Multivehicle Collision
Interstate 44 Eastbound
Gray Summit, Missouri
August 5, 2010

Accident Report

NTSB/HAR-11/03
PB2011-916203

National
Transportation
Safety Board

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Notation 8245A
Adopted December 13, 2011

Highway Accident Report

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

National Transportation Safety Board. 2011. ***Multivehicle Collision, Interstate 44 Eastbound, Gray Summit, Missouri, August 5, 2010*****. Highway Accident Report NTSB/HAR-11/03. Washington, DC.**

Abstract: On August 5, 2010, in Gray Summit, Missouri, traffic slowed in the approach to an active work zone on eastbound Interstate 44. A 2007 Volvo truck-tractor with no trailer was traveling in the right lane and had slowed or stopped behind traffic. About 10:11 a.m. central daylight time, a 2007 GMC Sierra extended cab pickup truck merged into the right lane and struck the rear of the Volvo tractor. This collision was the first in a series of three. Two school buses from St. James High School, St. James, Missouri, were approaching the slowed traffic and the collision ahead. The lead bus was a 71-passenger bus, occupied by 23 passengers. Following closely behind the lead bus was a 72-passenger bus, occupied by 31 passengers. Seconds after the lead bus passed a motorcoach that had stopped on the shoulder, it struck the rear of the GMC pickup. This collision—the second in the series—caused the pickup to overturn onto the back of the Volvo tractor. The front of the lead bus came to rest on top of the GMC pickup and the Volvo tractor. Moments later, the following bus struck the lead bus. As a result of this accident sequence, the driver of the GMC pickup and one passenger seated in the rear of the lead bus were killed. A total of 35 bus passengers, the 2 bus drivers, and the driver of the Volvo tractor were injured. Eighteen people were uninjured.

Major safety issues identified in this investigation were the potential use of video event recorder data in monitoring and oversight of driver performance; driver distraction due to use of a portable electronic device; necessity of maintaining adequate focus on the forward roadway and keeping recommended minimum following distance; medical oversight of interstate commercial drivers; inadequate Missouri state school bus inspection regulations and procedures; absence of Missouri state oversight of motor carriers involved in pupil transportation; frequency of rear-end accidents; design of emergency exit windows on school buses; and absence of a Missouri state requirement for pretrip safety briefings for pupils traveling to an activity or on a field trip in a school bus or a school-chartered bus. The National Transportation Safety Board makes recommendations to the National Highway Traffic Safety Administration, the 50 states and the District of Columbia, the state of Missouri, the Missouri Department of Elementary and Secondary Education, CTIA–The Wireless Association, the Consumer Electronics Association, the National Association of State Directors of Pupil Transportation Services, the National Association for Pupil Transportation, and the National School Transportation Association.

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Acronyms and Abbreviations

AAMVA	American Association of Motor Vehicle Administrators
ABS	antilock braking system
ACC	adaptive cruise control
ACM	air-bag control module
ADT	average daily traffic
CB	citizens band
CDL	commercial driver's license
CFR	*Code of Federal Regulations*
CMS	changeable message sign
CSA	Compliance, Safety, Accountability program (FMCSA)
CSR	(Missouri) *Code of State Regulations*
CVSA	Commercial Vehicle Safety Alliance
DMS	dynamic message sign
DOT	U.S. Department of Transportation
ECU	engine control unit
EMS	emergency medical services
FCW	forward collision warning
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSRs	*Federal Motor Carrier Safety Regulations*
FMVSS	Federal Motor Vehicle Safety Standard
g	acceleration due to gravity
GHSA	Governors Highway Safety Association
GPS	global positioning system
GVWR	gross vehicle weight rating
I-44	Interstate 44
IIHS	Insurance Institute for Highway Safety
ITS	intelligent transportation systems
MCMIS	Motor Carrier Management Information System (FMCSA)
MMVIRs	*Missouri Motor Vehicle Inspection Regulations*

MoDOT	Missouri Department of Transportation
MSHP	Missouri State Highway Patrol
MUTCD	*Manual on Uniform Traffic Control Devices*
NASDPTS	National Association of State Directors of Pupil Transportation Services
NCST	National Congress on School Transportation
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
ODI	Office of Defects Investigations (NHTSA)
PCP	phencyclidine
PRT	perception–reaction time
psi	pounds per square inch
SafeStat	Motor Carrier Safety Status Measurement System
SBMTC	School Bus Manufacturers Technical Committee
SDM	sensing and diagnostic module
USDOT	U.S. Department of Transportation (motor carrier number)
VER	video event recorder
VHS	video home system
VTTI	Virginia Tech Transportation Institute

Executive Summary

On Thursday morning, August 5, 2010, in Gray Summit, Missouri, traffic slowed in the approach to an active work zone on eastbound Interstate 44 (I-44), as motor vehicles merged from the closed left lane to the right lane. A 2007 Volvo truck-tractor with no trailer was traveling eastbound in the right lane and had slowed or stopped behind traffic. About 10:11 a.m. central daylight time, a 2007 GMC Sierra extended cab pickup truck merged from the left to the right lane and struck the rear of the Volvo tractor. This collision was the first in a series of three.

A convoy of two school buses from St. James High School, St. James, Missouri, was traveling eastbound in the right lane of I-44, approaching the slowed traffic and the collision ahead. Their destination was the Six Flags St. Louis amusement park in Eureka, Missouri. The lead bus was a 71-passenger school bus, occupied by 23 passengers. Following closely behind the lead bus was a 72-passenger school bus, occupied by 31 passengers. Seconds after the lead bus passed a motorcoach that had pulled over and stopped on the shoulder, it struck the rear of the GMC pickup. This collision—the second in the series—pushed the pickup forward, overturning it onto the back of the Volvo tractor. The front of the lead bus was ramped upward, as it came to rest on top of the GMC pickup and the Volvo tractor. Moments later, the following school bus struck the right rear of the lead bus.

As a result of this accident sequence, the driver of the GMC pickup and one passenger seated in the rear of the lead school bus were killed. A total of 35 passengers from both buses, the 2 bus drivers, and the driver of the Volvo tractor received injuries ranging from minor to serious. Eighteen people were uninjured.

Investigation Synopsis

The National Transportation Safety Board used scene evidence and information from cellular provider records, the GMC pickup air-bag control module, a video from the following school bus, and witness statements to reconstruct the three collisions.

The Volvo tractor was the last vehicle in a queue of slowed traffic in the right lane of the work zone. As the GMC pickup moved from the closed left lane to the right lane, approaching the Volvo tractor, the driver leaned to his right, possibly reaching for his cell phone to continue an ongoing text messaging conversation. One second prior to collision, the pickup was traveling at a speed of about 55 mph, and the driver had not applied the brakes.

Upon seeing the GMC pickup–Volvo tractor collision, the driver of a motorcoach steered his vehicle onto the right shoulder, stopping about 180 feet from the accident site. The lead school bus was approaching the accident site in the right lane at a driver-reported speed of 50 mph. The driver steered her bus to the left to clear the parked motorcoach and then moved back to the right lane. Almost immediately, the lead bus struck the GMC pickup, overriding it and lifting it onto the back of the Volvo tractor. The lead bus continued riding upward until it was resting on the Volvo tractor, with its front end high, its back wheels off the pavement, and its bumper on the ground. The time between the first and second collisions was about 6 seconds.

The driver of the following school bus was traveling in the right lane at 52 mph when she saw the lead school bus vault into the air. About 2 seconds before her vehicle collided with the lead bus, she applied the brakes and began steering to the right. The bus had decelerated to approximately 38 mph when it struck the lead bus above the rear bumper.

The Gray Summit accident investigation focused on (1) the potential use of video event recorder data in monitoring and oversight of driver performance; (2) driver distraction due to use of a portable electronic device; (3) necessity of maintaining adequate focus on the forward roadway and keeping recommended minimum following distance; (4) medical oversight of interstate commercial drivers; (5) inadequate Missouri state school bus inspection regulations and procedures; (6) absence of Missouri state oversight of motor carriers involved in pupil transportation; (7) frequency of rear-end accidents; (8) design of emergency exit windows on school buses; and (9) absence of a Missouri state requirement for pretrip safety briefings for pupils traveling to an activity or on a field trip in a school bus or a school-chartered bus.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the initial Gray Summit collision was distraction, likely due to a text messaging conversation being conducted by the GMC pickup driver, which resulted in his failure to notice and react to a Volvo tractor that had slowed or stopped in response to a queue that had developed in a work zone. The second collision, between the lead school bus and the GMC pickup, was the result of the bus driver’s inattention to the forward roadway due to excessive focus on a motorcoach parked on the shoulder of the road. The final collision was due to the driver of the following school bus not maintaining the recommended minimum distance from the lead school bus in the seconds preceding the accident. Contributing to the severity of the accident was the lack of forward collision warning systems on the two school buses.

Recommendations

As a result of its investigation, the National Transportation Safety Board makes recommendations to the National Highway Traffic Safety Administration (NHTSA), the 50 states and the District of Columbia, the state of Missouri, the Missouri Department of Elementary and Secondary Education, CTIA–The Wireless Association, the Consumer Electronics Association, the National Association of State Directors of Pupil Transportation Services, the National Association for Pupil Transportation, and the National School Transportation Association. This report reiterates and reclassifies previously issued recommendations to the Federal Motor Carrier Safety Administration (FMCSA) and to NHTSA, and also reiterates previously issued recommendations to the FMCSA, NHTSA, and the American Association of Motor Vehicle Administrators.

1 Factual Information

1.1 Accident Narrative

On Thursday morning, August 5, 2010, in Gray Summit, Franklin County, Missouri, traffic slowed approaching an active work zone on eastbound Interstate 44 (I-44), in the vicinity of mile marker 250.6, as motor vehicles merged from the left lane, which was closed ahead, to the right lane. A 2007 Volvo truck-tractor with no trailer, operated by a 43-year-old driver, was traveling eastbound in the right lane and had slowed or stopped behind traffic in the work zone. (See figure 1.) About 10:11 a.m. central daylight time,[1] a 2007 GMC Sierra extended cab pickup truck, operated by a 19-year-old driver, merged from the left to the right lane and struck the rear of the Volvo tractor.

A convoy of two school buses from St. James High School, St. James, Missouri, was traveling eastbound in the right lane of I-44, to the Six Flags St. Louis amusement park in Eureka, Missouri. A 2003 Blue Bird 71-passenger bus (the lead school bus), operated by a 75-year-old driver and occupied by 23 passengers, was approaching the slowed traffic and the accident ahead. A 2001 Blue Bird 72-passenger bus (the following school bus), operated by a 38-year-old driver and occupied by 31 passengers, was following the lead school bus. Seconds after the lead bus passed a motorcoach that had pulled over and stopped on the shoulder because of the initial collision, it struck the rear of the GMC pickup. This collision pushed the pickup forward, and it overturned onto the back of the Volvo tractor. The front of the lead bus was ramped upward, and it came to rest on top of the GMC pickup and the Volvo tractor. Moments later, the left front of the following bus struck the right rear of the lead bus. The following bus remained engaged with the lead bus. (See figures 2–5.)

As a result of this accident sequence, the driver of the GMC pickup and one passenger seated in the rear of the lead school bus were killed. A total of 35 school bus passengers from both buses, the 2 school bus drivers, and the driver of the Volvo tractor received injuries ranging from minor to serious. Eighteen people were uninjured.

The accident occurred on a straight section of roadway with a 3 percent upgrade. The temperature at the time of the accident was 81° F, the weather was clear, and the roadway was dry.

Appendix A presents background information on the National Transportation Safety Board's (NTSB) launch to the accident site.

[1] All times in this report are central daylight time unless stated otherwise.

Figure 1. Gray Summit, Missouri, accident location.

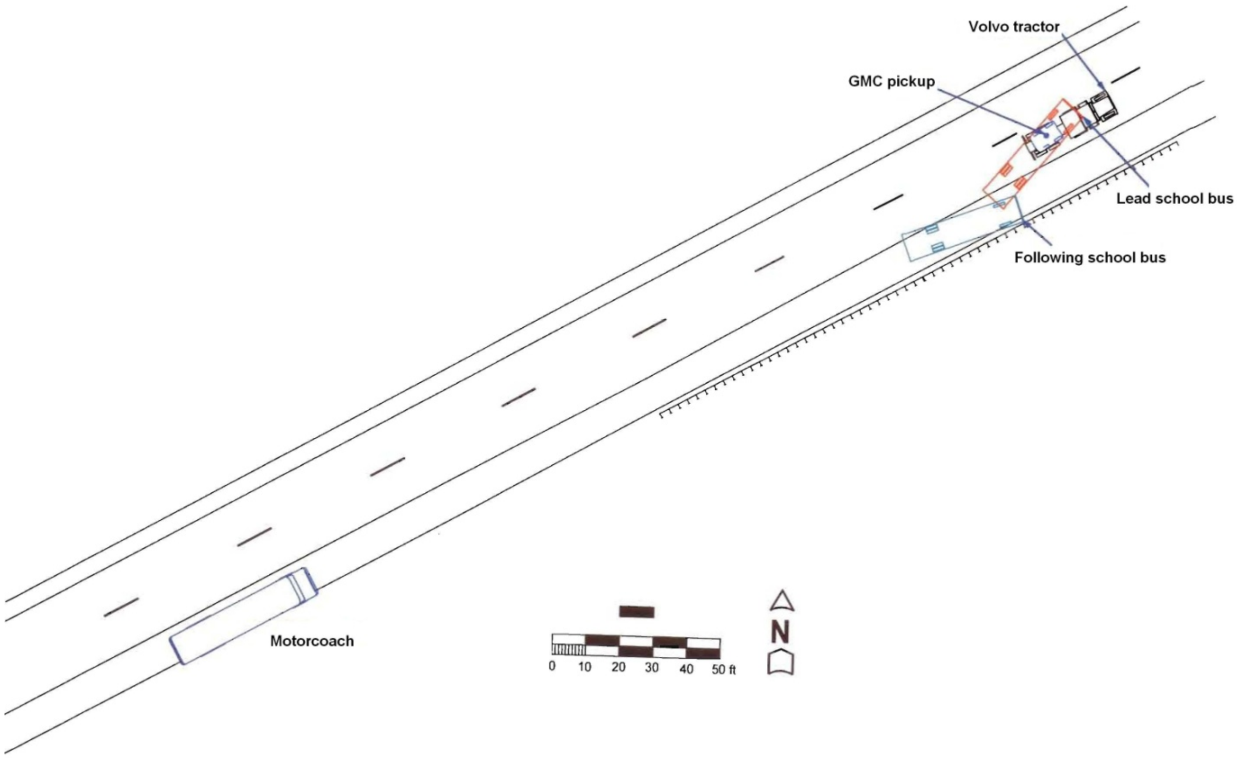

Figure 2. Diagram of accident vehicles at rest. Final rest position of GMC pickup was beneath lead school bus. Motorcoach shown to the west was not involved in accident but is referenced throughout the report.

Figure 3. Gray Summit accident scene, showing Volvo tractor and lead school bus. GMC pickup is located between the two vehicles and acted as a ramp for the school bus. The following school bus is located at right rear of photo. (Courtesy of Boles Fire Protection District)

Figure 4. Override and intrusion of following school bus into lead school bus. (Courtesy of Boles Fire Protection District)

Figure 5. Position of accident vehicles at rest, with GMC pickup located between lead school bus and top of rear wheels of Volvo tractor. (Courtesy of Boles Fire Protection District)

1.2 Witness Statements

A witness who had been driving in the left lane, approaching the rear of the GMC pickup, stated that he noticed the pickup driver lower his head to the right, as if he was leaning to reach for something. He said that he then noticed the Volvo tractor come to a stop and saw the GMC pickup hit the back of the tractor. According to the witness, he then looked in his right outside rearview mirror and saw the lead school bus hit the pickup truck and override the back of the Volvo tractor. When asked, the witness said that he did not see any brake lights from the GMC pickup prior to its collision with the Volvo tractor.

Another witness, who had been driving a motorcoach, told NTSB investigators that he was traveling about 45 mph before the accident, and cars were passing him. He reported that the traffic density was moderate to heavy. He saw a truck-tractor in front of him stop, and he began to slow. He then saw what he described as an “SUV” pass him from the left and enter the right lane. At an estimated distance of 600 feet in front of him, he saw the vehicle collide with the rear of the tractor. He stated that another vehicle also passed him on the left and continued past the collision. The motorcoach driver stopped his bus on the right shoulder about 180 feet behind the accident. The driver told NTSB investigators that he saw the collisions involving the two school buses approximately 5–6 seconds after the initial collision between the GMC pickup and the Volvo tractor. This statement contradicts what he told the Missouri State Highway Patrol (MSHP): that after parking his vehicle, he exited and attempted to slow down other drivers and that he did not see the accident with the buses because he was facing the opposite direction.

1.3 Injuries

Table 1 summarizes the injuries resulting from the accident. Figures 6 and 7 show the seating charts for the lead and following school buses, respectively. The passengers in the lead bus were female students, 13–17 years old. The passengers in the following bus included 1 chaperone and 30 male students, 6–18 years old. None of the occupants in either bus were ejected during the accident sequence.

Table 1. Injuries.

Injuries[a]	Drivers	Passengers	Total
Fatal	1	1	2
Serious	1	4	5
Minor	2	31	33
None	0	18	18
Total	4	54	58

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

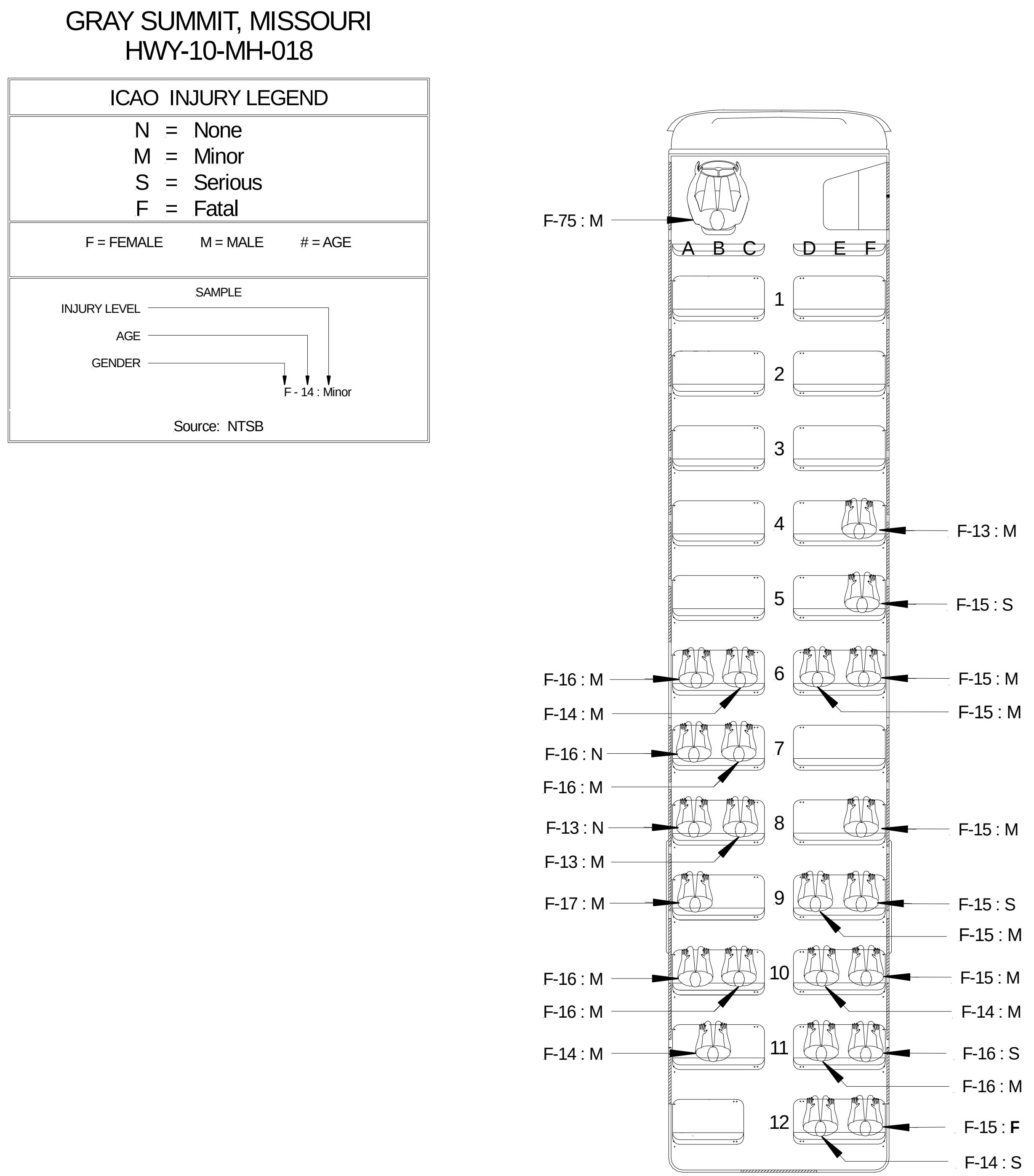

Figure 6. Seating chart for lead school bus.

