on the motorcoach, (6) motorcoach speed, or (7) highway design.

The first emergency responders arrived at the scene of the accident within 3 minutes of the initial 911 notification. Police, fire, and emergency services from several jurisdictions responded to the scene, assisting with victim extrication, triage, treatment, and transportation. The incident command established an on-scene triage operation that resulted in the efficient transfer of all seriously injured passengers to hospitals. Extrication of the viable and deceased passengers was accomplished effectively and quickly. Therefore, the NTSB concludes that the emergency response was timely and adequate.

The remainder of the analysis discusses the factors that caused or contributed to the accident and the major issue areas identified in the course of the investigation, as follows:

- Driver fatigue
- Motorcoach deficiencies in roof strength and occupant protection, associated with the lack of Federal standards
- FMCSA failure to exercise adequate safety oversight of Sky Express

2.2 Driver Fatigue

2.2.1 Factors Indicating Fatigue

Although many factors may affect driver fatigue, the investigation considered the following in this case:

(1) Previous night's sleep length and possible inverted sleep schedule

(2) Time of day, with consideration of circadian rhythms[64] and normal work schedule

(3) Length of time awake and time on task

(4) Potential sleep disorders

Sleep Length. The driver's cell phone records and his own statements and logbook indicated that during the 16.5-hour period he was off duty on May 30, he had a maximum sleep opportunity of 6.5 hours.[65] The driver logged off duty at 5:45 a.m. in Durham, North Carolina. He continued to make and receive cell phone calls until approximately 6:45 a.m., and then had a period of unknown activity for about 1 hour. After a call at 7:57 a.m., the driver had another period of unknown activity for approximately 2.5 hours, until 10:27 a.m., when he received an incoming call. During the morning, the driver had to take a company car from Durham to Greensboro, North Carolina, a trip requiring at least 1 hour. Once in the Greensboro location, he had to prepare for sleep. Given the driver's need to transit from Durham to Greensboro and the timing of his known cell phone activity, it is unlikely he could have obtained prolonged, restorative sleep during the morning hours after going off duty at 5:45 a.m. At 11:29 a.m., the driver received an incoming call.

Based on the foregoing information, if the driver did receive any sleep between 5:45 a.m. and 11:29 a.m., it would necessarily have been disrupted. He told the VSP he arose that day at 6:00 p.m., leaving a 6.5-hour period during which he could have received continuous sleep. However, the NTSB could not verify whether he used this entire period for sleep, and his sleep may have been less than the 6.5 hours available to him.

With respect to cumulative sleep loss, the driver was off duty May 28, 2011, and he made or received only a few calls, leaving most of the day available for rest, if he took this opportunity. Nothing is known about the driver's activities on May 29, 2011, until just before 7:00 p.m., when his cell phone activity began for that evening.

[64] Circadian rhythms affect patterns of brain activity, hormone production, cell generation, and other biological activities linked to a 24-hour cycle.

[65] The 16.5-hour period was from 5:45 a.m. to 10:15 p.m.

Inverted Sleep Schedule. The driver's general sleep pattern was not optimal. He was working in the nighttime hours of May 30 and 31, so he had an inverted sleep schedule—that is, he was awake (driving) during the nighttime hours and had the opportunity to sleep primarily during the daytime hours, which is the opposite of the human norm. Inverted sleep schedules have been shown to have a negative impact on sleep quality and quantity.[66] Research has shown that inverted work schedules are associated with shortened sleep lengths, higher subjective wake-time sleepiness, and degraded performance.[67]

Time of Day and Circadian Rhythms. The accident occurred at 4:55 a.m., nearly the midpoint of the lowest ebb of the circadian cycle. Studies of accident risk versus time of day have shown that the highest risk of a drowsy/dozing driver accident occurs between 4:00 a.m. and 6:00 a.m.[68] Sleepiness is most pronounced and human performance is most negatively affected during this early morning interval.[69]

Length of Time Awake and Time on Task. The length of time a person has been awake and his or her time on task have been associated with increased risk of fatigue. With respect to time on task, studies have shown that the risk of an accident increases exponentially beyond the eighth or ninth hour at work.[70] In this case, the driver had been awake for about 11 hours and working for about 7 hours by the time the accident occurred, less than the periods indicating increased risk. Time awake and on task, therefore, do not appear to be fatigue factors.

Potential Sleep Disorders. The driver's medical records did not indicate he had a sleeping disorder. None of his medical records indicated he had any symptoms of a medical condition that would have caused fatigue or any diagnoses of sleeping disorders. The FMCSA Medical Review Board has recommended screening for obstructive sleep apnea for commercial drivers with body mass indexes (BMI) over 30, and the driver had a BMI of 25.8, so he was unlikely to have had this disorder.

To summarize, the driver did not receive adequate sleep, either in length or quality, during his most recent sleep period, and his inverted sleep schedule may have contributed to a chronic sleep debt (factor 1). In addition, the time of day in which the accident occurred was within the lowest level of the circadian cycle (factor 2). The NTSB concludes that the driver fell asleep while driving due to fatigue resulting from acute sleep loss, poor sleep quality, and circadian disruption.

---

[66] D. Tepas and A. Carvalhais, "Sleep Patterns of Shiftworkers," in A. Scott, ed., *Shiftwork* (Philadelphia, Pennsylvania: Hanley and Belfus, 1990).

[67] G. Richardson and H. Malin, "Circadian Rhythm Sleep Disorders: Pathophysiology and Treatment," *Journal of Clinical Neurophysiology*, vol. 13, no. 1 (January 1996), pp. 17–31.

[68] R. Mackie and J. Miller, *Effects of Hours of Service Regularity of Schedules and Cargo Loading on Truck and Bus Driver Fatigue*, DOT HS 803 799 (Washington, D.C.: National Highway Traffic Safety Administration, 1978).

[69] H. Van Dongen and D. Dinges, "Circadian Rhythms in Sleepiness, Alertness, and Performance," in M. Kryger, T. Roth, and W. Dement, eds., *Principles and Practice of Sleep Medicine*, 4th ed. (March 2005).

[70] K. Hanecke and others, "Accident Risk as a Function of Hour at Work and Time of Day as Determined From Accident Data and Exposure Models for the German Working Population," *Scandinavian Journal of Work, Environment, and Health*, no. 24, supplement 3 (1998), pp. 43–48.

2.2.2 Behavioral Evidence of Fatigue

In addition to the information available from his schedule and history noted above, the accident driver exhibited clear indications of fatigue during the accident trip. Passengers noted the driver repeatedly swerved the bus and had difficulty maintaining his lane. At least one stated that she saw him leaning over the steering wheel with his head bobbing—physical signs that are indicative of a microsleep.[71] One passenger even overheard a cell phone conversation during which the driver complained he was tired.

Several passengers told investigators the driver was consuming coffee and energy drinks that night. Caffeine consumption is a popular fatigue countermeasure. The driver's heavy consumption of caffeinated beverages indicates he was aware of some level of fatigue and was attempting to compensate for it. Passengers also recalled his two unrecorded stops, each lasting at least 30 minutes, during which he disappeared from their view. Further, the physical circumstances of the accident—the shallow angle of drift from the road,[72] the driver's failure to make any evasive braking or steering correction until the bus had drifted from the road, and his sudden oversteering correction as the vehicle reached the barrier—all suggest a fatigue-caused event. Finally, when interviewed after the accident, the driver told police and the FMCSA that he fell asleep while driving. A passenger also heard him apologize after the accident and state that he had fallen asleep.