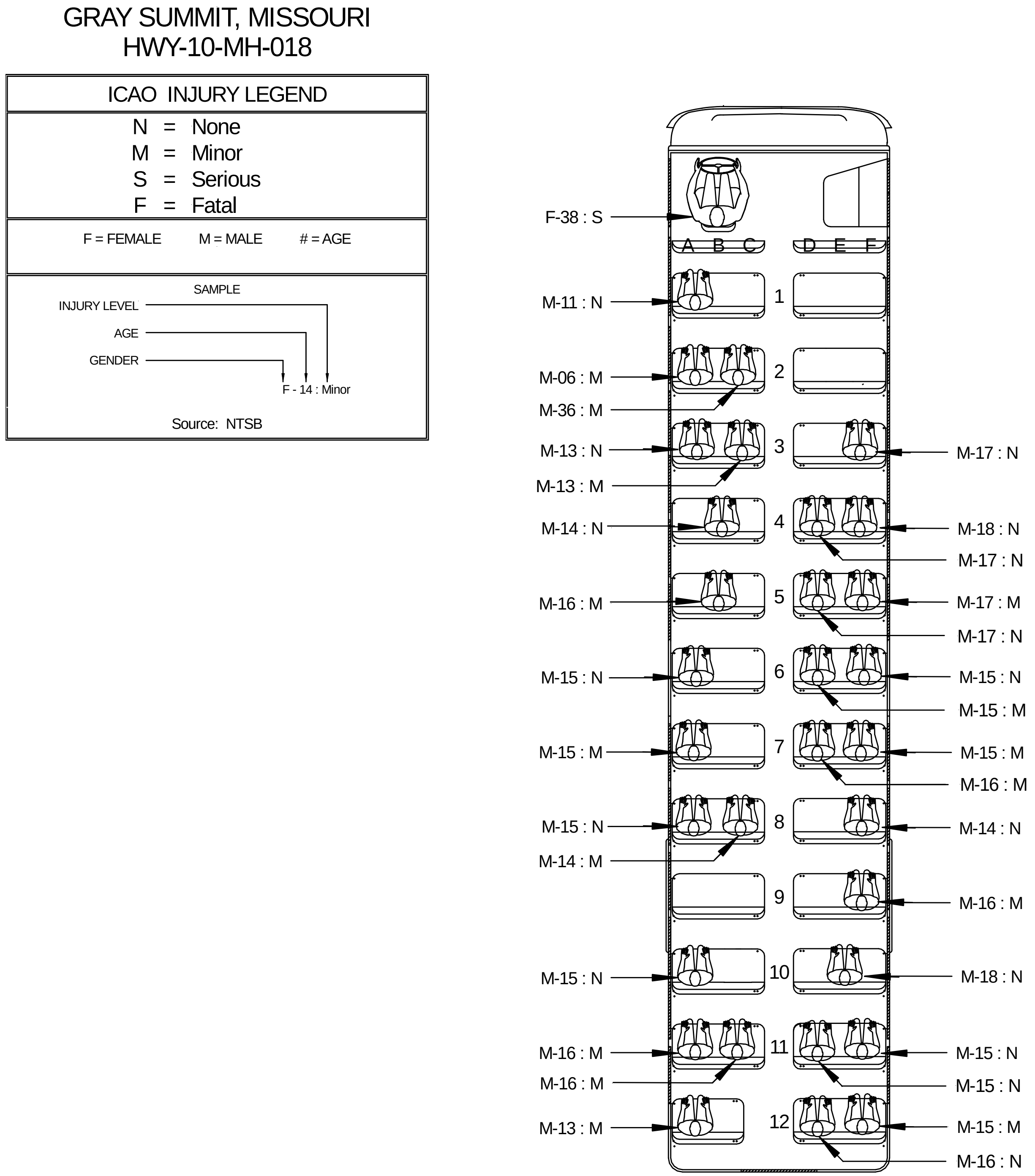

Figure 7. Seating chart for following school bus.

1.4 Medical and Pathological Information

According to autopsy reports, the driver of the GMC pickup sustained multiple fractures to the skull and lower right leg, and large lacerations and abrasions to the face, torso, and extremities. The 15-year-old female school bus passenger, who had been seated in the last row of seats on the right side of the lead school bus, sustained multiple fractures to the skull, chest, and extremities.

According to the emergency medical services (EMS) incident commander, ambulances transported 19 school bus occupants to five area hospitals—where they were evaluated, treated, and released, or transferred to higher trauma hospitals. Thirty-five occupants of the two buses were transported to Cardinal Glennon Children's Hospital. Two uninjured occupants left the accident scene.

1.5 Emergency Response

The Franklin County dispatcher was notified of the accident through the 911 system at 10:13 a.m. on August 5, 2011. The first call from dispatch went out to the Boles Fire Protection District at 10:14 a.m., and the incident commander arrived on scene at 10:19 a.m. Emergency responders from the Boles Fire District, the Meramec Ambulance District, and the MSHP arrived shortly afterward. A level 1 mass casualty incident was declared at 10:21 a.m. At 10:29 a.m., the incident commander asked dispatch to contact the Missouri Department of Transportation (MoDOT) to close down I-44 at exit 247. At 10:43 a.m., traffic was redirected to exit 247, and the eastbound and westbound lanes of I-44 were closed.

A total of two law enforcement agencies, three fire districts, and six ambulance services responded to the accident.[2] In all, 12 rescue and engine units and 13 ambulances were present at the scene. Fire engines placed foam over a gasoline spill from the GMC pickup, which was located under the lead school bus and atop the fifth wheel of the Volvo tractor. This task was completed at 11:01 a.m.

A surviving trapped occupant in the lead school bus was extricated at 10:37 a.m. Extrication of the two deceased occupants began at 1:00 p.m. and was completed by 2:11 p.m. MoDOT reopened traffic on this section of I-44 at 4:16 p.m.

In postaccident interviews, first responders commented that the rescue and recovery operations went smoothly and all responding agencies worked well together. The incident was handled as a unified command, with the MSHP investigating the accident; EMS units transporting the injured; and fire districts handling the rescue, extrication, and recovery efforts. Franklin County had an emergency operations plan in place, as required by the U.S. Department

[2] The MSHP, Franklin County Sheriff's Department, Boles Fire Protection District, Union Fire Protection District, Pacific Fire Protection District, Meramec Ambulance District, Eureka Fire Protection District EMS, Metro West Fire Protection District EMS, Big River Ambulance District, Washington Area Ambulance District, and St. Clair EMS responded to the accident.

of Homeland Security.[3] At the time of the accident, however, it did not have standard operating procedures for mass casualty incidents. The county completed a draft mass casualty incident plan and a draft mass patient care plan in May 2011.

1.6 Survival Factors

1.6.1 2007 Volvo Truck-Tractor

The GMC pickup–Volvo tractor collision caused moderate damage to the rear of the Volvo tractor and the top of the rear frame rails around the fifth wheel coupling. Both rear tandem mud flaps were broken off, and the left frame member was bent inward approximately 1 inch. In addition, the metal cross member between the frame rails, which supported the license plate and rear brake lights, was crushed inward approximately 9 inches. NTSB investigators measured the postaccident wheelbase on the right and left sides of the Volvo tractor at 244 inches and 242.5 inches, respectively.

The subsequent collision by the lead school bus damaged the top left corner of the Volvo tractor's fiberglass roof above the sleeper berth. The interior of the cab sustained significant damage to the top portion of the sleeper berth but no damage to the driver or front right passenger seating area.

The Volvo tractor was equipped with a driver air bag, and both the driver and passenger seats were equipped with three-point lap and shoulder restraints attached to the B-pillar of the cab. Because the Volvo tractor was involved in a rear-end collision, the air bag did not deploy, and no evidence of friction rub or stretching was found on the driver's seat belt.

1.6.2 2007 GMC Sierra Pickup Truck

The GMC pickup was taken to an impound lot in Saint Clair, Missouri, where it was examined by NTSB investigators. The damage to the exterior and interior was catastrophic. The front end of the pickup was severely damaged due to its impact with the rear of the Volvo tractor. The subsequent impact by the lead school bus resulted in the pickup overriding the back of the Volvo tractor and its undercarriage being folded into a "U" shape. During the accident sequence, the pickup's high-density polyethylene gasoline tank was torn and released fuel at the site. (See figures 8 and 9.)

The interior of the GMC pickup was fully destroyed and contained no survivable space. The rear seats were collapsed into the front seats, and the front seatbacks were folded down flat to the seat cushions. The steering wheel did not appear to be deformed; the steering column's

[3] The Franklin County emergency operations plan is currently in the all hazards format, with annexes for more specific topics. The plan contains the basic personnel roles and responsibilities—such as for triage and patient tracking—in accordance with the current Federal Emergency Management Agency National Incident Management System standards. The hazard-specific annexes contain more detail about specific topics. The health and medical services annex, for example, outlines the procedures for notification, request for more units, information flow, and activation. The Franklin County Mortuary Service standard operating procedures are included in an appendix.

shear capsule[4] was totally collapsed (that is, pushed inward) and separated by approximately 6 inches. The vehicle was equipped with a driver air bag, which deployed. The passenger-side air bag did not deploy because no one was seated in that position. An inspection of the driver's seat belt showed no evidence of usage at the time of the accident. According to first responders, the driver was found unrestrained by the available lap and shoulder belts.

Figure 8. GMC pickup in an inverted "U" shape, with its rear at left and its front at right. Undercarriage of pickup forms exterior of "U" shape.

[4] A shear capsule is a component of an energy-absorbing steering column that deforms with the application of a collision's direct forward force.

Figure 9. Gas tank tear in GMC pickup.

1.6.3 2003 Blue Bird Bus (Lead School Bus)

The lead school bus sustained moderate front-end damage from hitting the back of the GMC pickup and undercarriage damage from overriding the pickup and the sleeper berth of the Volvo tractor. The rear of the bus was seriously damaged as a result of being overridden by the following school bus. (See figure 10.)

Figure 10. Front and rear views of lead school bus. Emergency door supports and several roof pillars were cut to extricate an entrapped passenger.

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According to manufacturer specifications, the lead school bus had an original overall length of 427 inches, an overall width of 94 inches, and a wheel base of 210 inches. The initial frontal damage due to impact with the GMC pickup began at the left front corner and extended 80 inches to the right. Maximum crush was measured at 9.5 inches from the left front bumper, extending to the undercarriage of the bus. The driver-side windshield was knocked out. The passenger-side windshield was severely cracked but still in place. The right-side wheelbase was measured at 210 inches and the left at 211.5 inches.

The impact from the following school bus severely damaged the rear of the lead school bus. Direct damage to the rear bumper was primarily on the right side and spanned a width of 35 inches. The bumper was crushed inward 6 inches at its maximum point. The maximum residual crush into the passenger compartment was 62 inches. The override impact crushed the rear emergency door and rear wall inward, and caused the roof to buckle and crush inward and upward. In addition, the right outside side wall was crushed inward and to the right. The emergency door supports and several roof pillars were cut to extricate a passenger.

Interior damage to the lead school bus was primarily in the area of the right rear passenger compartment and the emergency exit door. The back right wall panel adjacent to the emergency door and roof sustained significant damage from the intruding front end of the following school bus. All rear windows, three side windows near the right rear, and one side window near the left rear were broken out. The rear emergency door, back right wall panel, and roof intruded into the occupant compartment. In the last two seating rows on the right side, the roof was crushed approximately 45 inches, to 6 inches below the seatbacks. The roof and side walls were also buckled inward at several locations near the rear of the bus.

The lead school bus was equipped with a bucket seat with cushion springs for the driver. Inspection of the driver's lap and shoulder restraint system revealed a small heat abrasion near the latch and buckle connection, indicating that the restraints were in use at the time of the accident. The steering wheel had no noticeable deformation. Behind the driver's seat were 11 rows of three-person bench seats and a twelfth row with a two-person seat. The right side had 12 rows of three-person seats. Each of the three-person bench seats was 39 inches wide, with the seatbacks 28.5 inches high. The two-person bench seat was 27 inches wide and 28.5 inches high. None of the passenger seating positions were equipped with seat belts.

The floor and wall anchors remained secured on both sides, postaccident, except at the seats in rows 10, 11, and 12 on the right side. The forward floor post for the right seat in row 12 was cut to allow extrication of the entrapped passenger, and the rearward floor post and wall anchors were torn out. The forward floor post of the seat in row 11 was bent forward at an angle of 20°, and the rear post was bent forward at an angle of 10°. The seatback in row 11 was touching the back of the seatback in row 10, and both wall anchors were pulled out. Both of the floor posts in row 10 were bent forward, with the front at a 20° angle and the rear at a 45° angle. The rear wall anchor was pulled out but the front remained attached.

The lead school bus was equipped with one loading door opposite the driver's seat, four emergency windows (located on the left and right sides of the bus, in rows 4 and 10), two emergency roof hatches (located above rows 3 and 9), and a rear emergency door. Based on interviews with emergency responders and passengers on both buses, all but one occupant exited the bus through the left rear emergency exit window. The one entrapped passenger was extricated by emergency responders and placed on a backboard before being removed through the right rear emergency exit window.

All four emergency exit windows were laminated and properly marked with identifying decals and instructions. The size of egress was 20 by 30 inches for all emergency exit windows.[5] According to a Blue Bird representative, the emergency exit windows were double 9-inch push-out, split-sash window assemblies with laminated glass. The push-out window assembly consists of two split-sash window panes within a hinged frame. A positive latch mechanism located on the bottom of the frame assembly, which releases, allows the window to swing outward while remaining hinged at the top to provide emergency egress. A warning buzzer alerts the driver of the opened window. A 4- by 3-inch emergency release latch plate, which is elevated about 1 inch from the window base, is exposed when the window is disengaged from the positive latch mechanism.

According to emergency responders and passengers in the lead school bus, evacuation was hindered by the design of the emergency window. The latch plate that protruded from the bottom of the window snagged the clothing of several passengers. (See figure 11.) Additionally, one person had to hold the hinged emergency window open so that another bus occupant could exit unimpeded. According to the Blue Bird representative, the company had changed the design of its newly manufactured emergency exit windows in 2005 so that the hinges are now vertically positioned, instead of horizontally, as in the accident buses.[6] In addition, Blue Bird representatives stated that they have decreased the elevation of the emergency release latch plate so that it does not extend more than 0.5 inch beyond the window opening.

The lead school bus was equipped with a first aid kit, a triangle/flare kit, and a fire extinguisher. According to the inspection sticker, the extinguisher was last inspected in February 2008, and the sticker expired in February 2009.

[5] Section 5.4.2.1(c) of Federal Motor Vehicle Safety Standard (FMVSS) 217, Bus Emergency Exits, specifies that the openings of school bus emergency exit windows must be large enough to admit unobstructed passage of a 50- by 33-centimeter ellipsoid (19.70 by 13.0 inches).

[6] According to representatives from Thomas Built and IC/Navistar, these school bus manufacturers still offer both the horizontal- and vertical-mounted emergency exit windows.

Figure 11. Raised emergency release latch plate (circled) at bottom of emergency exit window, lead school bus.

1.6.4 2001 Blue Bird Bus (Following School Bus)

The following school bus sustained moderate front-end damage from hitting the back of the lead school bus. (See figure 12.) According to manufacturer specifications, the following bus had an original overall length of 420 inches, an overall width of 94 inches, and a wheelbase of 190 inches. The frontal impact damage began at the left corner and extended to the right 64.5 inches. The damage also extended vertically to the roof. Maximum crush to the left front bumper was 13.5 inches. Damage to the left side of the bus extended approximately 49.5 inches, detaching the side rearview mirror and shattering the driver's window. Both windshield panes were also shattered. Postaccident measurement of the wheelbase showed the left side to be 189.5 inches and the right side 190.25 inches.

The following school bus was equipped with a bucket seat with cushion springs for the driver. Behind the driver's seat, on both sides of the bus, were 12 rows of three-person bench seats. Each of the bench seats was 39 inches wide, with 24.5-inch-high seatbacks. All of the floor and wall anchors on both sides of the bus remained secured.

Inspection of the vehicle's interior revealed that most of the damage was in the driver's seating area. Three of the five gauges located on the dash and instrument panels, directly forward of the steering wheel, were broken out. Inward deformation to the steering wheel was evident from loading by the driver. An inspection of the driver's lap and shoulder restraint showed a small heat abrasion near the buckle/latch connection, consistent with the seat belt being in use at the time of the accident.

Figure 12. Front view of following school bus.

The following school bus was equipped with one loading door opposite the driver's seat, four emergency windows (located on the left and right sides of the bus, in rows 4 and 10), two emergency roof hatches (located above rows 3 and 9), and a rear emergency exit door. All four emergency exit windows were properly marked with identifying decals and instructions. All but one occupant of the bus evacuated through the rear emergency exit door; the adult chaperone exited through the front loading door.

Safety equipment in the following school bus consisted of a first aid kit, a triangle/flare kit, and a fire extinguisher. According to the inspection sticker, the extinguisher was last inspected in July 2009, and the sticker expired in July 2010.

1.7 Driver Factors

1.7.1 Volvo Truck-Tractor Driver

The 43-year-old Volvo tractor driver obtained his first commercial driver's license (CDL) in May 2005 and had over 5 years of commercial driving experience. He has worked for Climate Express, Inc., since July 2009. The driver holds a current West Virginia class A CDL[7] with a hazardous materials ("H") endorsement, issued in December 2008 and expiring in November 2013. The CDL has no restrictions. The Volvo driver's medical certificate was valid for 2 years,

[7] A class A CDL allows the operation of any combination of vehicles with a gross vehicle weight rating (GVWR) of 26,001 pounds or more, provided that the GVWR of the vehicles being towed exceeds 10,000 pounds.

expiring in July 2011. The driver stated that he was familiar with the stretch of roadway from Union to St. Louis, Missouri—which encompassed the Gray Summit area.

NTSB investigators reconstructed the driver's 72-hour history, based on an interview with the driver, followup questions through a company attorney, review of logbooks, and review of cellular provider records. Table 2 summarizes the driver's activities from August 2–5, 2010.

Table 2. Condensed 72-hour history for Volvo tractor driver, August 2–5, 2010.

Monday, August 2			
Time	**Event**	**Location**	**Source**
7:10 a.m.	Makes outgoing cell call	Martinsburg, WV	Cellular records
5:00 p.m.	Departs residence	Martinsburg	Interview
5:00 p.m.	Begins work/on duty	Martinsburg	Logbook
Tuesday, August 3			
Time	**Event**	**Location**	**Source**
2:00 a.m.	Logs off duty	Catlettsburg, KY	Logbook
12:00 noon	Logs on duty	Catlettsburg	Logbook
9:45 p.m.	Logs off duty	Jefferson City, MO	Logbook
Wednesday, August 4			
Time	**Event**	**Location**	**Source**
7:00 a.m.	Awakes	Jefferson City, MO	Followup
Unknown	Logs off duty all day	Jefferson City	Logbook
9:15 a.m.	Departs for Climate Express	Jefferson City	Followup
10:45 a.m.	Arrives at Climate Express	Union, MO	Followup
9:00 p.m.	Goes to bed	Union	Followup
Thursday, August 5			
Time	**Event**	**Location**	**Source**
7:30 a.m.	Awakes	Union, MO	Followup
7:45 a.m.	Logs on duty	Jefferson City, MO	Logbook
10:11 a.m.	ACCIDENT	Gray Summit, MO	--

The driver of the Volvo tractor underwent postaccident alcohol and drug testing at the direction of his employer. The test was performed at St. John's Mercy Corporate Health Center in Washington, Missouri, on the day of the accident, August 5. A breath sample was taken at 2:15 p.m., and a urine sample was taken at 2:17 p.m. The breath sample indicated no alcohol, and the urine sample was negative for marijuana, cocaine, amphetamines, opiates, and phencyclidine (PCP).

The driver described his general health as good, denying any health problems prior to the accident. Upon further investigation, the NTSB uncovered serious health problems that the driver failed to disclose to his medical fitness examiner. Medical records indicate that after a visit to the emergency room in 2003 (before the driver obtained his CDL), a primary care physician warned him not to drive or operate machinery. The driver did not openly divulge the diagnosed condition to a commercial driver fitness examiner and subsequently obtained a medical certificate. Because NTSB investigators determined that the medical condition was not a factor in the accident, no details of such are discussed in this report. (Issues regarding the lack of a systematic medical oversight program are discussed in section 2.4.5, "Medical Oversight.")

1.7.2 GMC Pickup Truck Driver

The driver of the GMC pickup was a 19-year-old male, who held a valid Missouri class F driver's license,[8] issued in November 2008 and expiring in October 2011. The license was not subject to any restrictions. His driving record showed no moving violations or accidents.

The driver's family indicated that he was familiar with the GMC pickup, having driven it on several occasions. According to the family, he had never mentioned having any issues or problems with this vehicle. The driver's family further stated that he drove on the interstate near Gray Summit daily and was aware of the work zone.

NTSB investigators reconstructed the driver's 72-hour history based on interviews with family and friends, and review of his cellular provider records. Table 3 summarizes the driver's activities during this period.

[8] A Missouri class F license is the basic driver's (operator) license required to operate any vehicle that does not require a class A, B, C, or E license.

Table 3. Condensed 72-hour history for GMC pickup driver, August 2–5, 2010.

Monday, August 2			
Time	**Event**	**Location**	**Source**
12:25 a.m.	Sends text message	Unknown	Cellular records
6:13 a.m.	Sends text message	Unknown	Cellular records
11:58 p.m.	Sends text message	Unknown	Cellular records
Tuesday, August 3			
Time	**Event**	**Location**	**Source**
12:00 a.m.	Sends text message	Unknown	Cellular records
5:00 a.m.	Awakes	Sullivan, MO	Interview
5:30 a.m.	Departs for community center	Sullivan	Interview
7:00 p.m.	Departs for country club	Sullivan	Interview
10:30 p.m.	Departs for home	Sullivan	Interview
11:18 p.m.	Sends text message	Unknown	Cellular records
Wednesday, August 4			
Time	**Event**	**Location**	**Source**
6:00 a.m.	Awakes	Sullivan, MO	Interview
6:30 a.m.	Departs for work	Sullivan	Interview
7:00 a.m.	Begins work	Villa Ridge, MO	Interview
5:00 p.m.	Completes work	Villa Ridge	Interview
5:45 p.m.	Boats on river	Stanton, MO	Interview
8:30 p.m.	Returns boat	Sullivan, MO	Interview
9:00 p.m.	Arrives at resort	Bourbon, MO	Interview
11:56 p.m.	Sends text message	Unknown	Cellular records
Thursday, August 5			
Time	**Event**	**Location**	**Source**
12:30 a.m.	Drops off friend	Sullivan, MO	Interview
12:40 a.m.	Arrives home (estimate)	Sullivan	Interview
1:00 a.m.	Sends text message	Unknown	Cellular records
5:52 a.m.	Receives phone call	Unknown	Cellular records
6:30 a.m.	Departs for work	Sullivan, MO	Interview
7:00 a.m.	Begins work	Villa Ridge, MO	Interview
9:20 a.m.	Truck inspection appointment	Union, MO	Interview
9:58 a.m.	Receives text message	Unknown	Cellular records
9:58 a.m.	Sends text message	Unknown	Cellular records

Thursday, August 5 (cont'd)			
Time	**Event**	**Location**	**Source**
10:03 a.m.	Receives text message	Unknown	Cellular records
10:03 a.m.	Sends text message	Unknown	Cellular records
10:04 a.m.	Receives text message	Unknown	Cellular records
10:05 a.m.	Sends text message	Unknown	Cellular records
10:06 a.m.	Sends text message	Unknown	Cellular records
10:07 a.m.	Receives text message	Unknown	Cellular records
10:08 a.m.	Sends text message	Unknown	Cellular records
10:08 a.m.	Sends text message	Unknown	Cellular records
10:09 a.m.	Receives text message	Unknown	Cellular records
10:11 a.m.	ACCIDENT	Gray Summit, MO	--

The family of the GMC pickup driver described him as a morning person, an early riser, and easy to awake. They stated that he routinely awoke at 6:00 a.m. to begin his workday by 7:00 a.m. They also said that he was typically home by 10:30 p.m. each night.