Based on his consumption of caffeine, the overheard complaint of fatigue, and the unscheduled rest stops, the driver was aware he was driving while significantly fatigued. On this basis, technologies designed to alert drivers to their diminished performance would have had only limited benefit for a driver who was fully aware of his fatigued state. Despite this knowledge, he continued to drive. Alerter technologies can be effective only when the driver is willing to act on the warnings they provide. Such technologies do not address the root cause of fatigue, nor do they keep fatigued drivers from driving. In addition, some technologies are designed to alert the motor carrier in real time when drivers make frequent lane deviations or other fatigue indications occur. However, because of Sky Express's failure to oversee its drivers, it is unlikely that this motor carrier would have used such information to take action, even if it had been available.

To keep its fatigued drivers off the road, a motor carrier must provide appropriate guidance and exercise reasonable safety oversight. Sky Express did not have a fatigue management program and did not educate its drivers about the dangers of fatigue and the need to obtain adequate rest before driving. Nor did the carrier exercise oversight, such as by review of logbooks or other schedule supervision, to ensure its drivers were following good fatigue prevention practices. Sky Express did not have a program in place by which fatigued drivers could obtain a replacement driver if they felt debilitated by fatigue and did not provide backup

[71] A microsleep is a brief episode of sleep that may last from a fraction of a second up to 10 seconds. They occur most often when a sleepy person is trying to stay awake. Often the person who experienced the microsleep is not aware that it occurred.

[72] In the NTSB's 1995 safety study *Factors That Affect Fatigue in Heavy Truck Accidents* (NTSB/SS-95/01 and -02), the average angle of departure from the roadway was 5 degrees for 44 out of the 62 accidents considered.

drivers for overnight trips, as some passenger carriers do.[73] The NTSB concludes that Sky Express's failure to exercise even minimal oversight of its drivers' rest and sleep activities enabled the drivers to drive while dangerously fatigued.

In its 2008 accident report on a semitrailer rollover and subsequent strike by a motorcoach in Osseo, Wisconsin, the NTSB discussed the merits of fatigue management programs and their use by motor carriers to reduce fatigue-related accidents.[74] The programs are designed to manage fatigue within a specific industry, such as commercial motor transportation, and to address how fatigue affects that operational environment. Some motor carriers have established such programs on a voluntary basis. An effective fatigue management program for a motor carrier might include program-focused efforts to help employees avoid and mitigate fatigue as well as management practices for implementing, overseeing, and evaluating the effectiveness of the program. Possible elements of such a program might be testing and treatment options for sleep disorders; evaluation of off-duty actions (such as drivers' sleep when off duty); informational brochures/training for all carrier personnel on fatigue, including its consequences and countermeasures; implementation of a nonpunitive reporting system permitting drivers to report fatigue and request relief; training for dispatchers and management personnel on improving scheduling to consider driver sleep needs; company-imposed consequences for HOS violations; and use of fatigue management technologies.

In the Osseo report, the NTSB made the following recommendation to the FMCSA:

> Develop and use a methodology that will continually assess the effectiveness of the fatigue management plans implemented by motor carriers, including their ability to improve sleep and alertness, mitigate performance errors, and prevent incidents and accidents. (H-08-14)

This recommendation is currently classified "Open—Acceptable Response."

A 2009 NAFMP study to address the effects of fatigue management programs on driver fatigue found the programs can be beneficial to both drivers and companies.[75] In the study, drivers who had been working for 3 months under a fatigue management program that included educational sessions, sleep disorder diagnoses, and efforts to improve dispatch practices with respect to fatigue generally reported favorable results. Drivers indicated they had better sleep, in both quality and duration, and experienced fewer "close calls" associated with fatigue while driving. Motor carriers participating in the study reported benefits from the programs as well, indicating their accident rates declined and their drivers were absent less frequently.

For more than 10 years, the NAFMP has been studying driver fatigue to develop a comprehensive, integrated fatigue management program that could be implemented by motor

[73] An effective fatigue management program would include contingency planning for en route drivers who become fatigued.

[74] *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, D.C.: National Transportation Safety Board, 2008).

[75] A. Smiley and others, *Effects of a Fatigue Management Program on Fatigue in the Commercial Motor Carrier Industry: Summary Report*, TP 14921E (Ottawa, Ontario: Transport Canada, September 2009).

carriers to reduce the safety risks associated with fatigue. The NTSB expects the NAFMP to issue guidance materials for a model fatigue management program by the end of 2012.

In its 2010 report on a truck-tractor accident that took place in Miami, Oklahoma, the NTSB made the following recommendation to the FMCSA:[76]

> Require all motor carriers to adopt a fatigue management program based on the North American Fatigue Management Program guidelines for the management of fatigue in a motor carrier operating environment. (H-10-9)

In its September 1, 2011, response to this recommendation, the FMCSA indicated that, before mandating the use of fatigue management programs, a nonregulatory approach should be tried. The FMCSA stated it would continue to work to encourage carriers to implement such programs on a voluntary basis. The NTSB believes that, although some carriers will adopt fatigue management programs to improve the safety of their operations, many will not. In fact, those carriers with the weakest safety management—that is, the operations that most need a fatigue management program—are the least likely to implement one. For example, it seems improbable that a carrier such as Sky Express, given its extremely limited effort to train and supervise its drivers, would have enacted a fatigue management program unless required to do so to stay in business. Consequently, on March 28, 2012, the NTSB reclassified Safety Recommendation H-10-9 "Open—Unacceptable Response."

In its 2012 report on a March 12, 2011, motorcoach accident in New York City, New York, the NTSB reiterated Safety Recommendation H-10-9 due to the fatigue-related failures associated with the driver and carrier in that accident.[77] In connection with the Doswell accident, the NTSB considers that, had Sky Express taken reasonable steps toward overseeing the activities of its drivers, such as those that would normally appear in a fatigue management program, the driver might have been better rested and avoided falling asleep while driving, thus preventing this accident. Therefore, the NTSB again reiterates Safety Recommendation H-10-9 to the FMCSA, and the recommendation remains classified "Open—Unacceptable Response."

The NTSB does not consider, however, that Sky Express, which was reluctant to take even minimal steps to ensure the safety management of its operations, would necessarily have become a safer company simply by initiating a fatigue management program. As the NTSB found during this investigation, Sky Express lacked any systematic approach to maintaining safety and provided only the minimum safety management required by the FMCSA to keep its operating authority. (See section 2.4, "Motor Carrier Oversight.")

Sky Express undertook safety management actions only when forced to do so by FMCSA oversight. There is little reason to expect that Sky Express would have maintained an effective fatigue management program unless the FMCSA also undertook to ensure its effective

[76] *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, D.C.: National Transportation Safety Board, 2010).

[77] *Motorcoach Run-Off-the-Road and Collision With Vertical Highway Signpost, Interstate 95 Southbound, New York City, New York, March 12, 2011,* Highway Accident Report NTSB/HAR-12/01 (Washington, D.C.: National Transportation Safety Board, 2012).

continuance. Therefore, the NTSB concludes that, if the FMCSA requires carriers to implement fatigue management programs without ensuring the programs stay active and effective, some may not have the intended result of reducing driver fatigue and increasing safety.