As part of the NTSB's investigation, the driver's medical records were requested from local physicians and reviewed. The records did not reveal any medical conditions that could have caused or contributed to this accident. When asked about the driver's health, his family described him as very fit and indicated that he had undergone a sports physical the week prior to the accident. The family stated that he did not have any problems sleeping and did not snore. Following the accident, blood samples from the driver were sent to the Civil Aerospace Medical Institute, where they were tested for alcohol and nine legal and illegal drugs. The samples were found to be negative for alcohol and drugs.[9]

At the time of the accident, the GMC pickup driver was returning to work after taking his vehicle to Union, Missouri, for a state safety inspection. The driver's cellular provider records indicate that he was involved in a text messaging conversation prior to the accident. In an interview with NTSB investigators, the individual with whom the GMC driver was exchanging texts stated that the messages centered on activities from the previous night and on their plans for that evening. In the 11 minutes prior to the accident, from 9:58–10:09 a.m., the driver sent or received 11 text messages. Because the cellular records did not document transmission times to the second, the final incoming message could have arrived from 10:09:00–10:09:59 a.m.

[9] Amphetamines, opiates, marihuana, cocaine, PCP, benzodiazepines, barbiturates, antidepressants, and antihistamines.

Missouri's primary enforcement law prohibiting drivers 21 years old and younger from texting while driving went into effect in 2009.[10] In the 2 years since, the MSHP has written 120 citations for texting while driving.[11] The number of passenger-vehicle-related citations written by local law enforcement is not readily available because Missouri currently has no statewide repository for traffic citations. Media reports indicate that enforcement of the texting ban has been hindered by difficulties in discerning which drivers are under 21 years.[12] In June 2010, an attempt to expand the antitexting law to all drivers passed in the state house but failed to pass in the state senate.[13]

Missouri has specifically identified distracted driving as an issue in its Strategic Highway Safety Plan. A report by the Governors Highway Safety Association (GHSA)[14] notes that Missouri has initiated multimedia awareness campaigns on the dangers of distracted driving that specifically target teen drivers and their parents. In addition, the MSHP has conducted a public awareness campaign to reduce texting[15] and features distracted driving information on its website.[16] News media in Missouri are also conducting public awareness campaigns on this issue.[17]

Text messaging is banned for all drivers in 35 states and the District of Columbia.[18] Seven states (Alabama, Mississippi, Missouri, New Mexico, Oklahoma, Texas, and West Virginia) ban novice drivers from texting, though the definition of "novice" varies from state to state. Arizona bans texting by school bus drivers only. Seven states (Florida, Hawaii, Idaho, Montana, Ohio, South Carolina, and South Dakota) have no laws to prohibit texting while driving.

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[10] Primary enforcement allows a law enforcement officer to stop a vehicle and issue a citation for texting while driving, even if this is the only violation the officer notices. Secondary enforcement allows a law enforcement officer to issue a citation for texting only after the driver has been stopped for another violation.

[11] Data were provided by the director of the Statistical Analysis Center, MSHP, August 19, 2011.

[12] Missouri Texting Law Difficult To Enforce: Troopers Say Age Limits Problematic, <http://www.kmbc.com/r/22331476/detail.html>, accessed August 18, 2011.

[13] Actions on House Bill 600, <http://www.house.mo.gov/billtracking/bills111/sumpdf/HB0600P.pdf>, accessed December 7, 2011.

[14] *Curbing Distracted Driving: 2010 Survey of State Safety Programs* (Washington, DC: Governors Highway Safety Association, 2011).

[15] See <http://www.mshp.dps.missouri.gov/MSHPWeb/Root/Anti-textingstickerrelease.html>, accessed January 20, 2011.

[16] See <http://www.mshp.dps.missouri.gov/MSHPWeb/Root/DistractedDrivingFeaturedStatute.html>, accessed January 20, 2011.

[17] To view these videos, see <http://www.ksdk.com/life/community/hang_up_and_drive/default.aspx> and <http://www.komu.com/KOMU/d7e2017e-80ce-18b5-00fa-0004d8d229cb/1818bd7a-80ce-18b5-01bc-a08c5c4d21d5.html>, both accessed January 20, 2011.

[18] Cellphone and Texting Laws, <http://www.iihs.org/laws/cellphonelaws.aspx>, accessed August 16, 2011.

1.7.3 Lead School Bus Driver

At the time of the accident, the 75-year-old driver of the lead school bus held a current Missouri class B CDL, issued in June 2010 and expiring in June 2011.[19] She held passenger vehicle ("P") and school bus ("S") endorsements, and was subject to air brake commercial vehicle ("L") and corrective lens ("A") restrictions. The driver's record showed no moving violations or accidents in the past 10 years.

Missouri state law requires that drivers who transport pupils for a public school district complete at least 8 hours of training on school bus driving annually. It is the responsibility of the carrier to provide this training, and it is the responsibility of the school district to verify that the minimum amount of training is completed by each driver. Missouri does not stipulate what type of training must be taken, except that it be school-bus related. Carriers are encouraged to contact the Missouri Department of Elementary and Secondary Education for suggestions on training topics. In addition, the Missouri Department of Revenue, which oversees driver licensing, requires drivers 70 years of age and over to complete the school bus skills test to retain the "S" endorsement on their license at the time of renewal.[20] Annual training records provided by the employer of the lead school bus driver indicated that she had completed 7 hours of training in 2008 and 11 hours of training in 2009. At the time of the accident, the driver had completed 7.5 hours of training in 2010, including the school bus skills test. Table 4 summarizes the lead bus driver's training since 2008.

The lead school bus driver began driving for Copeland Bus Services in 1972 and continued to do so, on a full- and part-time basis, until the day of the accident. According to the driver, the accident bus had been her assigned "trip bus" for approximately 4 years.[21] NTSB investigators reconstructed the lead school bus driver's 72-hour history, based on an interview with the driver and review of her cellular provider records. Table 5 summarizes the driver's activities during this period.

At the time of the accident, the lead school bus was part of a two-bus convoy traveling from St. James High School, St. James, Missouri, to the Six Flags St. Louis amusement park. The driver had made this trip before and was familiar with the route and the roadway. She stated that she was maintaining a speed of 50 mph prior to the accident.[22,] When she noticed a motorcoach on the side of the road and a man walking around in front of it, she moved her bus a little to the left, creating additional space between the motorcoach and her vehicle. She watched the man, looked in her right mirror to be sure she was past the motorcoach, and then moved back to the right lane. As soon as she did so, the accident occurred. She described what she struck as a "mass." According to the driver, she did not have time to brake or steer. When asked about

[19] In Missouri, a CDL is valid only for 1 year for school bus drivers who are 70 years or older.

[20] The skills test covers three general areas: pretrip inspection; basic vehicle control, such as backing, turning, and maneuvering; and on-road testing, which may involve maneuvering along grade crossings, intersections, and multilane roadways.

[21] A trip bus is used for longer trips, typically school activities such as sporting events, and not for the daily pickup and drop-off of students.

[22] Based on NTSB's reconstruction of the accident, the lead school bus was probably traveling less than 50 mph.

internal distractions, the driver indicated that the children on the bus were well behaved and quiet for the entire trip. She stated that the bus was equipped with both a citizens band (CB) radio and an AM/FM radio, though neither was in use at the time of the accident. She stated that she was not eating, drinking, or using her cell phone. A check of her provider records indicated no cell phone use at or near the time of the accident.

Table 4. Lead school bus driver training, 2008–2010.

Year	Hours	Description
2008	2	Driving skills/pretrip
	1	MSHP driver license renewal test
	2	Daily pretrip inspection
	2	Sexual abuse and bullying
	--	School bus evacuation drill
2009	2	Railroad crossing
	2	Student behavior management
	--	School bus evacuation drill
	2	Driving skills/pretrip
	1	MSHP driver license renewal test
	2	Loading and unloading students
	--	School bus evacuation drill
	1	Student behavior management
	1	AGOSNET[a]
2010	2	Other training
	2	Pretrip inspections
	--	School bus evacuation drill
	2	Driving skills/pretrip
	0.5	Pretrip inspection review
	1	MSHP driver license renewal test

[a] AGOSNET is web-based training that generally includes employment practices, risk management, safety, and human resources topics.

Table 5. Condensed 72-hour history for lead school bus driver, August 2–5, 2010.

Monday, August 2			
Time	**Event**	**Location**	**Source**
~4:30 a.m.	Awakes	St. James, MO	Interview
9:30 p.m.	Goes to bed	Unknown	Interview
9:53 p.m.	Makes phone call	Unknown	Cellular records
Tuesday, August 3			
Time	**Event**	**Location**	**Source**
5:45 a.m.	Awakes	St. James, MO	Interview
Unknown	Goes to town	St. James	Interview
~9:00 p.m.	Goes to bed	St. James	Interview
Wednesday, August 4			
Time	**Event**	**Location**	**Source**
Unknown	Awakes	St. James, MO	Interview
Unknown	Cuts grass	St. James	Interview
Unknown	Goes to bed	St. James	Interview
Thursday, August 5			
Time	**Event**	**Location**	**Source**
5:30 a.m.	Awakes	St. James, MO	Interview
8:00 a.m.	Leaves home for Copeland	St. James	Interview
Unknown	Performs pretrip inspection	St. James	Interview
8:55 a.m.	Arrives at school	St. James	Interview
9:10 a.m.	Departs for Six Flags	St. James	Interview
10:11 a.m.	ACCIDENT	Gray Summit, MO	--

According to the MSHP, the lead school bus driver submitted to alcohol breath testing immediately following the accident, and no alcohol was detected. The driver underwent postaccident drug testing on the same day, at the direction of her employer. A urine sample was taken shortly after 5:00 p.m. on August 5. The tests on the sample were negative for marijuana, cocaine, amphetamines, opiates, and PCP.

The driver's most recent commercial driver fitness examination was conducted in August 2009 by a doctor in St. James, Missouri; her employer sends all of its drivers to the same physician. The driver was found to meet the Federal fitness standards specified in 49 CFR 391.41 and was given a 2-year certificate, with an expiration of August 2011. In addition, the driver was required to pass an annual physical examination for school bus drivers. Her most recent exam occurred in July 2010, and she was found to be physically qualified to safely operate a school bus.

In a postaccident interview, the lead school bus driver described her health as "pretty good for my age." She stated that she did not have any preexisting medical conditions and was not under the care of a physician. The driver denied taking any prescription medications, herbal supplements, over-the-counter medications, or illegal drugs both in general and in the 3 days prior to the accident. She stated that she tries not to take any drugs of any kind, including alcohol. The driver described her sleep quality as very good, stating that she typically slept from 7.5–8 hours at night and occasionally napped for 15–60 minutes during the day. She denied any history or diagnosis of sleep apnea.

1.7.4 Following School Bus Driver

The 38-year-old driver of the following school bus held a valid Missouri class B CDL, issued in August 2009 and expiring in May 2016. She held passenger vehicle ("P") and school bus ("S") endorsements and was subject to the air brake commercial vehicle ("L") restriction. The training records for this driver indicated that she had completed 10 hours of training in 2009 and 4 hours of training in 2010. Table 6 summarizes her training since 2009. According to the driver, she first obtained her CDL in 2009 and has spent her entire career with Copeland Bus Services. A check of Missouri driver records for the previous 10 years showed a suspension in 2006 for failure to appear for speeding in a noncommercial vehicle; that suspension was lifted in 2006.

NTSB investigators reconstructed the following school bus driver's 72-hour history, based on an interview with the driver and review of her cellular provider records. Table 7 summarizes the driver's activities during this period.

Table 6. Following school bus driver training, 2009–2010.

Year	Hours	Description
2009	1	Initial driver training
	2	Initial driver training
	2	Driving skills/pretrip (testing review)
	1	MSHP CDL test
	2	Loading and unloading
	--	School bus evacuation drill
	1	Student behavior management
	1	AGOSNET
2010	2	Other training
	2	Pretrip inspections
	--	School bus evacuation drill

Table 7. Condensed 72-hour history for following school bus driver, August 2–5, 2010.

Monday, August 2			
Time	**Event**	**Location**	**Source**
~7:00 a.m.	Awakes	St. James, MO	Interview
~9:30 p.m.	Makes phone call	St. James	Interview
Tuesday, August 3			
Time	**Event**	**Location**	**Source**
3:54 a.m.	Makes phone call	Unknown	Cellular records
~7:30 a.m.	Awakes	St. James, MO	Interview
11:00 p.m.	Goes to bed	St. James	Interview
Wednesday, August 4			
Time	**Event**	**Location**	**Source**
6:46 a.m.	Sends text message	Unknown	Cellular records
~7:30 a.m.	Awakes	St. James, MO	Interview
10:30 p.m.	Goes to bed	St. James	Interview
Thursday, August 5			
Time	**Event**	**Location**	**Source**
~7:00 a.m.	Awakes	St. James, MO	Interview
8:00 a.m.	Departs residence	St. James	Interview
Unknown	Performs pretrip inspection	St. James	Interview
9:00 a.m.	Arrives at school	St. James	Interview
9:15 a.m.	Departs for Six Flags	St. James	Interview
10:11 a.m.	ACCIDENT	Gray Summit, MO	--

At the time of the accident, the following school bus driver was traveling behind the lead school bus on their trip to the Six Flags St. Louis amusement park. The driver had made this trip before and was familiar with the route and the roadway. The bus was equipped with an on-board video recording system configured to record the interior of the bus, and it was in operation at the time of the accident. The system served to monitor the behavior of students/passengers during transport. In the video, an adult chaperone is seen standing and speaking to the driver, but he is fully seated 8 seconds before the accident occurs. The bus is steered to the right about 2 seconds prior to impact with the lead bus.

In a postaccident interview, the following school bus driver denied having a problem with the sun or glare and did not recall any other external distractions. She stated that both buses were traveling in the right lane and that traffic was lighter at the time of the accident than when they first drove onto the interstate. She estimated that her preaccident speed was 40–45 mph. She could not recall the distance between her bus and the lead school bus. She denied using her cell phone at the time of the crash. A check of her cellular provider records indicated that her cell phone was not in use at or near the time of the accident. Likewise, the bus driver stated that she was not using her CB radio. She also stated that the AM/FM radio was not on, and that she was not eating or drinking, explaining that Copeland had a policy against such activities. She did not recall passing the motorcoach on the side of the road.

The driver's first indication that anything was wrong was seeing the lead school bus go up in the air. She stated that the brake lights on the lead bus were not illuminated. She did not recall the lead bus making a lane change to the left prior to seeing it up in the air. She said that she applied the brakes and steered to the right in an unsuccessful attempt to avoid striking the lead bus, at which time she was hit in the head by the windshield of her bus. She was not aware that traffic ahead of the lead bus had slowed or stopped.

The following school bus driver submitted to alcohol breath testing immediately following the accident, and no alcohol was detected. Shortly before 5:00 p.m. on the same day, she underwent postaccident drug testing, at the direction of her employer.[23] Tests on the urine sample were negative for marijuana, cocaine, amphetamines, opiates, and PCP.

The driver's most recent commercial driver fitness examination was conducted in August 2009, and no abnormalities were noted. During that exam, the driver did not indicate any significant health history or that she was regularly taking any medications. Sugar was detected in her urine, but the performing physician indicated that the driver had a history of such and was not diabetic. The driver was found to meet the Federal fitness standards specified in 49 CFR 391.41 and was given a 2-year certificate. The driver was also required by Missouri to pass an annual physical examination for school bus drivers. Her most recent exam had occurred in July 2010, and she was found to be physically qualified to safely operate a school bus.

According to the following school bus driver, she takes hormones and an additional prescription medication daily but does not take any herbal supplements or illegal drugs. She confirmed that she had taken her normal medications on August 5, 2010. She stated that she takes over-the-counter medication as needed but did not take any in the 3 days prior to the accident. When asked if she consumed alcohol, the driver said that she does so occasionally but had not consumed any alcohol in the 3 days prior to the accident.

When asked about her sleeping habits, the driver of the following school bus stated that she normally sleeps "like a rock" and had no history of sleeping disorders or snoring. She went on to state that she typically sleeps 9–10 hours a night and indicated that this amount of sleep leaves her feeling well rested. Her normal time of waking is 7:30–8:00 a.m.

[23] The exact time is not legible on the provided copy of the results.

1.8 Motor Carrier Factors

1.8.1 Climate Express, Inc.

Climate Express, Inc., of St. Louis, Missouri, was the owner of the 2007 Volvo tractor. Climate Express is an interstate, authorized-for-hire carrier of general freight, fresh produce, and refrigerated food. The company operates under U.S. Department of Transportation (USDOT) number 648882 and motor carrier operating authority number 306127. Its fleet consists of 118 tractors and 240 semitrailers, including both dry van trailers and refrigerated trailers. All of the tractors are conventional cab units, and the semitrailers are 53 feet long. The average age of the fleet tractors is 2 years, and the average age of the semitrailers is 4 years. The majority of vehicle maintenance work is conducted in-house.

At the time of the accident, the company employed 118 drivers—7 of whom made local deliveries only. Driver applicants are required to have a minimum 2 years of experience to be considered for employment. They must also be at least 23 years of age and possess a class A CDL. Driver applicants must maintain a U.S. Department of Transportation (DOT) physical and have had no major traffic violation within the past 36 months.

Roadside inspection data for the 12 months prior to August 5, 2010, indicated that Climate Express had 69 vehicle inspections, with 7 vehicles placed out of service (10 percent). The data also indicated that the company had 152 driver inspections, with 8 drivers placed out of service (5 percent). Nationally, the average out-of-service rate was 22.2 percent for vehicles and 6.6 percent for drivers.

The Federal Motor Carrier Safety Administration (FMCSA) conducted a compliance review of Climate Express on October 29, 2002, which resulted in a satisfactory rating. This review was a followup on a compliance review conducted on November 8, 2000, from which Climate Express received a conditional rating for not conducting random alcohol tests (see 49 CFR 382.305) and for violating the 70-hour rule (see 49 CFR 395.3(b)(2)). Additionally, the FMCSA conducted a compliance review of Climate Express on May 11, 2001, due to the company's "B" rating on the Motor Carrier Safety Status Measurement System (SafeStat).[24] This compliance review resulted in a satisfactory rating. No compliance review was conducted on Climate Express following the Gray Summit accident.

According to MCMIS,[25] in the 12 months leading up to January 22, 2010, Climate Express vehicles traveled 11.6 million miles and had 12 reportable accidents[26] (9 towaway and 3 injury), resulting in an accident rate of 0.89. The FMCSA considers motor carriers with an accident rate of 1.50 or greater to be deficient. Under the new Safety Measurement System rating

[24] At the time of the accident, the FMCSA determined which carriers to target for compliance reviews using information from the Motor Carrier Management Information System (MCMIS) and SafeStat. Carriers were grouped into categories A through H, with carriers in the A through C categories prioritized for compliance reviews. This procedure changed with implementation of the Compliance, Safety, Accountability (CSA) program in 2010.

[25] MCMIS is an information system comprised of FMCSA inspection, crash, compliance review, safety audit, and registration data.

[26] Reportable accidents are classified as involving a fatality, an injury, or a vehicle towed from the scene.

program—which has recently replaced SafeStat in the CSA operational model—carriers are rated on seven on-road safety performance categories. Climate Express had a crash indicator rating[27] of 77, which meant that it was in an "alert" status in that category and the FMCSA would notify the motor carrier of the deficiency by letter. The company was below the threshold limit in all other Safety Measurement System categories, including unsafe driving, fatigued driving, driver fitness, controlled substances/alcohol, vehicle maintenance, and cargo.[28] Climate Express was notified of its deficiency, and the FMCSA initiated a nonrated compliance review on the company in March 2010.

MCMIS records indicated that the Volvo tractor driver had received a level 3 roadside inspection on April 12, 2010, in Kansas;[29] no violations were noted in the inspection. The driver had been subjected to another level 3 roadside inspection on February 8, 2010, in Maryland, and no violations were noted. He had also received a level 1 roadside inspection in Kentucky on November 12, 2009,[30] and no violations were noted. The driver was not placed out of service in any of these roadside inspections.

1.8.2 Copeland Bus Services

Copeland Bus Services, based in St. James, Missouri, is an intrastate passenger carrier of school children. Copeland also purchases, repairs, and sells used school buses. With a fleet of 23 buses, the company employs 17 drivers, 6 substitute drivers, and 2 mechanics—serving only the St. James School District. For the past 50 years, the school district has contracted with Copeland for the transport of students and staff to and from school, field trip activities, vocational school, and summer school.

Copeland's contract with the school district is renewed prior to the beginning of each school year. The contract for the 2010–2011 school year began on July 1, 2010.[31] The provisions of the contract state that Copeland agrees to provide transportation for pupils and employees of the school district, as directed by the superintendent, to and from school, to and from activities held away from school, to and from Rolla Technical Institute, and to and from the district-operated summer school. The contract also indicates that Copeland will schedule school

[27] The crash indicator category rating is based on accident involvement for the motor carrier over a 24-month period and includes fatal, injury, or towaway accidents.

[28] See <http://csa.fmcsa.dot.gov/about/basics.aspx> for a description of all seven on-road safety performance categories.

[29] This inspection includes a roadside examination of the driver's license; medical certification and waiver, if applicable; driver's record-of-duty status, as required; hours of service; seat belt; vehicle inspection report; and hazardous material requirements, as applicable.

[30] This inspection includes examination of the driver's license; medical examiner's certificate and waiver, if applicable; alcohol and drugs; driver's record-of-duty status, as required; hours of service; seat belt; vehicle inspection report; brake system; coupling devices; exhaust system; frame; fuel system; turn signals; brake lamps, tail lamps, head lamps, and lamps on projecting loads; safe loading; steering mechanism; suspension; tires; van and open-top trailer bodies; wheels and rims; windshield wipers; emergency exits on buses; and hazardous material requirements, as applicable.

[31] Copeland continues to contract with the school district to provide transportation in the 2011–2012 school year.

routes in consultation with the school board.[32] Establishing routes is not difficult because the school district is in a rural area; generally the same students ride the buses, and the number of roadways is limited. Additionally, the contract stipulates that Copeland provide minimum liability coverage and notify the school district if insurance is canceled or expired. Copeland provides service for 15 regular routes and 1 preschool route.

A postaccident review of Copeland's maintenance records revealed that they consisted of individual sheets of paper with several buses included on each sheet. There were no separate maintenance files for each bus. Although the company prohibits the use of cell phones by drivers while operating buses, it is not a written policy. Both of the Copeland drivers who were involved in the accident were aware of the prohibition. The owner meets individually with drivers when issues need to be addressed. A postaccident investigation found that Copeland complied with all regulations pertaining to its drivers, including CDL requirements, annual medical certification, and drug and alcohol testing.

MoDOT conducted a nonrated intrastate compliance review of Copeland in June 2011. Violations consisted of (1) no accident ledger, (2) failure to investigate the background of a driver applicant, (3) failure to maintain the information requirements of several drivers, (4) two hours-of-service violations, and (5) failure to conduct an annual vehicle inspection.

1.8.3 Intrastate Carrier Oversight

Intrastate carriers are exempt from most *Federal Motor Carrier Safety Regulations* (FMCSRs), except those regulations pertaining to CDL requirements, annual medical certification, and drug and alcohol testing. However, Missouri has adopted the FMCSRs for regulating its intrastate operations. Missouri's regulations do not apply to for-hire carriers transporting passengers to and from school and home, but they do apply to for-hire carriers engaged in extracurricular transportation, such as field trips.[33]

As the primary state agency responsible for motor carrier oversight, MoDOT grants operating authority and provides oversight of "for-hire" intrastate motor carriers; however, carriers conducting school/pupil transportation are exempt from requesting authority from MoDOT.[34] Because Copeland was a school bus operator, it was not required to seek operating authority from MoDOT. Although Missouri issues USDOT numbers to intrastate for-hire motor carriers for tracking purposes, Copeland was not required to have a USDOT number due to its exemption. Under its contract with the school district, Copeland provided both school bus operations and other types of pupil transportation, such as field trips. Its school bus operations

[32] School routes are determined by student locations and routes available. The superintendent of the school district reviews all routes.

[33] *Guidelines for School Bus Operators*, FMCSA-E-06-006 (Washington, DC: Federal Motor Carrier Safety Administration, March 2006).

[34] The exemption states that authority does not apply to "school buses transporting duly enrolled students of a school, college, or other recognized educational institution, where that transportation is approved by the governing school authority." See MoDOT frequently asked questions for additional exemptions, at <http://www.modot.mo.gov/mcs/FAQ.htm#OAmain>, accessed October 12, 2011.

were not within the MoDOT scope of oversight, but other operations were subject to state authority.

Missouri has a system of intrastate carrier oversight similar to the CSA program. The state uses out-of-service rates, carrier and roadside inspections, and crashes to establish a threshold score wherein a carrier that exceeds the score is prioritized for an intervention. The state has also established a "rated" compliance review program that mirrors the FMCSA program; the state rates its carriers "satisfactory," "conditional," or "unsatisfactory." Upon receiving an unsatisfactory rating, passenger carriers are given 45 days to submit a corrective action plan and request an upgrade of their rating, and cargo carriers are given 60 days. The state also conducts nonrated reviews when focusing on specific problem areas in a carrier's operation. MoDOT is responsible for conducting carrier safety audits and compliance reviews; and MoDOT, along with the MSHP, conducts roadside and destination inspections of vehicles and drivers.

The Missouri Department of Elementary and Secondary Education,[35] however, is responsible for oversight of school bus operations, under 5 *Code of State Regulations* (CSR) 30-261.010. Additionally, the department publishes the *School Transportation Administrator's Handbook*,[36] which summarizes the Revised Statutes of Missouri and the state regulations that specifically apply to pupil transportation. The Department of Elementary and Secondary Education oversight includes reviewing school bus driver qualifications (CDL certification, medical certification, and drug and alcohol testing), insurance, operation of school buses by drivers, school bus routing, and school bus design (body and chassis). The Missouri statutes have no provisions concerning the overall operation of the contracted carrier providing pupil transportation. It is the responsibility of each school district to ensure that the transportation provider adheres to the regulations that apply to drivers and vehicles.

The St. James School District was directly responsible for oversight of Copeland Bus Services and its drivers. Oversight primarily consisted of collecting and reviewing documents on driver qualifications, training, and fitness; vehicle maintenance; approving school bus routing information; and documenting the total number of students transported. No one at the school district conducted a formal review of the operations of Copeland; however, the district superintendent stated that she communicated with the company on a regular basis and addressed problems as they arose. School districts are required to submit annual reports to the Missouri Department of Elementary and Secondary Education on all aspects of operations, including pupil transportation. These reports are reviewed and evaluated. "Low performing schools"[37] are subject to a state audit. Each year about 10 percent of the districts are subject to these audits; the penalty for noncompliance is that the state may withhold funding to a school district.

[35] The Department of Elementary and Secondary Education is the administrative arm of the State Board of Education. For more information, see <http://www.dese.mo.gov/overview.html>.

[36] *School Transportation Administrator's Handbook* (Jefferson City, Missouri: Missouri Department of Elementary and Secondary Education, November 2008).

[37] The Department of Elementary and Secondary Education subjectively determines which schools are "low performing."

1.9 Vehicle Factors

NTSB investigators examined all four accident vehicles to determine whether any mechanical or maintenance defects may have contributed to the accident.

1.9.1 2007 Volvo Truck-Tractor

Table 8 lists the general characteristics of the 2007 Volvo tractor.

Table 8. Volvo tractor characteristics.

Component	Specification
Manufacturer	Volvo of North America
Model	VNL64T
Date of manufacture	May 2006
USDOT no.	648882
Odometer	460,094 miles
GVWR	50,350 pounds
Engine	Volvo D12
Transmission	Eaton Fuller FRO-16210C

Postaccident examination of the Volvo tractor steering system revealed no visible damage. The system remained functional, with movement of the steering wheel transcending through the steering column, steering gear box, and steering linkage to the wheels of the front axle.

The front axle leaf springs and shock absorbers—and the second axle leaf springs, shock absorbers, and air suspension—displayed no visible signs of damage, wear, or distortion. The third axle suspension was pushed forward, causing the leaf spring U-bolts to shift forward approximately 1 inch. The air suspension cushions were collapsed and pushed forward, detaching them from their bottom mounts on both the left and right sides of the third axle. The Volvo tractor was equipped with size 295/75R22.5-load range G tires, as recommended by the vehicle manufacturer. All tires had adequate tread depth in accordance with specifications in 49 CFR 393.75. Four of the 10 tires on the truck-tractor were slightly underinflated but not to the point that the tractor would be considered out of service using Commercial Vehicle Safety Alliance (CVSA) criteria.[38]

[38] The CVSA criteria do not consider a tire to be out of service until it has 50 percent less than the maximum inflation pressure listed on the side wall. None of the tires on the Volvo tractor were inflated to less than 55 pounds per square inch (psi), so none would have been considered out of service.

The brake components on the truck-tractor were found to be undamaged by the accident, in good condition, and within adjustment limits. Maintenance files for the vehicle indicated that it underwent regularly scheduled and as-needed repairs, the most recent on August 4, 2010, the day before the accident, when it passed a DOT inspection and had service to correct a slipping generator belt and inoperative air conditioning fan.

The two taillights from the rear of the Volvo tractor were shipped to the NTSB Materials Laboratory to determine if they had been lit at the time of the accident. None of the filaments showed evidence of hot stretching.[39] Because factors such as the magnitude and direction of force and filament cool down could result in the absence of hot stretching on an activated bulb, such absence is typically considered to be inconclusive.

According to the driver of the Volvo tractor, he had engaged the transmission into third gear, with one foot on the brake and one foot on the clutch, at the time of the accident. At the time of NTSB inspection, the transmission gear shaft was in the neutral position. The transmission gears were not inspected because the position of the gearshift at the time of the accident was unknown.

The Volvo tractor was equipped with an engine control module, an antilock braking system (ABS) control module, and an Xata mobile communications system. These modules sometimes have the capability of capturing event data, such as last stop, crash, and sudden decelerations; however, the modules in the accident vehicle were not designed with these functions. The Volvo tractor was also equipped with an air-bag control module (ACM), which did not record data because the vehicle was not involved in a front-end collision and its air bag did not deploy.

1.9.2 2007 GMC Sierra Pickup Truck

Table 9 lists the general characteristics of the GMC pickup.

Table 9. GMC pickup characteristics.

Component	Specification
Manufacturer	General Motors
Model	1500 extended cab 4x4
Date of manufacture	June 2006
Odometer	29,574 miles
GVWR	6,408 pounds
Engine	Vortec 5.3L V8 flex fuel
Transmission	4-speed automatic

[39] Hot stretching indicates that a filament is hot (lights on) at the time of introduction of a force, such as a crash, causing it to distort and stretch. Cold (lights off) filaments break rather than stretch when hit with a force.

The GMC pickup was extensively damaged; all major mechanical systems were compromised. The frame of the truck was folded into an upside down "U" shape during the collision sequence. The degree and nature of the collision damage limited the extent to which the vehicle could be inspected following the accident.

The GMC pickup was equipped with an ABS, front disc brakes, rear drum brakes, and four-wheel drive. The key mechanical damage is described below:

- Although the major components of the vehicle's powertrain remained within the wreckage, the main driveshaft between the transmission and the rear differential was broken off at its universal joints and was displaced from the vehicle.

- The functions of the steering system could not be inspected because of the extent of damage.

- The front suspension remained relatively intact, but the rear suspension was severely damaged. The forward halves of the rear leaf springs were bent and ungrouped. The left rear shock was bent, and the right rear shock was bent and broken away from its top mounting.

- The fuel system was also compromised; the rear fuel tank mounting strap was torn loose, and the bottom rear section of the tank had a small tear.

The extent of damage and space limitations within the wreckage prevented inspection or documentation of the driver's controls.

The tires on the GMC pickup were all Bridgestone Dueler A/T size 265/70R17. The minimum tread depth ranged from 5/32–6/32 inch for all tires, which is within requirements. Only the right front tire was flat; it held 12 psi at the time of inspection. A spare tire for the pickup—a Goodyear Wrangler size 265/70R17—was located at the accident scene. It was damaged at the side wall and wheel rim, and was flat.

On the morning of the accident, August 5, 2010, the GMC pickup had received an annual safety and emissions inspection as mandated under Missouri state law. No repairs were made or recommended during the inspection, which actually occurred about 25 minutes prior to the accident. The pickup passed both the safety and emissions portions of the inspection.

The GMC pickup was equipped with a sensing and diagnostic module (SDM), which was used for crash detection and air-bag deployment. As part of its function, the SDM records preaccident, crash severity, air-bag deployment, and diagnostic data. The SDM data included one acceleration and one deceleration event immediately prior to the pickup's collision with the Volvo tractor. Following the accident, the MSHP imaged these data and provided the results to NTSB investigators. According to SDM data, the pickup was traveling 58 mph 5 seconds before impact. Its speed was 55 mph 1 second before impact, and it underwent a 33-mph change in velocity over a 110-millisecond crash pulse. The SDM also indicated that the driver's seat belt was not buckled at impact.

1.9.3 2003 Blue Bird Bus (Lead School Bus)

Table 10 summarizes the general characteristics of the lead school bus.

Table 10. Lead school bus characteristics.

Component	Specification
Manufacturer	Blue Bird Corporation
Model	A3 FE 7200
Body no.	L054128
Date of manufacture	June 2002
Odometer	87,043 miles
GVWR	32,200 pounds
Length	427 inches
Width	94 inches
Wheelbase	210 inches
Engine	Cummins ISB diesel
Transmission	Allison 2000 automatic

The lead school bus was a transit-style (flat front) design with a front diesel engine accessible through a panel inside the center front console, between the entrance steps and the driver's seat. Unlike the following school bus, this bus was not equipped with a rear-facing video camera. Copeland equipped buses with surveillance cameras only when requested by drivers.

The driver's dash and interior switches and gauges were examined during the postaccident inspection. Initially, no power was available to the bus because of damage to the fuse box. A fusible link inside the box was replaced to restore power, and the engine was started. Four brake system indicator lights were located in the center of the dash: a red service brake application indicator, an amber ABS warning indicator, a red parking brake application indicator, and a red brake system warning indicator. The service brake and parking brake application indicators illuminated, as intended, when the respective brakes were applied. Neither the ABS warning indicator nor the brake system warning indicator illuminated when the bus was running or during the deceleration testing described in section 1.9.5, "Deceleration Tests on Accident School Buses."

Upon initial inspection, the speedometer needle was noted to have stopped at 47 mph. Correspondingly, the tachometer needle had stopped at 1,500 rpm. The automatic transmission gear selector was found in the "overdrive" position, and the cruise control switch was in the "off" position.

Among the engine components damaged during the frontal collision with the GMC pickup and the Volvo tractor were the electrical fuse box, engine oil pan, and engine exhaust system. No damage was observed to any of the suspension system components, and there was no damage to the tires or wheels. Although the front-end damage had altered alignment of the steering system components, it did not prevent steering wheel movement from reaching the lower steering linkage. The center link, connecting the left and right sides of the front axle steering, was damaged and bent upward into a portion of the exhaust system; however, movement of the steering wheel reached both sides of the axle, and both the left and right front wheels were articulated by rotating the steering wheel.

The lead school bus was equipped with four-wheel hydraulic disc brakes and an ABS unit. Hydraulic power boost was supplied in combination with the power steering pump and hydraulic power brake booster pump. In the absence of power, and with the engine off, the brakes functioned with manual hydraulic force only.

The brake pedal on the bus was mechanically linked through the floorboard to the master cylinder. Due to the front bumper damage, alignment of the mechanical linkage was slightly deformed, but movement was not restricted. The master cylinder was wet in appearance, showing hydraulic fluid seepage over the body of the unit. (See figure 13.) The left side of the front axle, adjacent to the brake lines that ran from the master cylinder to the hydraulic ABS unit, also had a wet appearance. (See figure 14.) These brake lines appeared to be corroded and leaking, with concentrated areas of corrosion where the lines were clamped to the left side frame rail. The paint on the frame rail next to, and below, the wet area was blistered and had begun to disbond from the metal. The brake line from the ABS unit to the left front wheel also appeared to be corroded and orange in color; however, it was dry and did not appear to be leaking. Corrosion was present on a few areas of the hydraulic brake lines from the ABS unit to the right and rear wheels of the bus; however, the brake lines were overall metallic gray in appearance and dry, and no other leaks were found. ABS sensors were found connected and undamaged at all four wheel locations.

The reservoir for the hydraulic brake fluid was located inside the lead school bus, under the driver’s seat. Upon initial inspection, the brake fluid reservoir was full, with 3.75-inch depth of fluid in both chambers. However, the fluid level dropped to just over 1.5 inches following brake deceleration testing. The results of this testing for both buses are discussed in section 1.9.5, “Deceleration Tests on Accident School Buses.” When the brake pedal on the lead bus was depressed, the movement of the pedal was soft and spongy; and a brake fluid leak was observed in the brake lines running from the master cylinder to the ABS unit.

On October 19, 2010, NTSB investigators further evaluated the hydraulic brake system. The brake fluid reservoir was found to be empty down to the fluid intakes at the bottom of both chambers, and no braking force was available. Mechanics from Central States Bus, the service and repair company that Blue Bird uses for school buses in the accident area, removed and replaced the two lines that ran from the master cylinder to the ABS unit so that further deceleration tests could be conducted. The brake lines were then shipped to the NTSB Materials Laboratory for further examination, where it was found that both lines were corroded, and one had a 0.06- by 0.03-inch hole.

Figure 13. Master cylinder (center) in lead school bus, with hydraulic fluid seepage covering cylinder body.

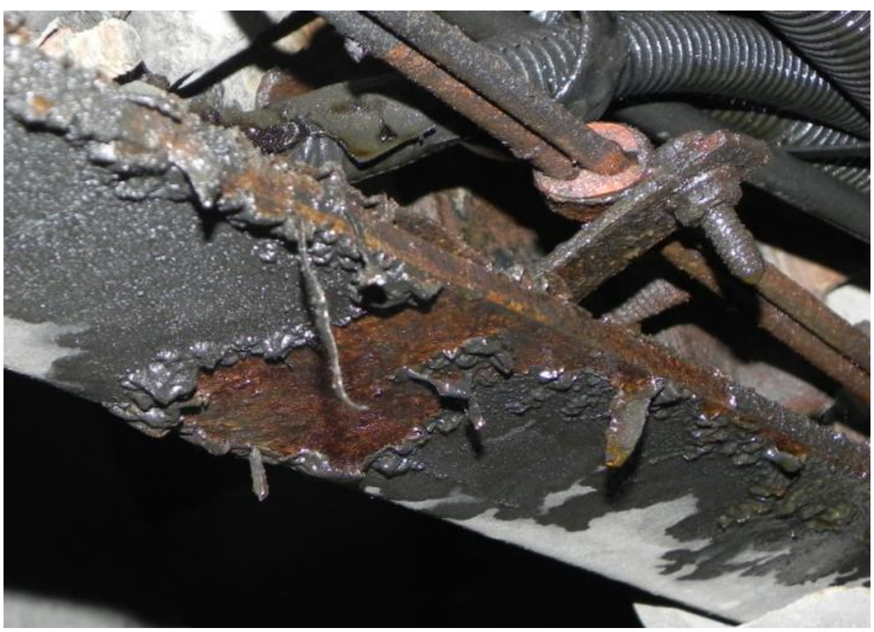

Figure 14. Location of ruptured brake line on lead school bus, with leaking hydraulic brake fluid apparent.

After the deceleration testing, the wheels of the lead school bus were removed for closer inspection of the brake pads and rotors. With the hydraulic brake system repaired, the brake calipers could be seen actuating, with the pads gripping the rotors at each wheel location. The brake rotors were measured for thickness using a micrometer, and the brake pads were measured to the nearest 1/32 inch using a machinist's scale. All of the brake rotors were smooth, showed even wear, and were within the manufacturer minimum thickness specification of 1.420 inches. The front brake pads were observed to have small cracks at the outer edges. The rear brake pads both had small sections of missing pad lining at the outer edges. According to the *Missouri Motor Vehicle Inspection Regulations* (MMVIRs), at 11 CSR 50-2.160, cracked and missing sections of brake pads would cause a vehicle to be rejected during inspection.

The lead school bus was equipped with an engine control unit (ECU). These modules sometimes have the capability of capturing event data, such as last stop, crash, and sudden decelerations; however, the ECU in this bus was not designed to record these data. The bus was also equipped with an ABS ECU, which recorded ABS configuration and diagnostic-related data. An examination of these data revealed seven inactive diagnostic fault codes and no active fault codes.

1.9.4 2001 Blue Bird Bus (Following School Bus)

Table 11 lists the general characteristics of the following school bus.

Table 11. Following school bus characteristics.

Component	Specification
Manufacturer	Blue Bird Corporation
Model	A3 FE 7200
Body no.	F129674
Date of manufacture	July 2000
Odometer	105,092 miles
GVWR	32,200 pounds
Length	420 inches
Width	94 inches
Wheelbase	190 inches
Engine	Cummins ISB diesel
Transmission	Allison 2000 automatic

The following school bus was of the same front engine transit style as the lead school bus. It sustained more substantial front-end damage than the lead bus, but the remainder of the bus exterior was undamaged.

NTSB investigators examined the vehicle dash and interior switches and gauges, at which time the speedometer needle was resting at 0 mph; the tachometer, oil pressure, and water temperature gauges had been broken out of the dash as a result of the frontal damage to the vehicle. The automatic transmission gear selector was found in the neutral position. Although the dash in the area of the cruise control switch was damaged, the switch appeared to be in the "off" position. Investigators could not determine if any of the three available brake indicator lights on the dash had been illuminated because they were not functional.

No damage was observed in any of the suspension system components of the following school bus. The vehicle tires were undamaged. The steering wheel was deformed and no longer completely concentric. The steering system transition box, mounting bracket, and linkages on either side were all pushed rearward as a result of the front bumper damage—which altered alignment of the steering components but did not prevent steering wheel movement from reaching the lower steering linkage.

The following school bus was equipped with four-wheel hydraulic disc brakes and an ABS unit. The brake pedal was mechanically linked through the floorboard to the master cylinder, which was dry and appeared to be undamaged. Due to the front bumper damage, the alignment of the mechanical linkage was deformed and pushed inward, but the linkage could still be moved with firm pressure.

Copeland Bus Services had fabricated a spring assembly to help return the brake pushrod from a braking actuation to its nonbraking position in an attempt to turn off the service brake application indicator light on the dash. The assembly was mounted between the housing of the 90° steering transition box and the front of the brake pushrod into the master cylinder.

The brake lines leading from the master cylinder to the ABS unit appeared to be newer than the surrounding lines and were in much better condition than the same lines on the lead school bus. Inspection of the brake lines from the master cylinder to the wheels revealed corrosion in some locations; however, all of the lines were dry, and no hydraulic fluid leaks were detected. The hydraulic brake fluid reservoir was full. When the brake pedal was depressed, the pedal movement was more firm and reactive than on the lead bus.

The following school bus was equipped with an ECU, though it was not designed to record event data, such as last stop, crash, and sudden deceleration. The bus was equipped with an ABS ECU, which recorded ABS configuration and diagnostic-related data. An examination of these data uncovered eight inactive diagnostic fault codes and one active fault code, manifest as frequent error signals from the "left rear wheel speed sensor."

At the time of postaccident inspection, the right rear ABS wheel speed sensor was found out of its placement hole in the wheel end and dangling from a wire. Investigators at the accident scene noted that the following school bus left one solid skid mark from the right rear tire, indicating that the ABS was not functioning at that location. NTSB investigators determined that the out-of-place right rear ABS sensor was most likely the cause of the active left rear ABS sensor fault code. It is not uncommon for the sensor wires to be crossed from left to right; and the left rear ABS sensor was found to be in place and functional.

The following school bus was equipped with a rearward-facing video camera mounted above the front windshield inside the bus, which recorded the entire trip on video home system (VHS) tape. The VHS recorder was located in a locked container on the bus. As discussed in section 2.2, "Video Analysis," the video was useful in estimating vehicle speeds and the sequence of events for this multivehicle accident.