In the 4 years since the NTSB first issued Safety Recommendation H-08-14, recommending that the FMCSA assess those fatigue management programs adopted voluntarily by motor carriers, the NTSB has issued Safety Recommendation H-10-9, and substantial progress has been made on the NAFMP. Given these developments, the NTSB reclassifies Safety Recommendation H-08-14 "Closed—Acceptable Action/Superseded" and recommends that the FMCSA establish an ongoing program to monitor, evaluate, report on, and continuously improve fatigue management programs implemented by motor carriers to identify, mitigate, and continuously reduce fatigue-related risks for drivers.

2.2.3 Overnight Driving Fatigue

Overnight Motorcoach Trips. The circumstances of this accident—a fatigued driver who ran his vehicle off the road in the early morning hours—have been encountered in multiple NTSB accident investigations. In many ways, the Doswell accident is strikingly similar to the NTSB's most recent investigation of a motorcoach accident, the New York City accident, which occurred at 5:38 a.m.;[78] the Doswell accident occurred at 4:55 a.m. Both accident reports cite fatigue in the probable cause. Also in both cases, the scheduled service trips began late at night and required the driver to work through the overnight hours.

HOS Rules for Commercial Drivers. The HOS rules for commercial drivers have been substantially revised four times. The HOS rulemakings in 1938, 1939, and 1962 applied to property- and passenger-carrying operators alike;[79] however, the fourth rulemaking, which occurred in 2003, applied only to property-carrying drivers (that is, truck drivers).[80]

In the 1990s, the NTSB made various safety recommendations concerning CMV driver HOS that did not distinguish between property- and passenger-carrying drivers.[81] The major HOS regulatory revisions for property-carrying drivers that took place in 2003 (and other subsequent revisions) have endeavored to incorporate updated scientific information about fatigue risk factors. However, the regulations for passenger-carrying operations, which have not been updated in 50 years, have remained unchanged despite the enormous progress that has been made over these decades in the scientific understanding of the effects of scheduling systems on performance and accident risk.

In its March 3, 2011, comments on the FMCSA-proposed HOS rule for property-carrying drivers, the NTSB stated, "The NTSB is strongly opposed to special provisions providing exemptions to certain HOS requirements, such as those the proposed rule applies to passenger-carrying CMVs." The NTSB concludes that passenger-carrying CMV operators

[78] NTSB/HAR-12/01.

[79] See 65 *Federal Register* 25540.

[80] See 68 *Federal Register* 22456.

[81] See Safety Recommendations H-95-01, H-99-2, and H-99-19.

should follow driver HOS rules at least as stringent as those required of property-carrying operators.

The FMCSA has begun research to initiate rulemaking for a new HOS rule for passenger-carrying drivers and has indicated that it intends to craft updated HOS rules for passenger-carrying operations. The FMCSA conducted two public listening sessions on January 9, 2012, to gather industry input on the proposed rulemaking. In February 2012, the Motor Carrier Safety Advisory Committee adopted the new task (#11-06) of providing information, concepts, and ideas to the FMCSA relating to HOS requirements for drivers of passenger-carrying vehicles.[82]

HOS Regulations Addressing Circadian Rhythms. A substantial body of research with a long history confirms the risks of fatigued driving during windows of circadian low, that is, during the early hours of the morning (approximately 2 a.m. to 6 a.m.) and, to a lesser extent, during the late afternoon.[83] Increasingly, HOS regulations have begun to address human circadian variability. For example, in the aviation mode, the Federal Aviation Administration's recent commercial passenger airline pilot scheduling rule reduced the maximum flight duty period limit during nighttime hours to help compensate for pilots' being awake during the circadian lows.[84] Pilot time at the controls (flight time) was limited to 8 or 9 hours, depending on the start time.[85]

In its 2011 HOS rulemaking revision for property-carrying drivers, the FMCSA acknowledged, "Research has long demonstrated that daytime sleep is shorter in duration and lower in quality than nighttime sleep."[86] The rule itself required that any driver utilizing the "restart provision"[87] include two periods between 1 a.m. and 5 a.m. (during the window of circadian low) in the off-duty time.[88]

The NTSB appreciates the challenges associated with establishing HOS regulations that promote safety and driver health while providing motor carriers with scheduling flexibility. Both the Doswell and New York City accidents took place in scheduled service, but charter trips also

[82] To view the text of the committee's task #11-06 statement, see http://mcsac.fmcsa.dot.gov/Documents/May2012/Task%20Statement%2011-06_Motorcoach_HOS.docx, accessed June 14, 2012.

[83] M. Mitler and others, "Catastrophes, Sleep, and Public Policy: Consensus Report," *Sleep*, vol. 11, no. 1 (1988), pp. 100–109.

[84] On August 1, 2010, the President signed the Airline Safety and Federal Aviation Administration Extension Act of 2010 (Public Law 111-216). Section 212 of Public Law 111-216 required the agency "to issue regulations to limit the number of flight and duty time hours allowed for pilots to address pilot fatigue." Subsection 212(a)(3) set a deadline of 180 days for the agency to publish an NPRM and 1 year for it to issue a final rule.

[85] In notable dissimilarity to the driver HOS requirements in the highway mode, the December 21, 2011, pilot scheduling final rule providing these circadian safety measures applies only to passenger-carrying, not cargo-carrying, operations. Legislation has been introduced in the U.S. Congress to include aviation cargo operations in the Part 117 rule (Safe Skies Act of 2012, H.R. 4350).

[86] See 76 *Federal Register* 81134.

[87] The restart provision allows a driver to restart his or her 7- or 8-day maximum on-duty limits by going off duty for a period of at least 34 hours.

[88] See http://www.fmcsa.dot.gov/rules-regulations/administration/rulemakings/final/HOS-Final-Rule-12-27-11.pdf, accessed June 14, 2012.

run the risks of nighttime operations. Motorcoach travelers often find it convenient to charter a service that transports their club, school group, sports team, or similar association to visit a location or to attend an event. In some cases, the trip transportation plan is designed to save travelers the expense of overnight accommodations by using the motorcoach as a "traveling hotel." Such arrangements may result in the driver's reporting for duty early to drive passengers to an event located up to 10 hours distant. After discharging passengers, the driver may have as little as 8 hours off duty to eat, sleep, and fulfill personal needs before reporting back to driving duty.[89] After the event, the driver picks up the passengers and drives the return trip, thereby prolonging his or her driving day. Such a pattern can result in a tired driver working in the early morning hours to transport a motorcoach full of sleeping passengers.

Regardless of whether the overnight trip occurs in scheduled or charter service, fatigue science has confirmed the dangers posed by degraded vehicle operator performance during windows of circadian lows. The NTSB is pleased that the FMCSA is proceeding with HOS rulemaking focusing on passenger-carrying drivers. The NTSB concludes that CMV HOS regulations for passenger-carrying drivers would be more effective if they addressed the scientifically established risk of drivers operating during windows of circadian lows. Therefore, the NTSB recommends that the FMCSA incorporate scientifically based fatigue mitigation strategies into the HOS regulations for passenger-carrying drivers who operate during the nighttime window of circadian low.

2.3 Motorcoach Roof Strength and Occupant Protection

A comprehensive occupant protection system considers many aspects of the vehicle, including roof strength, restraint systems and their anchorage strengths, seat strength, and window glazing—all working together to protect occupants should an accident occur. This accident illustrates that keeping occupants within their seating locations cannot, by itself, fully protect them in the event of a crash; the survivable space also must be preserved if occupants are to escape serious injury.

The motorcoach was equipped with a lap-only seat belt at the driver seating position; none of the passenger seats were equipped with any form of restraint system. Postaccident evidence indicates the driver was wearing the lap-only belt at the time of the accident. Although detailed injury information is not available for the driver (he refused on-scene medical treatment), it appears he experienced only minor injuries.