1.9.5 Deceleration Tests on Accident School Buses

To assess the deceleration capabilities of the two accident school buses, a series of tests were conducted by skidding the buses on a roadway with a similar coefficient of friction as the accident location and comparing the results to an exemplar bus from the same fleet. All of the deceleration tests were conducted on a level section of a two-lane undivided asphalt road in Cuba, Missouri. Five of the six tests were conducted on August 10, 2010; and a final test was conducted on October 19, following replacement of the leaking hydraulic brake lines on the lead school bus.

The following school bus could be started and driven.[40] The lead school bus could not be driven because of the drive shaft damage; however, after a fusible link was replaced inside the damaged fuse box, the engine was capable of starting. With the engines running on each of the three buses during testing, hydraulic power assist was available for both braking and steering.

Two tests (runs 1 and 5) were conducted by driving the exemplar bus and the following school bus to a constant speed of approximately 20 mph before the service brakes were fully applied to mimic an emergency brake application. The same procedure was repeated to conduct a second test with the exemplar bus at 30 mph (run 2). Because the lead school bus could not be driven, a tow truck was used to push the bus to approximately 20 mph and 25 mph before the service brakes were fully applied (runs 3 and 4, respectively).

The road was dry when the tests were conducted with the exemplar bus and the lead school bus. Light rain made the road surface damp but not rain soaked when the single test with the following school bus was conducted. Table 12 shows the speed at which hard braking was initiated, the amount of time expired for the vehicles to come to a full stop, the distance traveled from brake initiation to full stop, and the deceleration force produced.

[40] Although the engine of the following school bus could be started, before the bus could be driven, a rear section of the drive shaft—which had been removed for towing postaccident—was replaced.

Table 12. Deceleration tests results for lead school bus, following school bus, and exemplar school bus.

Run No.[a]	Test Vehicle (school bus)	Prebraking Speed (mph)	Time (seconds)	Distance (feet)	Acceleration (g-force)
1	Exemplar	19.3	1.4	21.2	-0.62
2	Exemplar	29.5	2.4	49.4	-0.57
3	Lead	19.7	4.0	58.2	-0.22
4	Lead	24.4	4.5	79.9	-0.25
5	Following	18.7	1.3	20.6	-0.64
6[b]	Lead	25.8	1.9	36.2	-0.63

[a] Runs 1–5 were conducted on August 10, 2010; run 6 was conducted on October 19.
[b] Run 6 was completed after replacement of the leaking brake lines on the lead school bus.

Based on the findings of the deceleration tests, it was calculated that at a speed of 50 mph, the lead school bus, with its damaged brake line, would require 9.13 seconds and 335 feet to come to a complete stop. With the brake lines repaired, the lead bus would require 3.60 seconds and 132 feet to come to a complete stop. The following school bus, traveling at 50 mph, would require 3.55 seconds and 130 feet to come to a complete stop.

1.9.6 Maintenance and Inspection of Accident School Buses

At the time of the accident, the St. James School District transportation fleet included 23 school buses—of which 18 were transit style, 3 were conventional, and 2 were mini. The two mini buses were manufactured by General Motors Company. Of the 21 other school buses, 19 were manufactured by the Blue Bird Corporation and 2 by Thomas Built Buses, Inc. Each of the buses was outfitted with hydraulic (and not air) brake systems. The owner of Copeland Bus Services stated that he operated only hydraulically braked buses so that his CDL drivers would not be required to have air brake endorsements.

The lead school bus involved in this accident was the newest in the fleet. Copeland had purchased all of the buses as preowned and operated by other school districts in the surrounding counties and states. NTSB staff toured the Copeland facilities and observed that there did not appear to be any set maintenance schedule for the buses or any established form of retention of maintenance records. In addition, there was no apparent organization of service manuals or reference materials. The entire set of maintenance records for the fleet of buses was contained in a small spiral-bound notebook, where each bus had less than one page of maintenance notes. The owner of Copeland and a staff mechanic indicated that many small repairs or service checks (such as topping off fluid and checking tire pressure) were not typically recorded in the notebook. Neither the owner nor the mechanic had any formal training in the service or maintenance of passenger or heavy vehicles.

According to maintenance notes, the lead school bus was purchased by Copeland in November 2005, and the following school bus was purchased in October 2005. The notes contained multiple mentions of preventative maintenance items, such as “lube” and “full service," as well as references to the installation of new tires. The most recent note regarding the lead bus was on April 29, 2010, for a "full service," which included a tailpipe and rear brake check. Other entries for this bus were a transmission computer service in April 2008 and a speedometer replacement in December 2008. The most recent reference to the following school bus was on March 31, 2010, for a "full service," which included tailpipe and clamp replacements to the driveline or exhaust system. Other entries for this bus were a "repaired 2 brake lines" reference in September 2009 and speedometer replacements in both October 2006 and March 2007.

1.9.7 School Bus Inspection Program

Missouri is 1 of 18 states (and the District of Columbia)—most located in the Northeast—with a mandatory passenger vehicle safety inspection program. Vehicles are periodically inspected to identify mechanical-related deficiencies with brake, steering, suspension, and lighting systems—or with tires—that could, if undetected, cause or contribute to motor vehicle accidents. Although the other 32 states do not mandate that all passenger vehicles be inspected on a regular basis, most have an annual or semiannual inspection program for specific vehicles, such as school buses, or conduct random roadside inspections of a targeted sample of the heavy commercial vehicles involved in intrastate and interstate travel.

The MSHP is responsible for licensing and monitoring inspectors/mechanics and private inspection stations affiliated with the state's motor vehicle safety inspection program. The MSHP is also the lead agency for planning, oversight, rule and policy development, and reporting on safety inspection for the Gateway Vehicle Inspection Program—a combined emissions testing and safety inspection program for vehicles registered in the St. Louis ozone nonattainment area.[41]

School bus inspections are conducted twice a year to comply with the MMVIRs, at 11 CSR 50-2.010–2.440, which set forth requirements for state-certified inspection stations and for the licensing of inspectors and mechanics. The first inspection is required to occur at least 60 days prior to the start of each school year. It is conducted at a private state-certified inspection station, which charges a nongovernment-subsidized fee of $12 for a vehicle inspection. The MSHP conducts the second school bus inspection between February 1 and May 1. The MSHP inspection stations, as well as the MSHP inspectors, are subject to the same certification, licensing, and permit regulations as the private stations and inspectors.

The MMVIRs contain sections on brake performance (at 11 CSR 50-2.150) and hydraulic brake system components (at 11 CSR 50-2.160(1)) under "Passenger Car and Truck Inspection." However, there are no similar specifications for brakes under "School Bus Inspection," though a single line of text, at 11 CSR 50-2.320(1), states: "In addition, the items listed in this rule will be inspected on all school buses." According to the MSHP, this requirement means that school buses are also subject to all of the inspection criteria within "Passenger Car and Truck Inspection," including the criteria pertaining to brakes.

[41] The combined emissions testing and safety inspection program in the city of St. Louis and Franklin, Jefferson, St. Charles, and St. Louis counties began on October 1, 2007.

At 11 CSR 50-2.160(1), the MMVIRs specify that a vehicle is to fail inspection if brake pedal movement exhibits signs of a fluid leak; if the master cylinder is leaking; or if worn, broken, or loose brake components are found.[42] This section advises that, in the absence of brake performance testing, one front or one rear wheel be removed for inspection of brake components on passenger vehicles and pickups or similar vehicles not equipped with dual rear wheels. According to the MSHP, a wheel is not required to be removed from dual rear-wheeled school buses, such as those involved in this accident, for the inspection of brake components. However, NTSB investigators noted that many of the listed brake inspection items are not visible with the wheel in place.

The accident buses were last inspected at Ray's Tire, a class A state-certified inspection station, on July 27, 2010, and by the MSHP on March 25, 2010. The July approval notices from Ray's Tire noted that each of the school bus inspections took approximately 20 minutes and listed no defects. Nothing was checked in a section marked "brake inspected" (one checkbox for each of four brakes). Ray's Tire also inspected both of the buses in July 2009, and those records show the same 20-minute inspection times, with no defects found, and none of the brake inspection boxes checked.

On March 25, 2010, during a prearranged inspection with Copeland Bus Services, the MSHP inspected all 23 buses. Each of the buses passed with no reinspections needed. The MSHP inspection certificates do not note the time the inspections started or ended, nor do they include brake inspection checkboxes. For the two accident buses, both certificates have an "approved" box checked and no defects listed. As a result of this fleet inspection, the MSHP gave Copeland a Total Fleet Excellence Award for having a 90 percent or greater approval rating.

After NTSB staff found the leaking master cylinder and hydraulic brake lines and cracks and the missing sections of brake pad lining on the lead school bus—and the out-of-place ABS sensor on the following school bus—the MSHP returned to Copeland for an unplanned spot fleet inspection on August 11, 2010. On this occasion, a total of 20 buses were inspected,[43] 8 of which were rejected, resulting in an approval rating of 60 percent. Five of the eight rejected buses were considered to be "out of service."[44] Six of the eight rejected buses were reinspected after repairs were made on the same day and they then passed inspection, with two out-of-service buses remaining as such.

Each of the rejected buses had been inspected by Ray's Tire in July 2010. Five of the eight rejected buses had been driven only 2–3 miles since their inspection. As a result of the

[42] Vehicles that fail inspection cannot be registered or have their license plate registration renewed until the component defect has been corrected. Owners have 20 days to repair the vehicle and return it to the station for reinspection without additional charge.

[43] Copeland's fleet of 23 buses was reduced to 20 because the 2 accident buses were in NTSB possession at the time, and 1 additional bus (a 2000 Blue Bird bus) had been involved in an accident in the parking lot of St. John's Mercy Hospital (now Mercy Hospital Washington) in Washington, Missouri, on the same day as the accident (August 5, 2010).

[44] The five out-of-service rejections were for: (1) an inoperative rear overhead warning light, (2) no brake pedal pressure, (3) a worn right front tire, (4) a right rear brake line leaking and low master cylinder fluid, and (5) a split in a left rear tire side wall.

defects found on August 11, 2010, the MSHP revoked the inspection station certification for Ray's Tire on August 24—as well as the lead mechanic's inspector permit—for the maximum term of 1 year each.

Immediately following the Gray Summit accident, Copeland had sent a bus to St. John's Mercy Hospital in case any uninjured students needed transportation back to St. James, Missouri. The bus was a transit-style, front diesel engine school bus, with hydraulic disc brakes, similar to the two school buses involved in the earlier accident. According to the police report, the driver of the bus experienced a loss of braking in the hospital parking lot and struck three parked cars before coming to rest against a small garage at the end of the lot. A trail of fluid was found along the path of the bus in the parking lot, and brake fluid was observed to be leaking from the left front undercarriage. This bus had also passed a 20-minute state inspection at Ray's Tire on July 19, 2010; no defects were found, and none of the brake inspection boxes were checked.

Because NTSB investigators detected hydraulic brake line failures on three similar buses during the course of this investigation, the National Highway Traffic Safety Administration (NHTSA) Office of Defects Investigations (ODI) was contacted. A query of ODI databases revealed no applicable brake line recalls, service bulletins, or complaints.

In Missouri, per 11 CSR 50-2.120, the MVI–2 form is used to document inspections performed on all types of vehicles. The form also serves as an approval certificate, rejection notice, and station record. This one-page form has two carbon copies attached. It contains general information about the vehicle owner, vehicle description, odometer reading, inspection station, and inspector/mechanic, and six blank lines for describing defective conditions. The MVI–2 form contains checkboxes for identifying the body style, fuel type, and which brake was inspected.

NTSB investigators reviewed inspection forms from 15 other states[45] that were available online to compare with the MVI–2 form. The state forms varied in content and format. Most of the forms were set up as checklists, where vehicle inspectors would specify whether a specific component passed or failed inspection. Most, if not all, of the checklists reflected vehicle inspection requirements in the FMCSRs. In most cases, the forms prompted inspectors to look for signs of leaks in the brake system and to inspect the condition of brake tubing.

1.10 Highway Factors

1.10.1 Highway Characteristics

I-44 was constructed in 1966–1967, running roughly southwest to northeast, from Wichita Falls, Texas, to St. Louis, Missouri. The general design of the highway matches the topography, with rolling terrain and numerous changes in vertical and horizontal alignment consisting of gentle curvature. The approach to the area of the collision—on an approximate

[45] Inspection forms were retrieved for the states of Alabama, Alaska, Arkansas, California, Florida, Indiana, Kansas, Minnesota, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, Texas, and Vermont.

2,550-foot-long, 3 percent upgrade—is on a straight and unobstructed section of roadway that was dry at the time of the accident.

The highway consists of four lanes, with the two eastbound and two westbound lanes separated by a 40-foot-wide depressed earthen median with a 1:4–1:5 traversable slope.[46] The median is protected by a test level 3[47] three-strand, low-tension generic cable barrier system with 16-foot post spacings. The median shoulder on the eastbound lane is 5.5 feet wide. The shoulder is delineated from the travel lanes by solid yellow pavement stripes and is equipped with rumble strips. The two eastbound lanes are 12 feet wide and delineated by white dashed lines 10 feet long and spaced 30 feet apart. The eastbound shoulder is 10 feet wide with a test level 3 longitudinal W-beam barrier at its edge. This shoulder is delineated from the main travel lanes by a solid white pavement stripe. The Gray Summit accident occurred at mile marker 250.6, about 38 miles southwest of St. Louis.

1.10.2 Highway Statistics

According to MoDOT, the average daily traffic (ADT) on this stretch of I-44 was 20,223 vehicles.[48] Commercial vehicles accounted for approximately 23 percent of this traffic volume.

I-44 is a principal arterial interstate with a design speed of 70 mph in the accident area. Due to the presence of a work zone, the speed limit was reduced to 50 mph at mile marker 250.4, approximately 0.2 mile west of the accident site.

Accidents statistics for the roadway between mile markers 245–255 eastbound showed three fatal accidents recorded from March–August 2010;[49] the Gray Summit accident was the third of these accidents. Two of the three fatal accidents involved commercial vehicles. Additionally, 11 injury accidents and 53 property damage accidents occurred on this 10-mile segment of road during the same 6-month period. Table 13 lists the number of fatality, injury, and property damage-only accidents that occurred on this segment of roadway between March and August, from 2005–2010.

A left lane closure was in effect at the time of each of the three fatal accidents in 2010. The first accident occurred on eastbound I-44 at mile marker 248.4 on April 13, 2010, about 4:20 p.m., when a passenger car struck the rear of a motorcycle. The second accident occurred at mile marker 251.6 on May 14, 2010, about 3:05 p.m., when a speeding passenger car struck the rear of a truck-tractor semitrailer. As a result of the first accident, MoDOT limited lane closures to 9:00 a.m.–2:00 p.m.

[46] With a 1:4 slope, the elevation drops 1 foot for every 4 feet of horizontal distance.

[47] The performance of safety barriers—distinguished by standard vehicle type, impact angles, and travel speeds—is categorized into six test levels of increasing strength and height. A test level 3 barrier is generally acceptable for a wide range of high-speed arterial highways with very low mixtures of heavy vehicles and favorable site conditions.

[48] The work-zone design plans showed an ADT of 54,000 vehicles 4 miles east of the accident site.

[49] These fatal accidents occurred between mile markers 248.4–251.6.

Table 13. Categories of accidents occurring on I-44 between mile markers 245–255 for March-August, 2005–2010.

Type of Accident	2005	2006	2007	2008	2009	2010	Total
Fatality	3	0	1	0	0	3	7
Injury	5	15	27	19	6	11	83
Property damage only	43	48	53	59	56	53	312

1.10.3 Work Zone

I-44 was straight for about 0.5 mile prior to the accident site. A postaccident survey determined that the accident scene—encompassed by preimpact tire friction marks, impact gouges, postaccident tire marks and gouges, and the final positions of all four vehicles—was 196 feet long. The Gray Summit accident occurred at mile marker 250.6, within the advance warning area of a work zone, about 0.5 mile from the work-zone entrance. According to Federal regulations, the location of the accident classifies it as work-zone related.[50] The work zone was a Federal aid project to widen the road by constructing an additional third lane in each direction over a 4.1-mile-long area beginning east of State Route 100 to east of State Route 00, near Pacific, Missouri.[51] As required for a work-zone project of this magnitude, at 23 CFR 630.1010, Subpart J, a traffic management plan was created to manage the anticipated impact to traffic flow during construction. An additional work zone was in place at mile marker 248 involving bridge construction repair; however, there were no lane closures for the bridge project on the day of this accident.

Because the work zone was federally funded, the FHWA had oversight of the project. On June 16, 2010, the FHWA had inspected the work zone as part of its evaluation of the entire construction project. The inspector found no problems or deficiencies. The inspector noted that the reduction of speed from 70–50 mph appeared to be adequate. Additionally, MoDOT had inspected the work zone on 21 occasions between January and August 15, 2010, and noted no significant issues. These inspections were conducted by MoDOT personnel not associated with the project. The last inspection occurred 10 minutes prior to the accident. A MoDOT Office of Work Zone Safety traffic technician, who was traveling through the area with her family, conducted a review of the work zone and found it to be acceptable. She indicated that traffic had briefly slowed to 25–30 mph in the area of the lane closure.

At the time of the accident, the left lane was closed on eastbound I-44 within the work zone. Several signs warned approaching motorists of the work zone and lane closure. A dynamic message sign (DMS) located 14 miles in advance of the work zone (at mile marker 237), flashing "ROAD WORK AT MM 251 LEFT LANE CLOSED," was the first sign warning of the left lane

[50] According to 23 CFR 630.1004, Subpart J, a work-zone-related accident is one in which the first harmful event occurs within the boundaries of a work zone or on an approach to or exit from a work zone, resulting from an activity, behavior, or control related to the movement of traffic units through the work zone. This definition includes crashes occurring on the approach to, exiting from, or adjacent to related work zones.

[51] Federal Highway Administration (FHWA) project J6I2011.

closure. Another DMS, located 1.1 miles from the work zone (at mile marker 249.9), carried the identical message. Temporary horizontal rumble strips were installed across the width of both eastbound lanes in advance of each DMS to attract the attention of motorists to the signage and messages. Changeable message signs (CMS) located at mile markers 246.8 and 247.9 displayed "PAVING WORK MON–FRI EXPECT INCREASED DELAY." Several traditional work-zone warning signs were placed at intervals along I-44 to further warn motorists of the lane closure. These signs met the color, dimensional, and placement requirements specified in the *Manual on Uniform Traffic Control Devices* (MUTCD).[52] As noted earlier, the speed limit was reduced to 50 mph at milepost 250.4, about 0.2 mile from the accident site.

MoDOT used its "Work Zone Safety and Mobility Policy" in the development of a traffic management plan to assess the traffic impact of the Gray Summit work-zone project. The plan included using CMSs, DMSs, restricted lane closure during peak traffic demand, a traffic queue detection system, and other special contract provisions. One such provision limited lane closure delays to 15 minutes and penalized contractors who failed to comply with this requirement. The queue or delay time was evaluated by the road contractor and the MoDOT Traffic Management Center by means of traffic cameras in the center, a wireless technology-based traffic delay prediction system, and visual inspection.

MoDOT kept daily work records detailing the status of traffic in the work zone. In several cases, notes were made about contractors being proactive and terminating the lane closure for brief periods to alleviate congested traffic. Four occasions were noted where traffic congestion exceeded the allowable 15-minute delay, and MoDOT inspectors instructed contractors to terminate the lane closure. At the time of the Gray Summit accident, traffic was backed up less than 0.5 mile—and the traffic delay was well under 15 minutes—thereby not warranting reopening of a lane. The accident occurred about 1 mile west of the closest traffic camera, which was located at mile marker 251.7. The accident scene could not be viewed from this location because of a horizontal curve.

In addition to the provisions in the traffic management plan, MoDOT also initiated a public service campaign to broadcast work-zone safety information, which included the Internet, public service announcements, public meetings, social media, and blogs on <www.stltoday.com> (*St. Louis Post Dispatch*). MoDOT also held quarterly meetings with private contractors and the FHWA to discuss work-zone mobility and safety issues.[53]

[52] The MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic.

[53] Work-zone evaluations were conducted using "Tracker," a strategic performance-oriented goal evaluation system in which progress toward 18 tangible results is reviewed statewide each quarter. For more information, see <http://www.modot.org/about/general_info/Tracker.htm>.

1.10.4 Recent Developments in Work-Zone Oversight

Nationwide, work-zone fatalities have been on a steady decline since 2002.[54] In 2007, Federal work-zone regulations and guidance were updated to include the following:[55]

- Development and implementation of an overall agency-level work-zone safety and mobility policy to institutionalize work-zone processes and procedures.
- Development of agency-level processes and procedures to support policy implementation, including procedures for work-zone impact assessments, work-zone data analysis, training, and process reviews.
- Development of procedures to assess and manage the work-zone impacts of individual projects.

In 2009, the FHWA amended the MUTCD to provide for the application of intelligent transportation system (ITS) improvements in work zones. Among the goals the FHWA hopes to achieve with ITS are the following:

- To inform road users in advance of the nature of the work zone, time and duration of its execution, anticipated effects on road users, and possible alternate routes of travel, with the intended effect of reducing traffic and related conflicts through the work zone.
- To promote efficient traffic flow and safety around the work zone through the use of traffic monitoring and management technology, data collection, and traveler information (for example, via portable camera systems, queue detection technology, ramp metering, variable speed limits, merge guidance, and highway advisory radio).

In 2010, 23 CFR Part 511, "Real-Time System Management Information Program," was amended to require the states to establish real-time traffic monitoring on interstate highways by November 8, 2014, and on state-selected routes of importance in metropolitan statistical areas by November 8, 2016.[56] The goal of the program is to provide motorists with information on when traffic lanes are closed due to construction, roadway or lane blocking incidents, or hazardous weather conditions. According to the program, information about construction activities that close roadways or lanes must be provided within 20 minutes of a lane closure for highways outside metropolitan areas and within 10 minutes for highways inside metropolitan areas. This requirement does not apply to short-term or intermittent lane closures.

Similarly, information about lane closures due to incidents or accidents must be provided within 20 minutes of the time the incident is verified for locations outside of metropolitan areas and within 10 minutes for locations inside metropolitan areas. The requirements also apply to

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[54] See <http://www.workzonesafety.org/crash_data>, accessed October 26, 2011.

[55] Changes to work-zone regulations found in 23 CFR Part 630, Subpart J, were the result of Federal rulemaking contained in *Federal Register*, vol. 69, no. 174 (September 9, 2004), p. 54562.

[56] *Federal Register*, vol. 75, no. 68 (April 9, 2010), p. 68427.

lane closures due to hazardous weather. States must also evaluate regional ITS architecture created in accordance with 23 CFR Part 940 to determine whether it explicitly addresses real-time highway and transit information.

1.11 Weather and Visibility

At the time of the accident, the temperature was 81° F, the weather was clear, and the roadway was dry. NTSB investigators observed that at the time (10:15–10:30 a.m.) and place of the accident, the sun would have been overhead and slightly to the right for eastbound drivers on I-44, and it would not have been in the forward field of view of drivers.

2 Analysis

2.1 Introduction

At the time of the Gray Summit accident, the weather was clear and the roadway was dry. The sun was not in the forward field of view of eastbound drivers on I-44, and glare was not a factor.

The drivers of the Volvo tractor, the GMC pickup, and the lead and following school buses were licensed, and the commercial drivers possessed current medical certificates. Each driver was familiar with this section of I-44. The driver of the lead school bus had completed the annual school bus skills test training required of drivers 70 years of age and over, and both bus drivers were near completion of the required 8 hours of annual pupil transportation training required by Missouri state law. Postaccident toxicological tests were administered on fluid samples from all four drivers, and all samples were negative for alcohol and illicit drugs.

No defects or maintenance problems that could have contributed to the accident or to its severity were found during a postaccident inspection of the Volvo tractor and the GMC pickup. Because of the extensive damage to the pickup, its steering system could not be inspected; however, the vehicle had undergone an annual safety and emissions inspection less than 1 hour prior to the accident, and no problems were noted. Postaccident inspection of the two school buses revealed corrosion on the hydraulic brake lines. The leakage of hydraulic fluid in the lead school bus reduced the vehicle's braking performance during deceleration tests. Investigators also found a nonfunctioning brake system warning indicator light and brake pads with cracks and missing sections. Nevertheless, the driver of the lead bus said that she did not have time to brake or steer before hitting the GMC pickup, a statement consistent with forensic evidence. Deceleration tests conducted on the following school bus demonstrated that the condition of the brake lines and the lack of ABS on the right rear wheel did not affect its ability to decelerate at a reasonable rate. Although the condition of the school buses was not causal or contributory to the accident, section 2.6.1, "School Bus Inspections," discusses the maintenance and inspection processes that allowed two poorly maintained vehicles to be used in pupil transportation.

The fire chief from the Boles Fire Protection District, who acted as incident commander, received the dispatch for the accident at 10:14 a.m. and arrived on scene at 10:19 a.m., less than 1 minute after arrival of the Franklin County Sheriff's deputy and the lieutenant from the Meramec Ambulance District. The MSHP arrived on scene at 10:31 a.m. The incident commander conducted a meeting to review what was known about the situation and how to proceed with extrication of vehicle occupants, transportation of the injured, removal of the vehicles, and recovery of the deceased. Twelve rescue and engine units from 3 fire districts and 13 ambulances from 6 ambulance services responded to the scene; 12 of the ambulances were used to transport occupants. Surviving passengers were evacuated or extricated from the buses by 10:37 a.m., 23 minutes after the initial dispatch call. First responders reported that the rescue and recovery effort proceeded smoothly and that all the responding agencies worked well together through the incident commander, with the MSHP investigating the accident; EMS units transporting the injured; and the fire districts handling the rescue, extrication, and recovery efforts.

NTSB investigators considered whether aspects of roadway design, work-zone signage, or work-zone policies may have factored into the occurrence of the Gray Summit accident. Apart from this accident, two other fatal accidents had occurred between mile markers 248.4–251.6 in April–May 2010. The accident site was preceded by 0.5 mile of straight roadway, which provided drivers with an unobstructed view of the traffic ahead. Investigators determined that the approach to the work zone was adequately signed, with warnings displayed using DMSs, CMSs, and traditional signs. The sign indicating the reduced speed limit was also placed an adequate distance from the work zone. Records show that the FHWA and MoDOT consistently noted no significant issues associated with the work-zone project. Following the first fatal accident on this stretch of roadway, MoDOT had limited lane closures to 9:00 a.m.–2:00 p.m. to reduce long traffic queues. Additionally, MoDOT had a policy in place limiting lane closure delays to 15 minutes, and the agency employed ITS queue detectors, CMSs, and DMSs to increase the mobility and safety of road users.

From 1999–2001, the NTSB investigated nine rear-end collisions, which resulted in 20 fatalities and 181 injuries; two of the nine accidents occurred in work zones. As a result of its investigations, the NTSB issued the following recommendation to the FHWA:[57]

> Develop a procedure that states can use to conduct a risk analysis for work zone backups; require, where appropriate, the use of a queue length detection and warning system; and incorporate that procedure for a queue length detection and warning system for work zones in the *Manual on Uniform Traffic Control Devices* work zone guidelines. (H-01-11)

On October 8, 2009, the FHWA responded that it had modified the regulations, developed analytical resources, and developed ITS-related guidance that would help states improve safety and mobility within work zones. The FHWA also stated that it had amended the MUTCD in 2009 to provide for the use of queue length detection systems and other ITS technologies in work zones. After evaluating these actions, the NTSB classified Safety Recommendation H-01-11 "Closed—Acceptable Alternate Action" on August 8, 2010. The FHWA has since developed a web-based curriculum for work-zone designers to use in treating potential "back-of-queue safety hazards." MoDOT had incorporated many of the latest solutions for reducing back-of-queue safety hazards into the Gray Summit work-zone project.

Accordingly, the NTSB concludes that the following were ***not*** factors in this accident: (1) weather; (2) driver qualifications or familiarity with the accident location; (3) alcohol or illicit drug use by any of the four drivers; (4) mechanical condition of the Volvo tractor, the GMC pickup, or either of the two school buses; (5) emergency response; or (6) highway design, work-zone signage, or work-zone policies.

[57] *Vehicle- and Infrastructure-Based Technology for the Prevention of Rear-End Collisions*, Special Investigation Report NTSB/SIR-01/01 (Washington, DC: National Transportation Safety Board, 2001).

The following safety issues were identified as factors in this investigation:

- Potential use of video event recorder (VER) data in monitoring and oversight of driver performance.
- Driver distraction due to use of a portable electronic device.
- Necessity of maintaining adequate focus on the forward roadway and keeping recommended minimum following distances.
- Medical oversight of interstate commercial drivers.
- Inadequate Missouri state school bus inspection regulations and procedures.
- Absence of Missouri state oversight of motor carriers involved in pupil transportation.
- Frequency of rear-end accidents.
- Design of emergency windows in school buses.
- Absence of a Missouri state requirement for pretrip safety briefings for pupils traveling to an activity or on a field trip in a school bus or a school-chartered bus.

As a prelude to the detailed discussion of these issues, section 2.2 reviews the analysis of video from the following school bus to establish the approximate vehicle speeds and timing of the three collisions.

2.2 Video Analysis

The following school bus was equipped with a rearward-facing video camera, mounted above the front interior windshield, which recorded the entire trip on VHS tape. This video was used to estimate the speed of the bus, the speed of the GMC pickup as it was passing the bus, the time of collision between the GMC pickup and the Volvo tractor, and the time between impacts of the two school buses.

2.2.1 Speed of 2001 Blue Bird Bus (Following School Bus)

Using images from the video and bus dimensions, it was possible to estimate the camera field of view, orientation, and location with respect to the bus. These estimated parameters were used as inputs to a mathematical model that mapped points in the three-dimensional field of view of the camera onto simulated two-dimensional video cassette recorder frames. The calibrated mathematical camera model placed points inside the bus, such as a corner of a side window, at the same location on a video frame as the real camera. The camera model was valid for points both inside and outside the bus and for points visible through the side or the rear windows.

The speed of the following school bus was estimated based on the length and spacing of the segments of the white lane dividing line. The standard specification is a 10-foot line segment followed by a 30-foot gap. When the bus was aligned with the left lane, it was possible to estimate its speed by counting the line segments. Using this relatively simple method, it was determined that the bus was traveling at a constant speed of 55 mph 30 seconds prior to impact with the lead school bus. Fourteen seconds before impact, the following bus had slowed to a speed of 51.6 mph.

During the last second prior to impact, it was not possible to estimate the speed of the following school bus using the above method because the bus was not aligned with the lane. However, NTSB investigators used a video analysis technique developed during the Mexican Hat, Utah, motorcoach accident investigation[58] to estimate bus location. The results indicated that the following bus had slowed to 43.1 mph a second before impact and was traveling at 38.1 mph at the time of impact. These estimates are consistent with estimates calculated from the skid tests and forensic data gathered on scene.

2.2.2 Passing Speed of GMC Pickup Truck

In the video, the GMC pickup passes the following school bus 59 seconds before the bus collides with the lead school bus. Using the broken white lane divide as a reference, the estimated speed of the following bus during this time was 56.8 mph. It is assumed that this speed remained constant during the 4 seconds it took for the GMC pickup to pass the bus. The speed of the pickup (with a length of 241.5 inches) was estimated using the time it took to pass the same point in a left side window of the bus. This calculation resulted in a speed estimate of 69.3 mph, which is 12.5 mph faster than the bus.

2.2.3 Time of Collision Between GMC Pickup Truck and Volvo Truck-Tractor

Video analyses and SDM data from the GMC pickup were used to determine whether an upper and lower bound could be placed on the time between the initial impact involving the GMC pickup and the final impact involving the following school bus. Analysis of the pickup's ACM determined that the pickup was traveling at 55 mph 1 second before it hit the Volvo tractor.[59,] Estimates of the time separation between the initial and final impacts are dependent on how soon after passing the following school bus the pickup began to decelerate and how quickly it did so prior to impact. There are no tire marks to indicate braking prior to impact, so it is assumed that the speed reduction occurred with constant deceleration. Models using representative times for deceleration suggest that 5.9–11.4 seconds passed between the pickup's initial impact with the Volvo tractor and the final impact in the collision sequence involving the following and the lead school buses.

[58] *Motorcoach Rollover Near Mexican Hat, Utah, January 6, 2008*, Highway Accident Report NTSB/HAR-09/01 (Washington, DC: National Transportation Safety Board, 2009).

[59] The SDM data included one deployment and one near-deployment event prior to the GMC pickup's collision with the Volvo tractor. The NTSB could not definitively determine whether either data element was an artifact of the crash.

2.2.4 Actions of Following School Bus

Video evidence showed that the following school bus began turning right when its front was 94 feet ahead of the front of the motorcoach that had stopped on the shoulder. This motion by the bus occurred 1.8 seconds before impact with the lead school bus. The surveillance video does not show the steering wheel of the following bus, so it is assumed that there was a 0.1-second delay between the driver's steering input and the corresponding rightward movement of the bus on the video.

2.3 Video Event Recorders

A VER is a device designed to capture video and other parameters related to operator and vehicle performance. Current VERs are capable of recording forward-looking video, interior video, interior audio, lateral acceleration, longitudinal acceleration, and global positioning system (GPS) data, among other parameters. VERs may also be configured to record manually when activated by the driver or automatically when preconfigured thresholds are met on such events as hard braking or steering. When the VER is triggered, it typically stores a video recording of the seconds prior to, during, and after the event. VER systems are available for use in private, public, and commercial vehicles.

The NTSB has recommended that the FMCSA require VERs in commercial vehicles over 10,000 pounds and that carriers use VERs to manage their drivers' performance. The NTSB recently issued the following two recommendations to the FMCSA as a result of its investigation of a truck-tractor semitrailer rear-end collision into passenger vehicles on I-44 near Miami, Oklahoma:[60]

> Require all heavy commercial vehicles to be equipped with video event recorders that capture data in connection with the driver and the outside environment and roadway in the event of a crash or sudden deceleration event. The device should create recordings that are easily accessible for review when conducting efficiency testing and systemwide performance-monitoring programs. (H-10-10)
>
> Require motor carriers to review and use video event recorder information in conjunction with other performance data to verify that driver actions are in accordance with company and regulatory rules and procedures essential to safety. (H-10-11)

Each recommendation is currently classified "Open—Initial Response Received."

In correspondence dated September 1, 2011, the FMCSA acknowledged the NTSB interest in improving motor carrier safety through the installation of VERs in all commercial motor vehicles. However, the FMCSA asserts that it is important to recognize that such recorders capture only a brief period of time prior to a safety-critical event (such as a crash, near crash, or

[60] *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, DC: National Transportation Safety Board, 2010).

unintended lane departure) and would be reviewed only by enforcement personnel or the motor carrier during an enforcement intervention. Additionally, VERs would not record unsafe driving behaviors that occur without a safety-critical event as a trigger. For these reasons, the FMCSA maintains that its CSA program, launched in December 2010, offers better monitoring of a carrier's safety performance. Although the NTSB acknowledges that the CSA program will offer improved monitoring of drivers and carriers, there is enough evidence from this and past accident investigations that VERs can provide a level of oversight beyond that available through CSA. In addition, VERs can help drivers and carriers identify unsafe driver behaviors and situations before they result in an accident.

The NTSB analysis of events leading to the Gray Summit collisions was greatly assisted by the presence of the video unit on the following school bus. Using the video, NTSB investigators were able to determine the speed of the GMC pickup approximately 1 minute prior to the collision, the speed of the following bus (and also to infer the speed of the lead school bus), and when the driver of the following bus began to take evasive action. However, had each commercial vehicle been equipped with a VER, as recommended by the NTSB, the accident sequence would have been more clearly understood; that is:

- A VER on the Volvo tractor would have clarified whether it was moving or stopped when it was hit by the GMC pickup.

- A VER on the motorcoach that pulled over to the shoulder would have more clearly shown when the GMC pickup driver entered the right lane, the actions of the motorcoach driver after the initial collision, and the timing of the subsequent collisions involving the two school buses.

- A VER on the lead school bus would have allowed investigators to determine how the driver's visual scanning behavior factored into the second collision.

- A VER on the following school bus would have allowed investigators to more accurately determine the distance between the two buses.

VER recordings could be reviewed by carriers, school officials, law enforcement, and regulators in developing programs to encourage safe driving behavior and in improving vehicle and roadway designs.

As useful as VER data are for analyzing accidents, their biggest benefit may be the potential to prevent accidents. VERs have been shown to reduce the occurrence of accidents involving emergency vehicles,[61] novice drivers,[62] and commercial drivers[63] when used in

[61] L. Myers and others, "Effect of an Onboard Event Recorder and a Formal Review Process on Ambulance Driving Behavior," *Emergency Medicine Journal* (February 23, 2011).

[62] D. McGehee and others, "Extending Parental Mentoring Using an Event-Triggered Video Intervention in Rural Teen Drivers," *Journal of Safety Research*, vol. 38, no. 2 (2007), pp. 215–227.

[63] J. Hickman and R. Hanowski, *Evaluating the Safety Benefits of a Low-Cost Driving Behavior Management System in Commercial Vehicle Operations*, Report No. FMCSA-RRR-10-033 (Washington, DC: Federal Motor Carrier Safety Administration, 2010).

combination with a driver management program. In an FMCSA study,[64] commercial vehicles were equipped with VERs, and baseline performance was measured over 4 weeks for the drivers of those vehicles. Over the next 13 weeks, the drivers were coached on their driving, based on the driving errors captured by the VERs. As a result of targeted coaching, the overall occurrence of unsafe events decreased significantly among the commercial drivers. Of the two carriers involved in this study, one experienced a 38 percent reduction in the mean rate of recorded safety-related events per 10,000 vehicle miles traveled, while the other experienced a 52 percent reduction in recorded safety-related events.

The presence of VERs on all school buses, in combination with a driver management program, could assist carriers and school districts alike in identifying and addressing systemic factors in school bus operations that increase the risk of accidents. VER data could also be used to target risky or improper driver behavior before it leads to an accident. The NTSB concludes that had the Volvo tractor, the two school buses, and the motorcoach been required to have VERs, the events leading up to this accident could have been more definitively assessed. Additionally, the NTSB concludes that the use of VER data for managing driver behavior could assist school bus operators in identifying driver performance issues before they lead to accidents. Thus, the NTSB reiterates Safety Recommendations H-10-10 and -11 to the FMCSA. Further, though the NTSB recognizes the possible monitoring benefits of the CSA program, the NTSB reclassifies these two recommendations “Open—Unacceptable Response” because the FMCSA has not yet required the installation of VERs or the use of the captured VER information.

2.4 Vehicle Drivers

Section 2.4 discusses how the NTSB investigates distraction, the role of distraction in the three Gray Summit collisions, and possible solutions to mitigate distracted driving.

2.4.1 GMC Pickup Truck Driver

There is evidence that the driver of the GMC pickup may have been distracted immediately before the initial collision. Records from the cellular telephone provider indicate that from 9:58–10:09 a.m., the driver received 5 text messages and sent 6—for a total of 11 messages. Because the records do not document transmission times to the second, the final incoming message could have arrived at any time between 10:09:00–10:09:59 a.m. This pattern of communication strongly suggests that the driver was in an active text messaging conversation; because the final exchange was an incoming text, it can be assumed that it was the driver’s turn to reply.

A witness traveling near the GMC pickup reported that the driver appeared to lean to the right before the pickup struck the rear of the Volvo tractor. The witness stated that he did not see brake lights illuminate, which is consistent with data from the pickup’s SDM, indicating that the brakes were not applied in the last second prior to impact. The driver of the pickup might have been engaged in reading an incoming text, typing an outgoing text, or leaning to the right to retrieve his cell phone. The NTSB concludes that the absence of a timely brake application, the

[64] FMCSA-RRR-10-033.

cellular provider records indicating frequent texting while driving, the temporal proximity of the last incoming text message to the collision, and the witness statement regarding the driver's actions indicate that the GMC pickup driver was most likely distracted from the driving task by a text messaging conversation at or near the time of the accident.

NHTSA estimates that in the year 2009, nearly 5,500 people died and 450,000 people were injured in distraction-related accidents.[65] The findings from analysis of police-reported crashes indicate that 11 percent of crashes involve some form of distraction. NHTSA's "100-car study" found that 23 percent of recorded crashes can be attributed to driver distraction.[66] Texting while driving is one distraction that has consistently been found to impair driving performance. A study of commercial driver distraction conducted by the Virginia Tech Transportation Institute (VTTI) found that drivers were 23 times more likely to experience a safety-critical event when they were involved in texting.[67] In one simulator study, drivers engaged in text messaging had slower reaction times (35 percent slower) and poor lateral vehicle control.[68] Another simulator study found that sending and receiving text messages led to poorer performance on safety-critical driving measures, including lateral position maintenance, detection of road signs, and time with eyes off the road.[69] A fourth study reported that texting drivers in a simulator responded more slowly to the onset of brake lights and demonstrated forward and lateral control impairments. In addition, text-messaging drivers were involved in more simulated crashes.[70] A Texas Transportation Institute study found that drivers responded more slowly when either reading or writing text messages.[71]

In addition to texting devices, the use of other forms of portable electronic devices[72] (such as music players and gaming units, cell phones, and computer tablets) has been found to result in visual, auditory, manual, and cognitive distractions—which have been shown to increase the likelihood of an accident. A VTTI study found that, among light vehicle drivers, the use of handheld wireless devices was the most common type of distraction and resulted in the most near crashes.[73] A safety-critical event was 6.7 times more likely when a driver was

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[65] See <http://distraction.gov/stats_and_facts/index.html>, accessed October 26, 2011.

[66] S. Klauer and others, *The Impact of Driver Inattention on Near-Crash/Crash Risk, An Analysis Using the 100-Car Naturalistic Driving Study Data*, Report No. DOT-HS-810-594 (Washington, DC: National Highway Traffic Safety Administration, 2006).

[67] R. Olson and others, *Driver Distraction in Commercial Vehicle Operations*, Report No. FMCSA-RRR-09-042 (Washington, DC: Federal Motor Carrier Safety Administration, 2009).

[68] N. Reed and R. Robbins, *The Effect of Text Messaging On Driver Behavior: A Simulator Study* (Berkshire, UK: Transport Research Laboratory, 2008).

[69] S. Hosking, K. Young, and M. Regan, "The Effects of Text Messaging on Young Novice Driver Performance," *Distracted Driving* (Sidney, NSW: Australasian College of Road Safety, 2007), pp. 155–187.

[70] F. Drews and others, "Text Messaging During Simulated Driving," *Human Factors*, vol. 51, no. 2 (2009).

[71] J. Cooper, C. Yager, and S. Chrysler, *An Investigation of the Effects of Reading and Writing Text-Based Messages While Driving*, Report No. 476660-00024-1 (College Station, Texas: Texas Transportation Institute, August 2011).

[72] This use includes, but is not limited to, dialing, answering, e-mailing, accessing the Internet, and viewing, reaching, locating, and operating portable electronic devices.

[73] T. Dingus and others, *The 100-Car Naturalistic Driving Study, Phase II: Results of the 100-Car Field Experiment* (Washington, DC: National Highway Traffic Safety Administration, 2006).

reaching for or using an electronic device, such as a cell phone.[74] A VTTI study of commercial drivers found that a safety-critical event was 163 times more likely if a driver was texting, e-mailing, or accessing the Internet.[75] This research also found that portable music players can divert a driver's attention from the driving task for prolonged periods.

Many states have enacted laws ranging from banning texting for younger drivers to banning the use of portable electronic devices by all drivers because of the associated driving risks.[76] In addition to the 35 states that ban texting, 30 states ban all cell phone use for novice drivers, and 10 states ban the use of handheld cell phones. The District of Columbia has bans for all three usages. However, a recent study by the Insurance Institute for Highway Safety (IIHS) found that these bans have not reduced vehicle accident insurance claims accordingly.[77] Some states that enacted bans actually experienced increases in accident insurance claims. The IIHS suggests that the bans may not have shown their intended benefits because drivers continued to text but in a more discreet manner, or drivers switched to a nonbanned activity that can also be distracting. The IIHS study did not attempt to examine the effects of enforcement or education along with the bans.

Other IIHS studies have found that cell phone and texting bans were effective in reducing observed handheld cell phone or texting behavior.[78] Observational studies conducted in New York, Connecticut, and Washington, DC, found that cell phone and texting bans reduced cell phone and texting behavior by more than 40 percent immediately after taking effect. Although cell phone use while driving trended upward in all three cases following implementation of the bans, it is still much lower than would be expected without the bans. A little over 1 year after going into effect, compliance with the bans was lower in New York than in Washington, DC.[79] One explanation for this discrepancy in the rates of compliance may be differing levels of enforcement and media attention.[80]

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[74] FMCSA-RRR-09-042.