The accident resulted in fatal injury to four passengers, all of whom were initially seated on the passenger side of the bus between rows 4 and 8, in the region of maximum roof deformation and loss of window integrity. Two of the four passengers who were killed were found with their upper bodies pinned between the top of a seatback and the roof; they died as a result of mechanical asphyxiation. Because of the lateral shift of the roof, the roof collapse, and the loss of the window glazing, the other two passengers who were killed were partially ejected and received crushing injuries. Fatal blunt force trauma to the head of one passenger and to the

[89] Motorcoaches, unlike many trucks, are not usually equipped with sleeper berths. The convenience of a sleeper berth makes it easier for a driver to obtain sleep because there is no need to find lodging. Motorcoach drivers usually do not have this on-board, bed-like sleeping accommodation, which is available to some truck drivers.

head and chest of the other occurred when the sidewall structure beginning at the base of the windows shifted laterally and collapsed during the motorcoach's 180-degree overturn. The NTSB concludes that the four fatalities in this accident resulted from crushing injuries as the motorcoach rolled over and the roof collapsed.

The 49 passengers known to have been non-fatally injured sustained injuries ranging from minor to serious.[90] These passengers were thrown from their seating compartments and sustained injuries that most likely resulted from impacts with the vehicle interior and/or with other passengers during the rollover event. Their injuries included brain contusions; spinal compression, pelvic, and extremity fractures; and abrasions and lacerations. The NTSB concludes that the passengers who survived the accident were thrown from the seating compartments and experienced injuries during the rollover event due to the lack of a passenger restraint system on the motorcoach.

Physical evidence in conjunction with the occupant simulation study showed that although injuries and fatalities to motorcoach passengers in rollovers have typically resulted from passenger ejection, in this accident, the roof crush was directly responsible for the fatal injuries. The extent of the roof collapse and intrusion into the passenger compartment indicated that even restrained passengers might not have been provided adequate protection, given the loss of survivable space. In the unrestrained condition, the simulated occupants traveled the width of the bus during the initial phases of the roll, struck interior surfaces and other occupants, and then were vulnerable to crushing injuries, depending on their exact positions within the vehicle relative to the seatbacks and the sidewalls, as the roof shifted laterally and collapsed vertically as the bus came to final rest inverted on the side of the roadway. The simulation results confirmed the potential for fatal crushing injuries due to roof collapse for unrestrained occupants. The simulation results also indicated lap/shoulder belts would have mitigated some of the injuries to occupants from interior contacts and occupant-to-occupant contacts during the roll event by keeping occupants in their initial seating positions. Nevertheless, the extent of roof crush seen in this accident might still have caused severe head injuries to lap/shoulder-belted occupants due to the extreme loss of survivable space as the roof collapsed. The NTSB concludes that both a restraint system and a system ensuring sufficient roof strength, working in combination as part of a comprehensive occupant protection system, are needed to provide adequate protection to motorcoach occupants in the event of a rollover.

The NTSB has a long history of investigating accidents involving the inadequacy of occupant protection systems on motorcoaches. The Board's 2008 report on its investigation of a motorcoach accident in Atlanta, Georgia,[91] lists 33 motorcoach accidents investigated, and since then, the NTSB has completed 6 more major investigations of this type. Nearly all these investigations have considered the issue of motorcoach occupant protection, with particular emphasis on the need to prevent ejections and maintain survivable space in the event of an accident. The following NTSB recommendations to NHTSA on occupant protection and roof

[90] The injury status of five passengers is unknown.

[91] NTSB/HAR-08/01.

strength standards, which were originally made in the NTSB's 1999 report on selective motorcoach issues, are classified "Open—Unacceptable Response:"[92]

> 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)

In spring 2009, partially in response to open NTSB safety recommendations, the Secretary of Transportation ordered a full departmental review of motorcoach safety. Based on this review, on November 16, 2009, the DOT published a Motorcoach Safety Action Plan that described a systems-oriented approach for enhancing motorcoach safety.[93] Three of the plan's seven action items—roof strength, seat belts, and accident avoidance technology—address the prevention or mitigation of the effects of rollovers.

In August 2010, NHTSA published an NPRM to amend FMVSS No. 208 on occupant crash protection to require lap/shoulder belts for each passenger seating position in new motorcoaches. The NPRM also proposed to require a lap/shoulder belt for the motorcoach and large school bus drivers' seating positions, which currently are required to have either a lap-only belt or a lap/shoulder belt. NHTSA is expected to publish an NPRM on roof strength standards for motorcoaches[94] and a final rule on motorcoach occupant crash protection later this year.

School buses have long demonstrated the ability to resist roof crush during rollover events in real-world accidents and in NHTSA testing (based on FMVSS No. 220 for school bus rollover protection). NHTSA has tested motorcoaches to the school bus roof strength standard. The two motorcoaches NHTSA tested in this fashion showed roof displacements of more than

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

[93] See http://www.fmcsa.dot.gov/documents/safety-security/MotorcoachSafetyactionPlan_finalreport-508.pdf, accessed June 12, 2012.

[94] The NTSB has an open recommendation to NHTSA concerning luggage racks on motorcoaches. Safety Recommendation H-10-4 reads "Develop performance standards for all newly manufactured buses with a gross vehicle weight rating above 10,000 pounds to require that overhead luggage racks are constructed and installed to prevent head and neck injuries and remain anchored during an accident sequence." The NTSB anticipates that the roof strength standards NHTSA is developing will address any interior object/surface that can intrude on the survivable space.

five times the allowable limit. Although NHTSA is working to improve occupant protection and roof strength on motorcoaches, standards are needed to advance these efforts effectively.

In its report on the New York City accident, the NTSB concluded that even in severe intrusion events, passenger lap/shoulder belts would most likely mitigate serious and fatal injuries for some passengers. As a result, the NTSB reiterated Safety Recommendations H-99-47 and -48.[95] The occupant protection failures in the Doswell motorcoach rollover further emphasize the need for full and prompt implementation of these recommendations. On this basis, the NTSB again reiterates Safety Recommendations H-99-47 and -48 to NHTSA, and these recommendations remain classified "Open—Unacceptable Response."

Further, given that the roof collapse of the motorcoach in the Doswell accident had such catastrophic consequences in terms of passenger deaths and injuries, the NTSB reiterates Safety Recommendations H-99-50 and -51 to NHTSA, and these recommendations remain classified "Open—Unacceptable Response."

Window glazing is also important for a complete occupant protection system. Window glazing that remains intact can act as a form of passive occupant protection by preventing full ejection of unrestrained passengers and reducing injuries due to partial ejection of restrained passengers. One of the objectives under the occupant protection category of vehicle integrity in the DOT Motorcoach Safety Action Plan is to accelerate research on improved glazing and window retention techniques. This effort was planned to follow the development of roof crush performance requirements.

Also in its 1999 report on motorcoach issues, the NTSB made the following recommendation concerning window glazing to NHTSA:[96]

> Expand your research on current advanced glazing to include its applicability to motorcoach occupant ejection prevention, and revise window glazing requirements for newly manufactured motorcoaches based on the results of this research. (H-99-49)

The recommendation is currently classified "Open—Acceptable Response."