[75] J. Hickman, R. Hanowski, and J. Bocanegra, *Distraction in Commercial Trucks and Buses: Assessing Prevalence and Risk in Conjunction With Crashes and Near Crashes*, Report No. FMCSA-RRR-10-049 (Washington, DC: Federal Motor Carrier Safety Administration, 2010).

[76] Connecticut General Statutes 14-296aa bans the use of mobile electronic devices (such as a text messaging device, a paging device, a personal digital assistant, a laptop computer, equipment that is capable of playing a video game or a digital video disk, or equipment on which digital photographs are taken or transmitted) while such vehicle is in motion.

[77] "Texting Laws and Collision Claim Frequencies," *Highway Data Loss Institute*, vol. 27, no. 11 (Arlington, Virginia: Insurance Institute for Highway Safety, September 2010).

[78] A. McCartt and others, "Long-Term Effects of Handheld Cell Phone Laws on Driver Handheld Cell Phone Use," *Traffic Injury Prevention*, vol. 11, no. 2 (2010), pp. 133–141.

[79] See <http://www.iihs.org/research/topics/cell_phones.html>, accessed October 26, 2011.

[80] A. McCartt, L. Hellinga, and K. Bratiman, "Cell Phones and Driving: Review of Research," *Traffic Injury Prevention*, vol. 7, no. 2 (2006), pp. 89–106.

Past safety campaigns have shown that laws aimed at changing behavior are much more likely to experience long-term success when combined with highly visible enforcement and public information campaigns,[81,82] such as the "Click It Or Ticket" campaign for promoting seat belt use. A recent study analyzing the first 7 years of the campaign found that states that had enacted primary laws (where a motorist could be cited solely for being unbelted) had substantially higher seat belt use and higher levels of enforcement than states with only secondary enforcement (where a motorist could be cited for being unbelted only if stopped for a different violation).[83] The study found that seat belt use had increased in states that converted from secondary to primary laws and was higher among states with high visibility enforcement. Additionally, communication campaigns have been found to improve long-term shifts in attitudes and behavior, especially when implemented in conjunction with laws and high visibility enforcement.[84,85,86] The European Union recently completed a project to assist policymakers in implementing and evaluating road safety communication campaigns to inform motorists about new laws, educate them on the safety risks of unwanted behaviors, and ultimately decrease the frequency and severity of accidents.[87]

The DOT—along with the GHSA and other organizations—has long recognized the benefits of combining laws, high visibility enforcement, and communication campaigns. Examples of past campaigns in which the DOT has used this approach include the aforementioned "Click It or Ticket," as well as the "Over the Limit Under Arrest" campaign to reduce drinking and driving. The DOT driver distraction program calls for evaluating laws and high visibility enforcement, developing targeted media messages, drafting sample laws for states, publishing guidance on banning texting while driving for Federal workers, evaluating training programs, and developing resources through the World Health Organization.[88,89]

In 2010, the GHSA examined distracted driving as a state priority, data collection, outreach to novice drivers, education, public/private collaborations, state laws, and enforcement. Missouri has banned drivers under 21 years of age from texting and driving, implemented an enforcement campaign, made distracted driving a priority issue, developed traditional and

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[81] A. McCartt and others, 2010.

[82] See <http://www.ntsb.gov/doclib/recletters/1997/H97_1_6.pdf>, accessed October 26, 2011.

[83] J. Tison and A. Williams, *Analyzing the First Years of the "Click It or Ticket" Mobilizations*, Report No. DOT-HS-811-232 (Washington, DC: National Highway Traffic Safety Administration, 2010).

[84] M. Regan, K. Young, and J. Lee, "Driver Distraction Injury Countermeasures, Part 1: Data Collection, Legislation and Enforcement, Vehicle Fleet Management, and Driver Licensing," in M. Regan, J. Lee, and K. Young, eds., *Driver Distraction: Theory, Effects, and Mitigation* (Boca Raton, Florida: CRC Press, 2009).

[85] B. Elliot, *Road Safety Mass Media Campaigns: A Meta Analysis*, Federal Office of Road Safety, Report No. CR 118 (Canberra, Australia: Federal Office of Road Safety, 1993).

[86] P. Delhomme and others, *Evaluated Road Safety Media Campaigns: An Overview of 265 Evaluated Campaigns and Some Meta-Analysis on Accidents*, GADGET Project (Bron, France: National Institute for Transport and Safety Research, 2000).

[87] P. Delhomme and others, *Manual for Designing, Implementing, and Evaluating Road Safety Communication Campaigns* (Brussels, Belgium: Belgium Road Safety Institute, 2009).

[88] For additional information on DOT programs, see <www.distraction.gov>.

[89] Overview of the National Highway Traffic Administration's Driver Distraction Program, <http://www.distraction.gov/files/dot/6835_DriverDistractionPlan_4-14_v6_tag.pdf>, accessed October 26, 2011.

electronically based educational materials for young drivers and their parents,[90] and conducted public awareness campaigns. However, Missouri's enforcement campaign has been hindered by the difficulty law enforcement has had in identifying and stopping only drivers who are underage.[91] Recent efforts to change the law so that it applies to all drivers failed in the state legislature.

Although there is recognition that combining laws, enforcement, and communication campaigns is the most effective way to change driver behavior, not all states have fully adopted this multifaceted approach to mitigate the risks associated with portable electronic devices. In fact, many states are just beginning to address distracted driving. Several state efforts to curb distracted driving are limited to reaching out to novice drivers and driver education. Three states have not developed any programs; and six states have implemented only one of the three approaches. The NTSB concludes that a combination of enforceable state laws, high visibility enforcement, and supporting communication campaigns can reduce the number of accidents caused by drivers distracted by the use of portable electronic devices. Therefore, the NTSB recommends that the 50 states and the District of Columbia: (1) ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers; (2) use the NHTSA model of high visibility enforcement to support these bans; and (3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving.

Manufacturers of portable electronic devices also play a vital role in promoting the safe use of their products. Although a majority of people are aware of the risks associated with cell phones and driving, almost three-fourths of cell phone owners report using their phones while driving.[92] It is possible that this disconnect may be due to a common driver misperception: that you are a safer driver than others and better able to safely multitask. It is also possible that drivers gravitate to portable electronic devices in times of low driving workload—a temptation that could quickly increase the risk of experiencing a critical event. Some cellular providers have begun offering mobile phone applications that disable texting and block nonemergency calls when a vehicle is in motion;[93] and third-party devices are currently available that allow motorists to voluntarily disable nonemergency calls on their cell phones while driving.[94]

The NTSB maintains that for those devices designed for use while driving or that are frequently used while driving—such as cell phones and computer tablets—manufacturers and providers of these devices should be sensitive to the distractions that they can cause and disable

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[90] Governors Highway Safety Association, 2011.

[91] (a) See <http://www.mshp.dps.missouri.gov/MSHPWeb/Root/DistractedDrivingFeaturedStatute.html>, accessed January 20, 2011. (b) See <http://www.mshp.dps.missouri.gov/MSHPWeb/Root/Anti-textingstickrelease.html>, accessed January 20, 2011.

[92] "Large Majority of Drivers Who Own Cell Phones Use Them While Driving Even Though They Know This Is Dangerous," *The Harris Poll #58* (New York, New York: Harris Interactive, June 8, 2009).

[93] T-Mobile offers "DriveSmart Plus" for a monthly fee of $4.99, and Sprint offers "Sprint Drive First" for a monthly fee of $2.00.

[94] N. Lerner and others, *An Exploration of Vehicle-Based Monitoring of Novice Teen Drivers: Final Report*, Report No. DOT-HS-811-333 (Washington, DC: National Highway Traffic Safety Administration, 2010).

features that do not provide an emergency or driving-related benefit when the vehicle is in motion. The NTSB concludes that manufacturers and providers of portable electronic devices known to be frequently used while driving should reduce the potential of these devices to distract drivers by developing features that discourage their use or that limit their nondriving- or nonemergency-related functionality while a vehicle is in operation. The NTSB recommends that CTIA–The Wireless Association and the Consumer Electronics Association encourage the development of technology features that disable the functions of portable electronic devices within reach of the driver when a vehicle is in motion; these technology features should include the ability to permit emergency use of the device while the vehicle is in motion and have the capability of identifying occupant seating position so as not to interfere with use of the device by passengers.

2.4.2 Lead School Bus Driver

Like the GMC pickup driver, the driver of the lead school bus did not attempt to brake or avoid the stopped vehicles ahead. According to the motorcoach driver who had been traveling behind the GMC pickup, he saw the initial collision occur 600 feet ahead of him and stopped his vehicle on the shoulder about 180 feet from the accident site. When interviewed by the MSHP, the motorcoach driver stated that, after pulling over, he exited his bus to attempt to warn other drivers to slow down.

The lead school bus driver stated that when she saw the motorcoach on the side of the road, and a man walking around in front of it, she became concerned about clearance between her vehicle and the motorcoach, so she steered a little to the left. She went on to say that she continued to watch the motorcoach from her side mirror; and, when she felt that her bus had cleared the motorcoach, she moved back to the right and almost immediately struck the GMC pickup. The driver's statements suggest that her actions were the result of driving-related safety concerns, not nondriving-related distractions. However, the length of time the bus driver spent selectively attending to the motorcoach—instead of monitoring the traffic ahead—was excessive and directly resulted in her involvement in the accident. The NTSB concludes that the collision between the lead school bus and the GMC pickup was the result of the bus driver's attention being drawn away from the forward roadway by the motorcoach parked on the shoulder.

Apart from the motorcoach, it appears that no other vehicle occupied the right lane between the lead school bus and the initial collision ahead; once the motorcoach had moved to the shoulder, the bus driver's forward view was unobstructed. Had the bus driver been attentive to the forward roadway, she would have had ample time and sight distance to perceive and possibly avoid the initial collision. According to the SDM data recovered from the GMC pickup, 6 seconds passed between the first collision involving the pickup and the second collision involving the lead bus. Depending on when the motorcoach moved to the shoulder, the lead bus driver might have had as much as 6 seconds to notice and react to the initial accident ahead. The Missouri *Commercial Driver License Manual* warns drivers of several situations that could present a hazard, among which are parked buses along the roadway from which passengers could emerge.[95] However, the manual also states that drivers should look 12–15 seconds ahead of them (in the context of stopping and lane-changing maneuvers). Further, the manual states: "When you use your mirrors while driving on the road, check quickly. Look back and forth between the mirrors and the road ahead. Don't focus on the mirrors for too long. Otherwise, you will travel quite a distance without knowing what's happening ahead."[96]

The sequence of events leading to the involvement of the lead school bus in the accident is consistent with the literature on external distractions. Research has found that a significant number of distractions originate from objects external to the vehicle. External distractions may include vehicles on the shoulder of the road, billboards, and animals. The 100-car naturalistic[97] study conducted by VTTI found that attending to external objects away from the forward roadway for more than 2 seconds increased the risk of accidents threefold.[98] The AAA Foundation for Traffic Safety examined NHTSA's National Automotive Sampling System/Crashworthiness Data System and found that 29 percent of distraction-related crashes were due to distractions outside of the vehicle.[99] A NHTSA-funded study on driver distraction in commercial vehicle operations, based on naturalistic data, found that—though glances outside the vehicle had an overall protective effect—long glances away from the forward roadway when an external distraction was present increased the risk of a safety-critical event. Overall, the study found that glances away from the forward roadway for any reason for more than 1.5 seconds significantly increased the risk of a safety-critical event.[100]

These findings highlight the importance of proper glance behavior in promoting safety and avoiding accidents. Scanning the external environment is an essential part of the driving task. However, the risk of safety-critical events and accidents increases when drivers fixate on objects that are not in the forward view.

The state of Missouri requires school bus drivers to take 8 hours of school-bus related training annually but does not stipulate the specific content. The errors made by the school bus drivers in this accident suggest that periodic defensive driver training on such topics as driver inattention, proper scanning behavior, and safe following distance could help drivers avoid rear-end accidents when approaching traffic queues. Therefore, the NTSB recommends that the Missouri Department of Elementary and Secondary Education incorporate into school bus driver

[95] *Commercial Driver License Manual: New Test Standards Effective October 1, 2008* (Jefferson City, Missouri: Missouri Department of Revenue/American Association of Motor Vehicle Administrators, August 2009), p. 2-19.

[96] *Commercial Driver License Manual*, p. 2-11.

[97] Naturalistic studies attempt to observe the behavior or phenomenon of interest in its natural setting with a minimum amount of interference.

[98] S. Klauer and others, 2006.

[99] The AAA Foundation for Traffic Safety defines distraction as, "when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task." See J. Stutts and others, *The Role of Driver Distraction in Traffic Crashes* (Washington, DC: AAA Foundation for Traffic Safety, 2001).

[100] For glances between 1.5–2 seconds, overall risk equals 1.29. For glances greater than 2 seconds, overall risk equals 2.93. See R. Olson and others, *Driver Distraction in Commercial Vehicle Operations*, 2009.

training the risk of driver inattention, the need for proper scanning behavior, and the necessity of keeping a safe following distance.

2.4.3 Following School Bus Driver

There is no evidence that the following school bus driver was distracted from monitoring the forward view prior to the accident. The surveillance video showed that—just prior to the collision—a chaperone walked up the aisle to speak to the driver; however, the chaperone ended the conversation and returned to his seat 8 seconds before the driver began her evasive maneuver. The bus driver stated that she was not using her cell phone, CB radio, or AM/FM radio immediately prior to the accident. Records from the cellular provider confirm that she was not engaged in a conversation during this time. She also stated that she was not eating or drinking. There are no witnesss statements indicating that the driver was engaged in any activity other than driving at the time of the accident. She stated that she did not recall her bus passing the motorcoach on the side of the road, suggesting that the motorcoach did not pose a distraction to her. All factors indicate that the driver of the following bus was not distracted just prior to hitting the lead school bus.

NTSB investigators attempted to determine what factors led to the involvement of the following school bus in the accident. According to the bus driver, the first indication that anything was wrong was when she saw the lead school bus go up in the air. She said that she applied her brakes and steered to the right in an attempt to avoid a collision, a statement that is consistent with physical evidence from the accident scene.

An analysis of the physical evidence and video footage from the interior-mounted camera on the following school bus provided information on the speed of the bus as it approached the accident location. Because this dynamic situation involved the movement of vehicles throughout the impact sequences, it was necessary to conduct a time–position analysis to determine the following distance of the bus in the moments leading up to the accident. From the video footage, it was determined that the bus was traveling approximately 52 mph, and the evasive steering and braking maneuver occurred about 1.9 seconds prior to impact with the lead school bus. The video footage provided detailed positional information on where this evasive steering maneuver was initiated. From this location, it was necessary to assume a reasonable perception–reaction time (PRT) range to determine at what point the following bus driver would have perceived the accident ahead.

In approximating a reasonable PRT range for the following school bus driver, it was necessary to examine the human performance characteristics of the driver and visual cues that were available to her. The 38-year-old bus driver was most likely adequately rested and alert on the day of the accident. When asked about her sleeping habits, she stated that she normally sleeps "like a rock" and denied any history of sleeping disorders or snoring. In the 72 hours preceding the accident, she reserved 8–9 hours each night for sleep. On the night before the accident, she stated that she went to bed at 10:30 p.m. and awoke about 7:00 a.m., allowing as much as 8.5 hours for rest. The driver took a prescription medication daily; however, that particular medication is not detrimental to driver performance.

Establishing the PRT for a specific individual in a particular situation is very challenging. A driver's PRT can vary widely, depending on such factors as the intensity of the stimulus, amount of information to be processed, and complexity of required decision-making. Age, medical conditions, distractions, fatigue, visual contrast, and medications, among other factors, have been found to adversely affect PRT. The driver of the following school bus was apparently alert and not distracted prior to the accident; however, the amount of time she needed to perceive and react to the developing situation ahead was probably no less than 1.5 seconds because the brake lights on the lead school bus did not illuminate prior to its collision with the GMC pickup. These circumstances probably lengthened the following bus driver's time to perceive and react because she had to interpret and formulate a response to the unfamiliar and complex scene of the lead bus suddenly assuming a vertical posture. Therefore, investigators examined a range of possible PRTs from 1.5–2.5 seconds.

Accordingly, it was determined that the following school bus was 188–262 feet behind the lead school bus when it collided with the GMC pickup. At an approximate speed of 52 mph, the following time ranged from 2.5–3.5 seconds. According to the Missouri *Commercial Driver License Manual*, the bus driver should have maintained a following time of 4.5 seconds or greater between her vehicle and the lead bus.[101] With the additional 1–2 seconds of following time, the driver would have had an additional 76–151 feet of distance to take evasive action to avoid hitting the lead bus. Because the following bus driver braked and steered to the right approximately 124 feet prior to colliding with the lead bus, the additional following distance would have allowed a total of 200–275 feet available to avoid a collision. As stated in the factual discussion, the following bus was capable of stopping in 130 feet. Therefore, the NTSB concludes that had the driver of the following school bus maintained the recommended minimum distance from the lead school bus, she would have been able to avoid the accident.

2.4.4 Driver Fatigue

The NTSB examined whether fatigue might have played a role in the failure of the GMC pickup driver to notice and react to the slowed traffic ahead. To make this determination, the NTSB first examined whether the pickup driver might have been suffering from the effects of fatigue at the time of the accident. The NTSB examined four factors that contribute to fatigue: quantity of sleep, sleep disorders, time of day, and time awake. A reconstruction of this driver's 72-hour history indicated that he slept an average of 5.5 hours during the three nights prior to the accident and less than 5 hours on the night of August 4, immediately preceding the accident the following morning (table 14). The amount of nightly sleep needed is influenced by genetics, circadian timing, and sleep debt, among other factors;[102] however, the National Sleep Foundation states that adults (over age 17) typically need 7–9 hours of sleep a night.[103]

[101] *Commercial Driver License Manual*, p. 2-16.

[102] M. Carskadon and W. Dement, "Normal Human Sleep: An Overview," in M. Kryger, T. Roth, and W. Dement, eds., *Principles and Practice of Sleep Medicine* (Philadelphia, Pennsylvania: Elsevier-Sanders, 2005).

[103] "How Much Sleep Do We Really Need?" <http://www.sleepfoundation.org/article/how-sleep-works/how-much-sleep-do-we-really-need>, accessed November 23, 2010.

Table 14. Summary of available sleep opportunity for GMC pickup driver, August 3–5, 2010.

Last Activity of Record	First Morning Activity	Total Time Available for Sleep
Aug 3, 12:00 a.m.	Aug 3, 5:00 a.m.	5 hr 00 min
Aug 3, 11:18 p.m.	Aug 4, 6:00 a.m.	6 hr 42 min
Aug 5, 1:00 a.m.	Aug 5, 5:52 a.m.	4 hr 52 min
		Average: 5 hr 31 min

Research has shown that sleep loss results in deficits in a number of driving-related performance measures, including slowed reaction time,[104] reduced vigilance and attention,[105] and impaired cognitive processing.[106] The odds of being in a crash are 12 times higher for a driver who had only 4–4.9 hours of sleep the night before.[107] It is possible that the decision of the GMC pickup driver to continue a text messaging conversation as he approached a work zone was influenced by fatigue due to chronic and acute sleep loss—which may also have affected his reaction time to the slowing traffic ahead. The NTSB concludes that the GMC pickup driver was fatigued at the time of the accident due to cumulative sleep debt and acute sleep loss, which could have resulted in impaired cognitive processing or other performance decrements.

Aside from insufficient sleep, no other factors appear to contribute to fatigue for the GMC pickup driver. According to the family of the driver, he did not have problems sleeping, a history of snoring, or any diagnosed sleep disorders. Family members described the driver as a morning person who typically arose at 6:00 a.m. to begin his workday at 7:00 a.m. On the day of the accident, the driver awoke at 5:52 a.m., in line with his typical circadian pattern. The accident occurred at 10:11 a.m., which is generally a time of high alertness. The driver had been awake for only 4.5 hours, which makes it less likely that he was worn down by the day's activities.

The NTSB also attempted to examine whether fatigue might have caused the lead school bus driver to fixate on the motorcoach parked on the shoulder of the roadway, because fatigue

[104] (a) T. Roehrs and others, "Ethanol and Sleep Loss: A 'Dose' Comparison of Impairing Effects," *Sleep*, vol. 26, no. 8 (2003), pp. 981–985. (b) N. Kleitman, ed., "Deprivation of Sleep," *Sleep and Wakefulness* (Chicago, Illinois: University of Chicago Press, 1963), pp. 215–229. (c) H. Babkoff, T. Caspy, and M. Mikulincer, "Subjective Sleepiness Ratings: The Effects of Sleep Deprivation, Circadian Rhythmicity and Cognitive Performance," *Sleep*, vol. 14, no. 6 (1991), pp. 534–539.

[105] (a) M. Glenville and others, "Effects of Sleep Deprivation on Short Duration Performance Measures Compared to the Wilkinson Auditory Vigilance Task," *Sleep*, vol. 1, no. 2 (1978), pp. 169–176. (b) D. Dinges, "Performance Effects of Fatigue," *Fatigue Symposium Proceedings, November 1–2, 1995* (Washington, DC: National Transportation Safety Board and NASA Ames Research Center, 1996), pp. 41–46.

[106] (a) D. Dinges and N. Kribbs, "Performing While Sleepy: Effects of Experimentally Induced Sleepiness," in T. Monk, ed., *Sleep, Sleepiness, and Performance* (Chichester, UK: John Wiley & Sons, 1991), pp. 98–128. (b) N. Lamond and D. Dawson, "Quantifying the Performance Impairment Associated With Fatigue," *Journal of Sleep Research*, vol. 8, no. 4 (1999), pp. 255–262.

[107] J. Stutts and others, "Driver Risk Factors for Sleep-Related Crashes," *Accident Analysis & Prevention*, vol. 35, no. 3 (2003), pp. 321–331.

has been found to result in longer glance times and perceptual narrowing.[108] However, the lead driver was unable to provide NTSB investigators with sufficient detail about her sleep/wake times for the day prior to the accident to determine whether fatigue was an issue. She stated that she did not have a history of sleep disorders, slept 7.5–8 hours each night, and occasionally napped during the day.