Two occupants of the accident motorcoach were partially ejected due to the collapse of the roof and the loss of the window glazing; the vehicle structure subsequently struck these two occupants during the roof collapse, causing fatal crushing injuries. Therefore, the NTSB concludes that the loss of window glazing contributed to the fatalities in this accident, in connection with the deterioration of vehicle integrity due to the roof collapse. Consequently, the NTSB reiterates Safety Recommendation H-99-49 and classifies it "Open—Unacceptable Response."

[95] NTSB/HAR-12/01.

[96] NTSB/SIR-99/01.

2.4 Motor Carrier Oversight

2.4.1 New Entrant Safety Assurance Program

New Entrant Sky Express. When, in 2005, Sky Express applied for interstate operating authority, the FMCSA entered it into the new entrant safety assurance program.[97] Since January 1, 2003, the FMCSA has required all new motor carriers operating in interstate commerce to apply for registration as a new entrant. Before a new entrant completes 18 months of operation, the FMCSA is to conduct a safety audit of the carrier and evaluate its crash and roadside inspection data. At a minimum, the safety audit covers driver qualifications, driver duty status, vehicle maintenance, accident register, and controlled substance and alcohol use testing requirements. If the FMCSA identifies deficiencies, the carrier must provide evidence that it is correcting the faults found during the audit.

After Sky Express initially failed to respond to FMCSA requests to schedule a new entrant safety audit, the FMCSA indicated in February 2007—after nearly 2 years of Sky Express's operating as an interstate passenger carrier—that it would revoke the carrier's operating authority if it did not participate in a safety audit. Warned of the possibility of revocation, the company arranged for the audit, which took place on February 27, 2007. During the safety audit, the FMCSA identified three areas needing improvement: driver qualification files, driving/employment histories, and vehicle maintenance files.[98] Despite these shortcomings, Sky Express passed the audit.

The FMCSA new entrant safety audit, as conducted in 2007, did not pose a significant obstacle to the carrier's maintaining operating authority. Sky Express, which had no effective safety programs in place and safety deficiencies in three important areas, passed the new entrant audit and had its operating authority confirmed by the FMCSA. The fact that Sky Express management subsequently failed to implement any safety programs during its entire period in business suggests the new entrant safety audit process is not effectively keeping poorly prepared new operators from obtaining and maintaining operating authority. The NTSB concludes that Sky Express passed the FMCSA new entrant safety assurance audit despite safety shortcomings in its operation, which indicates the new entrant audit process is not always keeping unsafe carriers from entering the motor carrier industry.

In its report on a 2002 accident in Loraine, Texas, the NTSB made the following safety recommendation to the FMCSA:[99]

[97] In 2005, the firm was still known as "Lei Shi." The firm changed its name, but not its operating style, sometime before 2009. To avoid confusion, this portion of the report will refer to the motor carrier as "Sky Express" for its full period of operation as an interstate passenger carrier.

[98] The new entrant audit is composed of 60 questions concerning safety regulations; of these, 28 are rated critical if failed and 16 are rated acute if failed; those remaining are unrated. For the purposes of scoring methodology, the questions are categorized into four factors (general, driver, operations, and maintenance) with additional factors for hazardous materials and accidents. The carrier failed two critical driver questions and one critical maintenance question.

[99] *Collision of Greyhound Lines, Inc., Motorcoach and DelCar Trucking Truck Tractor-Semitrailer, June 9, 2002, Loraine, Texas*, Highway Accident Report NTSB/HAR-03/01 (Washington, D.C.: National Transportation Safety Board, 2003).

> Require all new motor carriers seeking operating authority to demonstrate their safety fitness prior to obtaining new entrant operating authority by, at a minimum: (1) passing an examination demonstrating their knowledge of the *Federal Motor Carrier Safety Regulations*; (2) submitting a comprehensive plan documenting that the motor carrier has management systems in place to ensure compliance with the *Federal Motor Carrier Safety Regulations*; and (3) passing a Federal Motor Carrier Safety Administration safety audit, including vehicle inspections. (H-03-2)

Since implementing its new entrant safety assurance program in 2003, the FMCSA has taken steps to improve and enhance the program. For instance, in 2006, the FMCSA developed an evasion detection algorithm (EDA) to identify corporate information associated with passenger carriers with histories of poor safety performance. In August 2008, the FMCSA began applying the EDA screening process to newly registered passenger carriers before granting them operating authority. The FMCSA has indicated that it is continuing to work to improve the program. On the basis of these FMCSA actions, the recommendation has been classified "Open—Acceptable Response."

Despite these FMCSA efforts, however, the new entrant safety assurance program does not yet fully address Safety Recommendation H-03-2, particularly with respect to element (1). The NTSB continues to consider that, particularly before beginning passenger service, new entrants should be required to demonstrate that they understand the safety responsibilities codified in the FMCSRs. Such a demonstration would be consistent with the procedure some states use before granting intrastate operating authority, in which applicants must undergo a public hearing to convince a hearing officer that they have the resources and knowledge to conduct safe passenger-carrying operations.[100] Had Sky Express been required to fulfill such a prerequisite, it might have been prevented from entering the passenger-carrying industry. Element (1) of Safety Recommendation H-03-2 calls for the new entrant to demonstrate knowledge of the FMCSRs prior to receiving operating authority. Consequently, the NTSB reiterates Safety Recommendation H-03-2 to the FMCSA. On the basis of the FMCSA's generally fulfilling elements (2) and (3) of the recommendation through the imposition of, and continuing work on, the new entrant safety assurance program, the safety recommendation remains classified "Open—Acceptable Response." The NTSB expects the FMCSA will continue to work to improve its new entrant program and notes that the agency's 2012 strategic plan proposes to "raise the bar to enter the motor carrier industry through new credentialing standards to include effective vetting, education, and testing elements of all regulated entities."[101]

Safety Processes. To fulfill its intended purpose, the new entrant screening undertaken at the time of the safety audit should consider the prospective carrier's safety processes. Such processes should, at a minimum, demonstrate commitment of the ownership/management to safe operation and include procedures to identify and manage safety risks, programs to prevent and mitigate risks, and measures to continually evaluate and enhance safety.

[100] For example, Massachusetts General Law, chapter 159A and 200, *Code of Massachusetts Regulations*, Department of Public Utilities, chapter 155, requires the state to conduct a public hearing prior to an operator's beginning intrastate passenger-carrying operations.

[101] *Federal Motor Carrier Safety Administration Strategic Plan 2012–2016*, May 2012, p. 7. (See http://www.fmcsa.dot.gov/documents/STRATEGIC-PLAN/FMCSA_StrategicPlan_2012-2016.pdf, accessed June 12, 2012.)

The FMCSA has begun advocating a program called the Safety Management Cycle, which can be used, either by the carrier or by safety investigators, to determine whether a carrier has a safety problem and to pinpoint the source of the issue. The six-element cycle provides a systematic and continuous approach to assessing a carrier's safety practices. In its New York City report, the NTSB made the following recommendation to the FMCSA:[102]

> Include in the safety fitness rating rulemaking for the new Compliance, Safety, Accountability initiative a structured process, such as the Safety Management Cycle, to be used by Federal Motor Carrier Safety Administration investigators and their state Motor Carrier Safety Assistance Program agents, as an audit tool for investigators to (1) identify the root cause of safety risks found during compliance reviews, and (2) deliver constructive guidance to motor carriers to ensure the promotion of safety management. (H-12-18)

The recommendation is currently classified "Open—Await Response."

The new entrant safety audit enables the FMCSA to check whether a new carrier has demonstrated both its commitment to, and plan for, identifying and mitigating safety risks. The NTSB concludes that the FMCSA missed the opportunity provided by the new entrant safety audit to ensure that Sky Express had a programmatic commitment to safety, and the carrier entered the passenger transportation industry without demonstrating an understanding of its safety responsibilities. The NTSB further concludes that applying a structured process such as the Safety Management Cycle would help new entrant carriers demonstrate their intention to provide a positive safety culture and a systematic safety effort. Therefore, the NTSB recommends that the FMCSA, as a component of its new entrant safety audits, review with each new entrant motor carrier a structured process, such as the Safety Management Cycle, to (1) identify the root cause of safety risks and (2) maintain an effective safety assurance program. Implementation of this recommendation would enhance the effectiveness of Safety Recommendation H-12-18, because it would help prepare carriers for use of this tool during compliance reviews.

2.4.2 Compliance Reviews of Sky Express

Compliance Review Process. Between its passing the new entrant audit in early 2007 and the May 2011 accident, Sky Express was the subject of five FMCSA compliance reviews: they occurred on May 6, 2008; May 12, 2009; April 12, 2010; April 7, 2011; and May 23, 2011. The relatively high level of FMCSA scrutiny of the carrier's operation was triggered by warning signs such as poor SafeStat and Safety Measurement System (CSA program) scores or previous unsatisfactory or conditional safety ratings. In each case, the FMCSA found deficiencies in the Sky Express operation but the carrier remained in service.

When Sky Express received notice from the FMCSA of a proposed unsatisfactory rating in May 2009 due to deficiencies in the driver and operational factors, it employed a safety consultant to help improve its compliance review rating; in this way, by July 2009, Sky Express was able to upgrade its rating to conditional via the statutory rating appeals process. It then

[102] NTSB/HAR-12/01.

terminated the services of the consultant. During its next compliance review, in April 2010, Sky Express still had violations, but the overall rating given by the FMCSA was satisfactory. Then, after receiving a proposed overall unsatisfactory rating from the FMCSA following an April 2011 compliance review, the carrier again employed a safety consultant to appeal its safety rating.

The pattern of Sky Express's safety compliance record is clear. The carrier would minimally comply with safety regulations or, when failures were so evident that Sky Express's operating authority was threatened—by a proposed unsatisfactory rating—it would temporarily undertake a superficial makeover of its safety programs, by working with an external safety consultant and sending the FMCSA a safety improvement plan, making use of the statutory appeals process. However, the evidence shows Sky Express never attempted to develop and implement a long-term, comprehensive program to comply with safety regulations.

By the time of the accident, 6 years after becoming a motor carrier, Sky Express had experienced a nearly tenfold expansion, increasing its number of motorcoaches from 3 to 31 and its number of drivers from 6 to more than 50. However, during these years of growth, the carrier never developed a more structured organization and never had a central business office, passenger terminal, or company garage for vehicle repair.

Sky Express was also lax with respect to the safety oversight and training of its drivers. It collected HOS records from drivers irregularly and stored them haphazardly; these records were not maintained, as required, for 6 months after receipt. For example, for the 6 months prior to the May 31, 2011, accident, Sky Express could only supply logbooks for the accident driver for December, February, and parts of April and May. Moreover, the carrier appears to have exercised no HOS oversight of its drivers, as evidenced by the repeated instances of HOS violations found in postaccident examination of the accident driver's logbooks that were available. NTSB investigators found 71 violations for this one driver in February 2011.

Until a month before the accident, Sky Express had no written safety policies. Only in April 2011, through its independent safety consultant, did the carrier provide written safety documents for its drivers—after Sky Express had been operating as a passenger carrier for 6 years. Despite the increasing size of its operation, Sky Express never demonstrated an understanding of the requirements of operating a safety-conscious motor carrier business and was unwilling to place a high value on regular compliance with safety regulations. In short, it did as little as possible with respect to compliance, consistent with maintaining its operating authority. Therefore, the NTSB concludes that Sky Express management failed to follow adequate safety practices and to exercise safety oversight of its drivers.

The compliance review history of Sky Express highlights fundamental weaknesses in the FMCSA oversight process. The FMCSA focused attention on the carrier's operations, and it appears to have recognized Sky Express as a problem carrier with significant shortfalls in its compliance with safety regulations. Nevertheless, the FMCSA did not put the carrier out of business until it issued Sky Express a "cease and desist" order following the fatal May 31, 2011, accident.

A compliance review is based on the carrier's compliance with the FMCSRs; however, only violations of FMCSRs classified as critical or acute are considered in determining the carrier's overall compliance rating. In the case of Sky Express, of the 63 violations cited during its compliance reviews, only 24 (38 percent) were classed as either critical or acute, and of those 24, only 18 counted toward the carrier's compliance rating. Because FMCSA compliance reviews classify only a limited number of FMCSRs as critical or acute, the final ratings of Sky Express did not fully reflect the degree of safety problems found during the compliance reviews, and the carrier was permitted to continue to operate despite known safety shortcomings.

The condition of its vehicles and the performance of its drivers are among the most important factors in assessing the safety of a motor carrier's operation. However, current rules prevent the FMCSA from giving a carrier an unsatisfactory rating if it is unsatisfactory in only one of the six rating factors of (1) general, (2) driver, (3) operational, (4) vehicle, (5) hazardous materials, and (6) accident rate. At least two unsatisfactory factors are necessary before the FMCSA may issue an overall unsatisfactory rating.[103] Thus, a carrier could be unsatisfactory in either the vehicle or driver factor yet still be permitted to operate. In the view of the NTSB, an unsatisfactory rating in either the vehicle or driver factor should be sufficient cause to put a carrier out of service. In its 1999 report on selective motorcoach issues, the NTSB issued the following recommendation to the FMCSA:[104]

> Change the safety fitness rating methodology so that adverse vehicle and driver performance-based data alone are sufficient to result in an overall unsatisfactory rating for the carrier. (H-99-6)

In its April 12, 2010, compliance review, Sky Express received a conditional rating in the vehicle factor but an overall rating of satisfactory. Had the FMCSA implemented the intent of Safety Recommendation H-99-6 by this date, the carrier most likely would have received an overall rating of conditional, due to this deficient vehicle factor. A 2010 overall conditional rating, coupled with its 2009 overall conditional rating, would have established a clear history of problematic compliance by Sky Express before its 2011 compliance review. Having established this record of successively poor safety compliance by Sky Express, when the April 2011 compliance review then resulted in a proposed overall unsatisfactory rating, the FMCSA might have acted faster to put this unsafe carrier out of business. Therefore, the NTSB concludes that had the FMCSA changed the safety fitness rating methodology to give appropriate weight to vehicle and driver performance-based data, it would have had additional evidence before the accident that Sky Express was a habitually unsafe carrier.

The NTSB has repeatedly reiterated Safety Recommendation H-99-6, most recently in its report on the investigation of a 2008 motorcoach rollover near Victoria, Texas.[105] Also in the Victoria report, the recommendation was reclassified "Open—Unacceptable Response" due to its age (more than 10 years) and the fact that the FMCSA compliance review process did not

[103] The FMCSA may also issue an overall unsatisfactory rating if a carrier has an unsatisfactory rating in one factor and more than two conditional ratings in any other factors.

[104] NTSB/SIR-99/01.

[105] *Motorcoach Rollover on U.S. Highway 59 Near Victoria, Texas, January 2, 2008*, Highway Accident Summary Report NTSB/HAR-09/03-SUM (Washington, D.C.: National Transportation Safety Board, 2009).

effectively identify unsafe motor carriers and prevent them from operating. In October 2, 2009, correspondence concerning Safety Recommendation H-99-6, the FMCSA indicated the implementation of CSA would address the intent of the recommendation. It stated "CSA 2010 will promote corrective action and the understanding that even a single area of poor performance will result in an intervention by FMCSA."

The NTSB acknowledges that, as it implements CSA, the FMCSA is working to improve its procedures to more accurately rate and respond to the safety risk posed by a motor carrier. The NTSB also appreciates that the rating process as reflected in Safety Recommendation H-99-6 is being supplanted by the CSA system's new rating procedures. However, the FMCSA has not yet fully implemented CSA and, until rulemaking on the safety rating process is completed, will continue to use the current compliance review process for determining a carrier's fitness to operate. Thus, the problem addressed by Safety Recommendation H-99-6, that the rating process may not be appropriately valuing driver and vehicle factors in compliance review ratings, remains.

In its New York City report, the NTSB made the following safety recommendation addressing the new safety rating system being enacted under CSA:[106]

> Include safety measurement system rating scores in the methodology used to determine a carrier's fitness to operate in the safety fitness rating rulemaking for the new Compliance, Safety, Accountability initiative. (H-12-17)

This recommendation is currently classified "Open—Await Response." The NTSB encourages the FMCSA, as it finalizes the implementation of CSA and completes rulemaking on 49 CFR 385 Subpart D, to address the intent of Safety Recommendation H-99-6 as well as Safety Recommendation H-12-17. Until the FMCSA completes these processes, however, the NTSB reiterates Safety Recommendation H-99-6 to the FMCSA, and the recommendation remains classified "Open—Unacceptable Response."

FMCSA 10-Day Extension of Operating Authority. When the accident occurred, Sky Express was doing business under an extension of operating authority that had been granted by the FMCSA following an April 7, 2011, compliance review that had resulted in a proposed overall rating of unsatisfactory. Such a rating, if not revised by the FMCSA, would put the carrier out of business. As part of the standard ratings process, the FMCSA warned the carrier of the proposed rating and informed it that it had an opportunity to submit a corrective action plan during a 45-day period for appeal. The period began on April 13 and was to expire on May 28 (3 days before the accident on May 31).

Sky Express took advantage of this opportunity and, using the services of a safety consultant, submitted a corrective action plan, which the FMCSA found insufficient. On May 12 and 13, the FMCSA informed the carrier that it would perform another compliance review sometime before June 7, and that the FMCSA would hold its final rating in abeyance until June 7, 2011, thus granting an extension of operating authority of 10 days beyond the standard

[106] NTSB/HAR-12/01.

45-day appeals period. The regulatory language at 49 CFR 385.17 provides that the FMCSA may grant such 10-day extensions at its discretion.

On May 23 to 26, 2011, the FMCSA conducted another compliance review of Sky Express; the FMCSA was reviewing the results of this compliance review when the accident occurred on May 31. Thus, the extension of the rating appeals period took place while the FMCSA completed its compliance review process. In 2011, following the Doswell accident, the FMCSA administrator testified before Congress that the agency would cease issuing 10-day extensions during the appeals process for carriers receiving unsatisfactory ratings in compliance reviews. Subsequently, the FMCSA changed its internal policy so that such extensions would no longer be issued.

3. Conclusions

3.1 Findings

1. The following were not factors in this accident: (1) driver health, (2) alcohol or drug use, (3) cell phone use by the driver, (4) weather, (5) preexisting mechanical defects or deficiencies on the motorcoach, (6) motorcoach speed, or (7) highway design.

2. The emergency response was timely and adequate.

3. The driver fell asleep while driving due to fatigue resulting from acute sleep loss, poor sleep quality, and circadian disruption.

4. Sky Express, Inc.'s, failure to exercise even minimal oversight of its drivers' rest and sleep activities enabled the drivers to drive while dangerously fatigued.

5. If the Federal Motor Carrier Safety Administration requires carriers to implement fatigue management programs without ensuring the programs stay active and effective, some may not have the intended result of reducing driver fatigue and increasing safety.

6. Passenger-carrying commercial motor vehicle operators should follow driver hours-of-service rules at least as stringent as those required of property-carrying operators.

7. Commercial motor vehicle hours-of-service regulations for passenger-carrying drivers would be more effective if they addressed the scientifically established risk of drivers operating during windows of circadian lows.

8. The four fatalities in this accident resulted from crushing injuries as the motorcoach rolled over and the roof collapsed.

9. The passengers who survived the accident were thrown from the seating compartments and experienced injuries during the rollover event due to the lack of a passenger restraint system on the motorcoach.

10. Both a restraint system and a system ensuring sufficient roof strength, working in combination as part of a comprehensive occupant protection system, are needed to provide adequate protection to motorcoach occupants in the event of a rollover.

11. The loss of window glazing contributed to the fatalities in this accident, in connection with the deterioration of vehicle integrity due to the roof collapse.

12. Sky Express, Inc., passed the Federal Motor Carrier Safety Administration new entrant safety assurance audit despite safety shortcomings in its operation, which indicates the new entrant audit process is not always keeping unsafe carriers from entering the motor carrier industry.

13. The Federal Motor Carrier Safety Administration missed the opportunity provided by the new entrant safety audit to ensure that Sky Express, Inc., had a programmatic commitment to safety, and the carrier entered the passenger transportation industry without demonstrating an understanding of its safety responsibilities.

14. Applying a structured process such as the Safety Management Cycle would help new entrant carriers demonstrate their intention to provide a positive safety culture and a systematic safety effort.

15. Sky Express, Inc., management failed to follow adequate safety practices and to exercise safety oversight of its drivers.

16. Had the Federal Motor Carrier Safety Administration changed the safety fitness rating methodology to give appropriate weight to vehicle and driver performance-based data, it would have had additional evidence before the accident that Sky Express, Inc., was a habitually unsafe carrier.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the motorcoach driver to maintain control of the vehicle due to his falling asleep while driving because of fatigue resulting from acute sleep loss, poor sleep quality, and circadian disruption and the failure of Sky Express, Inc., management to follow adequate safety practices and to exercise safety oversight of the driver. Contributing to the accident was the Federal Motor Carrier Safety Administration's lack of adequate oversight of Sky Express, Inc., which allowed the company to continue operations despite known safety issues. Contributing to the fatalities and the severity of the injuries was the lack of a comprehensive occupant protection system, including systems for providing passenger restraint and for ensuring sufficient roof strength.

4. Recommendations

4.1 New Recommendations

As a result of its investigation of the Doswell, Virginia, motorcoach accident, the National Transportation Safety Board makes the following safety recommendations:

To the Federal Motor Carrier Safety Administration:

> Establish an ongoing program to monitor, evaluate, report on, and continuously improve fatigue management programs implemented by motor carriers to identify, mitigate, and continuously reduce fatigue-related risks for drivers. (H-12-29) *[This safety recommendation supersedes Safety Recommendation H-08-14.]*
>
> Incorporate scientifically based fatigue mitigation strategies into the hours-of-service regulations for passenger-carrying drivers who operate during the nighttime window of circadian low. (H-12-30)
>
> As a component of your new entrant safety audits, review with each new entrant motor carrier a structured process, such as the Safety Management Cycle, to (1) identify the root cause of safety risks and (2) maintain an effective safety assurance program. (H-12-31)

4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendations:

To the Federal Motor Carrier Safety Administration:

> Require all motor carriers to adopt a fatigue management program based on the North American Fatigue Management Program guidelines for the management of fatigue in a motor carrier operating environment. (H-10-9)
>
> Require all new motor carriers seeking operating authority to demonstrate their safety fitness prior to obtaining new entrant operating authority by, at a minimum: (1) passing an examination demonstrating their knowledge of the *Federal Motor Carrier Safety Regulations*; (2) submitting a comprehensive plan documenting that the motor carrier has management systems in place to ensure compliance with the *Federal Motor Carrier Safety Regulations*; and (3) passing a Federal Motor Carrier Safety Administration safety audit, including vehicle inspections. (H-03-2)
>
> Change the safety fitness rating methodology so that adverse vehicle and driver performance-based data alone are sufficient to result in an overall unsatisfactory rating for the carrier. (H-99-6)

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)

4.3 Previously Issued Recommendation Reclassified in This Report

The National Transportation Safety Board reclassifies the following safety recommendation:

To the Federal Motor Carrier Safety Administration:

> Develop and use a methodology that will continually assess the effectiveness of the fatigue management plans implemented by motor carriers, including their ability to improve sleep and alertness, mitigate performance errors, and prevent incidents and accidents. (H-08-14)

Safety Recommendation H-08-14 is reclassified "Closed—Acceptable Action/Superseded" (superseded by Safety Recommendation H-12-29).

4.4 Previously Issued Recommendation Reiterated and Reclassified in This Report

The National Transportation Safety Board reiterates and reclassifies the following safety recommendation:

To the National Highway Traffic Safety Administration:

> Expand your research on current advanced glazing to include its applicability to motorcoach occupant ejection prevention, and revise window glazing requirements for newly manufactured motorcoaches based on the results of this research. (H-99-49)

Safety Recommendation H-99-49 is reiterated and reclassified "Open—Unacceptable Response" in this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

DEBORAH A.P. HERSMAN
Chairman

ROBERT L. SUMWALT
Member

CHRISTOPHER A. HART
Vice Chairman

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: July 31, 2012

Vice Chairman Hart and Member Rosekind filed the following concurring statements on August 1, 2012, and August 3, 2012, respectively.

Board Member Statements

Vice Chairman Christopher A. Hart, concurring:

I concur with this report and would like to address two areas that are not mentioned in the report: the selection by casinos of the carriers that bring passengers to the casino, and the concept of allowing carriers to operate before they have demonstrated their ability to operate safely.

Selection of Carriers by Casinos. Although this accident did not involve the carriage of passengers to or from a casino, the report notes that the company involved in this accident was also engaged in casino transportation. Hence, this is the second accident report the Board has issued in less than two months involving passenger motor carriers that carry passengers to and from casinos. Given that our investigators found numerous safety deficiencies with both carriers, these two accidents should constitute a major wake-up call to casinos to pay closer attention to the safety records of the motor carriers they select.

Casinos have a major "dog in this fight" not only because they engage the motor carriers to bring passengers, but because they frequently also provide financial enticements for passengers to ride the carrier to the casino. Given that in many instances the casinos have the deepest pockets of anyone involved in an accident, typically much deeper than the motor carriers, it would appear that the casinos should, from the standpoint of their own potential liability, inquire very extensively into the safety record of the carriers they select. In much the same way that the Department of Defense carefully scrutinizes the safety record of the carriers they choose to carry our soldiers, the casinos should want to conduct a detailed "due diligence," and have a very high bar, regarding the safety record of the carriers they select to bring passengers to the casino.

Operation Before Demonstrating Safety. The report notes that new entrants need not demonstrate their capability to operate safely before they begin carrying passengers, but the safety check must occur within 18 months of the commencement of operations. In 18 months, however, a carrier with two 50-passenger buses running two trips a day could have carried more than 100 thousand passengers before having its first safety examination; and the motor carrier involved in this accident operated for 22 months before its first safety check.

The public would be appalled if airlines could carry passengers before demonstrating their ability to do so safely. Query why a motor carrier should be allowed to carry passengers before demonstrating its safety fitness.

Chairman Hersman and Members Sumwalt, Rosekind, and Weener joined in this concurring statement.

Member Mark R. Rosekind, concurring:

The fatigue-related recommendations issued in this accident report further advance the NTSB's efforts to address fatigue as a serious and pervasive transportation safety issue. Three specific recommendations deserve emphasis.

First, the NTSB reiterates the recommendation to require fatigue management programs (FMP) for all motor carriers (H-10-9). It has become clear that the complex nature of fatigue requires a comprehensive and programmatic approach to manage effectively the safety, performance, and alertness risks created by fatigue. While science-based hours-of-service regulations are necessary, they are not sufficient to manage this complexity. The multiple elements of an FMP can include education, fatigue countermeasures training, scheduling policies and practices, diagnosis and treatment of sleep disorders, non-punitive fatigue reporting systems, and other activities.

The reiterated recommendation is to adopt a fatigue management program based on the North American Fatigue Management Program (NAFMP) guidelines. The NAFMP guidelines and materials have not been released since this recommendation was made two years ago. Science-based FMP information and materials are now widely available and implementing a requirement for motor carriers to adopt FMPs will take time. Therefore, given the known fatigue-related safety risks that will continue until effective FMPs are implemented, it is critical that FMCSA move forward expeditiously on this reiterated recommendation.

Second, the NTSB issued a new recommendation to "...establish an ongoing program to monitor, evaluate, report on, and continuously improve fatigue management programs implemented by motor carriers to identify, mitigate, and continuously reduce fatigue-related risks for drivers." superseding a previous recommendation (H-08-14). Once adopted, an ongoing process of evaluation and improvement will be important to ensure that FMPs are effectively managing fatigue risks as intended.

Third, the NTSB issued a new recommendation to "...incorporate scientifically based fatigue mitigation strategies into the hours-of-service regulations for passenger-carrying drivers who operate during the nighttime window of circadian low." As discussed in the Board Meeting, operating through the night during the window of circadian low when alertness and performance are physiologically degraded creates known safety risks. Just last year, on May 12, 2011, a motorcoach ran off the road in New York City and collided with a vertical signpost killing 15 passengers and injuring 17. Again, the motorcoach was operating through the night and during the window of circadian low. The Board identified the Probable Cause as the driver's failure to control the motorcoach due to fatigue resulting from failure to obtain adequate sleep, poor sleep quality, and the time of day at which the accident occurred.

Enhancing the hours-of-service regulations to address the known safety risks associated with the nighttime window of circadian low will significantly improve their effectiveness to manage fatigue.

The staff is to be commended for the solid, thorough investigation and fatigue-related recommendations that raise the bar in addressing the known safety risks created by fatigue on our roadways.

Mark R. Rosekind, Ph. D.

Chairman Hersman, Vice Chairman Hart, and Members Sumwalt and Weener joined in this concurring statement.

Appendix: Investigation

The National Transportation Safety Board (NTSB) received notification of this accident on May 31, 2011. The NTSB launched a team of accident investigators to address motor carrier, survival and occupant protection, human performance, vehicle, and highway factors. NTSB Member Earl F. Weener took part in the on-scene investigation.

Parties to the investigation were the Federal Motor Carrier Safety Administration, the National Highway Traffic Safety Administration, the Virginia Department of Transportation, the Virginia State Police, and Setra North America (the accident motorcoach manufacturer).

No investigative hearing was held in connection with this accident.