2.4.5 Medical Oversight

During the course of its investigation, the NTSB found that the driver of the Volvo tractor had a medical condition that should have precluded licensure. However, witnesses confirmed that the driver had slowed his vehicle due to the traffic congestion ahead—and there were no reports indicating that he had been driving erratically prior to the accident—which strongly suggest that he was not medically incapacitated at the time. The NTSB concludes that the medical condition of the Volvo tractor driver did not cause or contribute to the accident.

However, the NTSB is concerned that in the 10 years since its report on the 1999 New Orleans motorcoach accident,[109] commercial drivers with disqualifying medical conditions are still able to obtain current medical certificates and CDLs. Medical records indicate that in 2003, before the driver of the Volvo tractor obtained a CDL, he was warned by his primary care physician not to drive or operate machinery. By not divulging his medical history to a commercial driver fitness examiner, he subsequently obtained a CDL and current medical certificate.[110] The driver was licensed in West Virginia, which does not provide anonymity or legal protection to health care providers or anyone else who reports an individual as unfit to operate a vehicle. This circumstance makes it unlikely that a physician, employer, or concerned citizen with knowledge of a driver's illness would come forward to report an unfit driver to licensing authorities.

As a result of its investigation into the New Orleans accident and testimony gathered at the subsequent hearing on CDL and driver medical oversight, the NTSB recommended in 2001 that the FMCSA develop a comprehensive medical oversight program for interstate commercial drivers. Two of the eight program elements recommended were covered by the following safety recommendations:

> Develop a comprehensive medical oversight program for interstate commercial drivers that contains the following program elements: the review process

[108] (a) P. Green, "Where Do Drivers Look While Driving (and for How Long)?" in R. Dewar and P. Olson, eds., *Human Factors in Traffic Safety* (Tucson, Arizona: Lawyers and Judges Publishing, 2002), p. 97. (b) N. Kaluger and G. Smith, "Driver Eye-Movement Patterns Under Conditions of Prolonged Driving and Sleep Deprivation," *Highway Research Record* (Washington, DC: Transportation Research Board, 1970), pp. 92–106.

[109] *Motorcoach Run-Off-the-Road Accident, New Orleans, Louisiana, May 9, 1999*, NTSB/HAR-01/01 (Washington, DC: National Transportation Safety Board, 2001).

[110] Under 49 CFR 383.73(g), Penalties for False Information, if a driver supplies false information on any part of the CDL application process, either at the time of application or discovered after issuance of the CDL, the issuing state must (at a minimum) suspend that license for 6 months, pending a review. A final determination of CDL status would depend on evaluation of the correct information and whether the applicant then qualifies for retention of the CDL.

> prevents, or identifies and corrects, the inappropriate issuance of medical certification. (H-01-21)
>
> Develop a comprehensive medical oversight program for interstate commercial drivers that contains the following program elements: mechanisms for reporting medical conditions to the medical certification and reviewing authority and for evaluating these conditions between medical certification exams are in place; individuals, health care providers, and employers are aware of these mechanisms. (H-01-24)

Safety Recommendations H-01-21 and -24 are each classified "Open—Unacceptable Response." The NTSB also issued a companion recommendation to the American Association of Motor Vehicle Administrators (AAMVA) to develop a comprehensive medical oversight program for intrastate commercial drivers (Safety Recommendation H-01-26). It contained all the program elements specified in the FMCSA recommendations. Safety Recommendation H-01-26 is classified "Open—Acceptable Response," because AAMVA continues to work with the FMCSA in developing the Federal medical oversight program, and upon implementation of this program, to encourage its members to adopt it. The NTSB also issued the following recommendation to the National Conference of State Legislatures:

> Inform State legislatures about this accident and make them aware of the importance of establishing immunity laws for the good-faith reporting of potentially impaired commercial drivers by all individuals and of ensuring that the medical community and the commercial transportation industry are familiar with these laws. (H-01-27)

Safety Recommendation H-01-27 was classified "Closed—Acceptable Action" in 2001 after the conference published an article highlighting the Board's recommendations.

The FMCSA has made progress on most of the eight program elements; for example, the agency published a Notice of Proposed Rulemaking in December 2008 to create a national registry of certified medical examiners, an initiative that could significantly reduce doctor shopping if a final rule is implemented.[111] Yet, it is still possible for a driver to withhold information about a disqualifying condition from a fitness examiner and secure a valid medical certificate. To rectify this situation, all health care providers need to be made aware that the motoring public is at risk if a commercial driver is allowed to operate with a disqualifying condition. Mechanisms are also needed to encourage the reporting of medical conditions to the medical certification and reviewing authority and to evaluate these conditions between medical certification exams.

The NTSB continues to be concerned that 41 states still do not require unfit drivers to be reported in good faith to a regulatory authority. Additionally, 19 states do not offer immunity to health care providers who, in good faith, report an unfit driver.[112] For these reasons, the NTSB

[111] *Federal Register*, vol. 73, no. 231 (December 1, 2008), p. 73129.

[112] *Physician's Guide to Assessing and Counseling Older Drivers* (Chicago, Illinois: American Medical Association, 2010).

reiterates Safety Recommendations H-01-21 and -24 to the FMCSA and Safety Recommendation H-01-26 to AAMVA.

2.5 Motor Carrier

This section discusses state oversight of the operations of Copeland Bus Services. The Missouri Department of Motor Vehicle Inspections regulates school bus inspections, and each school bus is subject to an inspection twice a year. Per 5 CSR 30-261, the Missouri Department of Elementary and Secondary Education has authority to adopt and enforce regulations for the operation of all school buses used for transporting school children. This authority includes reviewing school bus driver qualifications, insurance, operation of school buses, school bus routing, and school bus design.

A comprehensive carrier oversight program includes not only evaluation of a carrier's drivers and vehicles, but also inspection of its operation, administration, and policies. Copeland did not have an accident history that would signal to authorities that its operation was deficient. However, the NTSB documented numerous examples of bad record-keeping, neglected maintenance, and poorly performed maintenance.

Copeland did not have a written vehicle maintenance plan or an organized method of retaining maintenance records. The entire set of maintenance records for the fleet of 23 school buses—the sole transportation source for the St. James School District—was contained in a small spiral-bound notebook. Some repairs or service checks, such as topping off fluid and checking tire pressure, were not written in the notebook. The company was also unable to produce inspection reports for a number of buses. Because of the lack of comprehensive maintenance records, it was difficult for NTSB investigators to determine the maintenance history of the two accident school buses, including which components had been repaired, when they were repaired, and what items were scheduled for maintenance. The condition of the brakes on the accident vehicles was a consequence of the lack of scheduled maintenance; so, too, were the neglected fire extinguishers in the buses, one of which bore an inspection sticker that had been expired for more than 1.5 years.

Combining a carrier oversight program with effective oversight of drivers and vehicles would help ensure that all pupil transportation carriers operate safely. The lack of oversight in driver, vehicle, and carrier operations could lead to mismanagement, poor maintenance practices, and other errors that could endanger pupil safety. The NTSB concludes that the state of Missouri had no effective oversight of the operations of Copeland Bus Services. Therefore, the NTSB recommends that Missouri revise state regulations to require a periodic safety review of motor carrier operations for those carriers involved in pupil transportation.

2.6 Vehicles

2.6.1 School Bus Inspections

Missouri requires all school buses used in public school transport to be inspected twice a year; yet, the NTSB found several serious problems during postaccident inspection of the lead school bus, as noted below:

- The master cylinder was wet in appearance, showing hydraulic fluid seepage over the body of the unit.
- A hydraulic fluid leak in the area of the brake lines ran from the master cylinder back to the hydraulic ABS unit.
- When the brake pedal was depressed, the movement of the pedal was soft and spongy, and fluid squirted out of the brake lines behind the left side of the front axle.
- The leaking hydraulic fluid had caused paint on the adjacent frame rail to blister and disbond from the metal.

The level of corrosion, the size of the hole in the brake line, and the degradation of frame rail paint in the area of the brake line strongly suggested that the lines might have been leaking for months prior to the accident.[113]

According to the MMVIRs, a leak in a hydraulic brake line would cause a bus to fail inspection. Yet, the hydraulic fluid leak was not discovered when the MSHP inspected the 23 buses from Copeland Bus Services in March 2010, nor when a private state inspection station inspected the same buses 10 days before the accident. A properly conducted inspection should have identified this leak.

Although the MMVIRs—under “Passenger Car and Truck Inspection”—contain sections on “Brake Performance,” “Brake Components,” and “Air and Vacuum Brake Systems,” there is no such discussion of brakes under “School Bus Inspection” other than a single line of text, at 11 CSR 50-2.320(1), that states: “In addition, the items listed in this rule will be inspected on all school buses.” According to the MSHP, this statement means that school buses are then also subject to all of the inspection criteria under “Passenger Car and Truck Inspection,” including the sections pertaining to brakes. However, because the MMVIRs do not explicitly describe all items that should be inspected on a school bus and the corresponding inspection procedures, inspectors might have overlooked, misinterpreted, or ignored that single line of text.

Unless the MMVIRs more clearly specify all inspection areas and procedures applicable to school buses, school bus inspectors working for the MSHP and the state-certified inspection stations may fail to identify defects in critical systems, such as brakes. Therefore, the NTSB

[113] Although the brake reservoir was found to be full after the accident, investigators were unable to determine when brake fluid had last been added to the vehicle due to Copeland’s inadequate maintenance records.

concludes that the MMVIR "School Bus Inspection" section does not adequately delineate the bus systems to be included in an inspection.

According to the hydraulic brake system discussion in the MMVIRs, at 11 CSR 50-2.160, a vehicle fails inspection if any brake system defects are found, including leaking or cracked tubing, and worn, broken, or loose brake components. This section further states that, in the absence of brake performance testing, one front or one rear wheel must be removed to inspect brake components on passenger vehicles and pickups or similar vehicles "not equipped with dual rear wheels." As with many school buses, the accident buses were equipped with dual rear wheels, and many of the brake defects listed in the MMVIRs would not have been visible without removal of the wheels. The NTSB concludes that the state's current inspection procedures do not allow for the identification of all school bus brake defects included in the MMVIRs. Therefore, the NTSB recommends that the state modify the MMVIRs so that all inspection areas and procedures that apply to school buses are contained within the "School Bus Inspection" section. Further, the NTSB recommends that the state modify its school bus inspection procedures so that all brake defects specified in the MMVIRs can be identified during biannual inspections.

The MVI–2 form used in Missouri to document inspections is contained on a single page that requires inspectors to describe the defects found on a vehicle. Unlike most of the school bus inspection forms gathered by the NTSB, the MVI–2 does not list the school bus components to be inspected, nor does it include checkboxes for inspectors to easily indicate vehicle defects. A review of inspection forms developed by other states revealed that most contain a detailed checklist of vehicle components to be inspected, primarily based on interstate inspection requirements in the FMCSRs. Inspectors and mechanics in Missouri would benefit from a form that contains all of the vehicle components marked for inspection in the MMVIRs and thereby prompts them to assess the condition of all critical items. For example, had the MVI–2 form included checkboxes prompting inspectors to check the condition of the brake lines for the presence of air and fluid leaks, the brake defects found on the lead school bus might have been detected months before the accident. The NTSB concludes that the MVI–2 vehicle inspection form is insufficient because it does not effectively prompt state inspectors to evaluate all of the safety-critical items listed in the MMVIRs. The NTSB, therefore, recommends that Missouri revise its MVI–2 vehicle inspection form so that it lists all items to be inspected, as required by the MMVIRs; and include on the form a means of succinctly describing whether each of those items passes inspection.

Vehicle inspection problems were not restricted to the two accident buses. In March 2010, when the MSHP inspected all 23 Copeland buses, each bus passed inspection. After the NTSB's postaccident inspection uncovered numerous issues with the brake pads and brake lines on the lead school bus—as well as the out-of-place ABS sensor on the following school bus—the MSHP conducted an unannounced vehicle inspection of Copeland's fleet and rejected 8 of the 20 buses present due to defects. Among the problems identified were inoperable warning lights, tire defects and low tread depths, and defective and inoperable brakes. Ray's Tire had also inspected the eight rejected buses in July 2010, yet records showed that no defects were found and none of the brake inspection boxes were checked. Following the postaccident inspection, the MSHP revoked the inspection station certification for Ray's Tire and the inspector permit for the lead mechanic for the maximum term of 1 year.

In summary, the NTSB accident investigation uncovered what appears to be lax vehicle inspections by both the MSHP and Ray's Tire. The problems identified during the postaccident inspection were not limited to brake systems, making it unlikely that these oversight deficiencies were solely due to the lack of clarity in the MMVIRs regarding brake system inspections for school buses. Therefore, the NTSB concludes that both the MSHP and a state inspection facility conducted inadequate vehicle inspections of buses operated by Copeland Bus Services. Improvements in the thoroughness and quality of vehicle oversight are needed to ensure that both the state and state-certified inspection facilities conduct adequate vehicle inspections according to the MMVIRs. Accordingly, the NTSB recommends that the state of Missouri audit its vehicle inspection program to ensure that inspections conform to requirements of the MMVIRs.

2.6.2 Forward Collision Avoidance Systems

The Gray Summit accident consisted of three rear-end collisions involving a passenger vehicle and two large buses. Forward collision warning (FCW) systems are currently available as options from nearly all major manufacturers of passenger vehicles as well as heavy commercial motor vehicles. Collision warning systems are vehicle-based systems that monitor the roadway in front of the host vehicle, and in some applications to the side, and warn the driver of potential collision risks. These systems use radar technology, camera technology, or both, typically mounted within the front bumper assembly. Additionally, NHTSA is evaluating FCW systems based on radio communications between vehicles (vehicle-to-vehicle) equipped with GPS. When other vehicles or stationary objects are within predefined distances or closing speeds in the forward path of the host vehicle, an in-cab display unit provides audible and visual alerts to the driver. An add-on to this system is adaptive cruise control (ACC), which uses the same technology to adjust or disengage conventional cruise control when a collision risk is detected. Collision warning systems can also be designed to engage the foundation and engine brakes of the vehicle when an imminent hazard is detected, which is referred to as active braking;[114] this technology combined with FCW is another collision mitigation option.

When a heavy vehicle equipped with an FCW system approaches a slower moving vehicle or stationary object, the system issues progressively more urgent warnings according to preset thresholds.[115] Some currently available systems can detect and display warnings at a distance of 350 feet or a following distance period of up to 3 seconds. If the following distance closes to less than 0.5 second or if the radar detects slow-moving or stopped traffic within 350 feet of the vehicle, the system alerts the driver with visual indicators and an audible tone. FCW systems significantly reduce the risk of rear-end collisions by allowing more time for the driver to react to fast-closing situations. Commercial vehicles equipped with FCW generally begin braking earlier, thereby reducing the risk of accidents. Additionally, when using FCW systems, drivers usually adopt longer following-distance driving behaviors.

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[114] Some active braking systems on the market claim to generate decelerations of up to 0.35 g in commercial vehicles.

[115] *Analysis of Benefits and Costs of Forward Collision Warning Systems for the Trucking Industry*, FMCSA-RRT-09-021 (Washington, DC: Federal Motor Carrier Safety Administration, 2009), p. v.

For over a decade, the NTSB has advocated technological solutions to reduce the occurrence of rear-end collisions for both passenger and commercial vehicles. In 2001, the NTSB made the following recommendations to the DOT:[116]

> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new commercial vehicles. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-6)
>
> After promulgating performance standards for collision warning systems for commercial vehicles, require that all new commercial vehicles be equipped with a collision warning system. (H-01-7)
>
> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new passenger cars. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-8)

Following its investigation of a 2005 multifatality accident involving a motorcoach and an overturned truck-tractor semitrailer combination unit on Interstate 94 near Osseo, Wisconsin, the NTSB issued a recommendation to NHTSA requiring FCW systems on commercial vehicles:[117]

> Determine whether equipping commercial vehicles with collision warning systems with active braking and electronic stability control systems will reduce commercial vehicle accidents. If these technologies are determined to be effective in reducing accidents, require their use on commercial vehicles. (H-08-15)

Following the investigation of a 10-fatality accident, when a truck-tractor semitrailer combination unit rear-ended and overrode several passenger vehicles on I-44 near Miami, Oklahoma, the NTSB reiterated Safety Recommendations H-01-6 and -7 to NHTSA[118] and reclassified their status to “Open—Unacceptable Response.”[119] The Miami report also reiterated Safety Recommendation H-08-15 to NHTSA, and its status is “Open—Acceptable Response.” Safety Recommendation H-01-8 is currently classified “Open—Acceptable Response.”

[116] NTSB/SIR-01/01.

[117] *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, DC: National Transportation Safety Board, 2008).

[118] Safety Recommendations H-01-6, -7, and -8 were originally assigned to the FMCSA, in 2001; the DOT subsequently transferred them to NHTSA.

[119] NTSB/HAR-10/02.

The DOT has sponsored a variety of research into collision avoidance systems. Much of the passenger vehicle research has been conducted as part of the NHTSA crash avoidance research program in the area of integrated vehicle-based safety systems. Commercial vehicle research has found that 21 percent of rear-end crashes could be prevented with FCW systems alone, and 28 percent of rear-end crashes could be prevented with a combination of FCW and ACC. If all 1.8 million commercial trucks in the United States were equipped with FCW systems, the DOT estimates that 4,700 rear-end crashes, 2,500 injuries, and 96 fatalities could be prevented each year.[120]

NTSB investigators were unable to determine whether FCW and ACC could have prevented or mitigated the initial Gray Summit collision because of insufficient information about the actions of the GMC pickup driver. Had the pickup entered the right lane several hundred feet behind the Volvo tractor, an FCW system might have warned the driver in time for him to take evasive action and avoid the collision. Unfortunately, it is not possible to determine from the available evidence when the pickup entered the right lane and how soon after that the initial collision occurred.

Had the lead school bus been equipped with an FCW system, it is possible that the driver would have been alerted far enough in advance to take action to avoid the GMC pickup–Volvo tractor collision. An FCW system would have alerted the bus driver to the accident 350 feet ahead. Although the ruptured brake line of the lead bus would not have allowed the driver to stop her vehicle in time, the FCW alert might have given her enough time to swerve to avoid a frontal collision, or at least to mitigate the severity of the impact. Moreover, the activation of brake lights on the rear of the lead bus would have given the driver of the following school bus a readily recognizable cue to initiate braking, and more time and distance to decelerate her vehicle. Had the following bus also been equipped with an FCW system, the bus driver would have been alerted to the slowing or stopped vehicles ahead. The braking cues of the lead bus and the FCW alerts might have allowed her to avoid the collisions ahead, regardless of the involvement of the lead bus.

The NTSB concludes that FCW systems on the two accident buses—and possibly on the GMC pickup—could have prevented the accident or at least mitigated its severity. Because NHTSA has not yet completed rulemaking requiring FCW systems on private and commercial vehicles, and because the NTSB continues to investigate serious accidents that could have been prevented or mitigated with FCW systems, the NTSB reiterates Safety Recommendations H-01-8 and H-08-15 to NHTSA and reclassifies each recommendation "Open—Unacceptable Response." The NTSB also reiterates Safety Recommendations H-01-6 and -7 to NHTSA.

[120] *Volvo Trucks Field Operational Tests: Evaluation of Advanced Safety Systems for Heavy Truck Tractors* (Washington, DC: U.S. Department of Transportation, February 2005).

2.7 School Bus Evacuation

2.7.1 Emergency Exit Windows

All but one occupant of the lead school bus evacuated through the left rear emergency exit window. One injured passenger who had been entrapped between seats was extricated and removed by emergency responders through the right rear emergency exit window. According to the incident commander, all occupants, except for the one fatality, were removed from the bus by 10:37 a.m., 24 minutes after the first call to 911. Several passengers, and a witness who assisted in the evacuation, stated in postaccident interviews that egress was hindered due to (1) a raised emergency release latch plate at the bottom of the emergency exit window, which snagged clothing; and (2) the failure of the emergency window to independently remain in the open position as occupants climbed out.

According to the School Bus Manufacturers Technical Committee (SBMTC),[121] it has never received negative feedback from end users (buyers) regarding evacuation through emergency exit windows. An SBMTC representative stated that when a school bus is involved in an accident and does not roll over, the front, rear, and side doors are the primary points of egress; when a bus rolls on its side, evacuation occurs primarily through the emergency exit windows or roof hatches. In this accident, the 71-passenger lead school bus remained upright, but the rear-end collision blocked the rear emergency exit door, and the elevated resting position of the bus prevented egress through the loading door and roof hatches. Because the accident bus was not equipped with side emergency exit doors, the emergency exit windows were the only egress option.

The Federal standard for bus emergency exits and window retention and release, FMVSS 217 (at 49 CFR 571.217), was established to minimize the likelihood of occupants being thrown from a bus and to provide a means of readily accessible emergency egress. FMVSS 217 specifies the minimum number of emergency exit windows, minimum window size, designation as emergency exit windows, and maximum force allowed to push the window out, among other characteristics. To assist manufacturers in meeting the requirements, NHTSA published laboratory test procedures for school bus emergency exits and window retention and release.[122]

The NTSB reviewed the test procedures for side emergency exit windows and found separate procedures for determining the maximum force requirements to push the window out and the minimum size requirements for egress. However, the procedures do not address scenarios in which an occupant would need to push the window out and maintain it in the open position while attempting egress. On the lead school bus, one person was needed to hold the emergency window open while another attempted egress. Although the opening size of the emergency exit window met Federal standards, this opening could not be maintained by a single occupant while simultaneously exiting from the window. Both FMVSS 217 and the associated

[121] The SBMTC—a committee within the National Association of State Directors of Pupil Transportation Services (NASDPTS)—comprises school bus and chassis manufacturers, such as Freightliner, Blue Bird, Ford Motor Company, and Thomas Built Buses.

[122] *Laboratory Test Procedures for FMVSS 217: School Bus Emergency Exits and Window Retention and Release*, TP-217-06 (Washington, DC: National Highway Traffic Safety Administration, December 1996).

NHTSA laboratory test procedures require that each emergency exit be manually extendable by a single occupant to admit unobstructed passage, but neither directive then specifies that the same occupant be able to egress while manually extending the window.

The National Congress on School Transportation (NCST) publishes specifications and procedures to supplement FMVSS 217.[123] For rear emergency exit on school buses with a rear engine, large windows are used in lieu of emergency exit doors, and the NCST specifies that a lifting assistance device be in place to aid in lifting and holding the window open. However, no such specification is provided for side emergency exit windows during evacuation.

According to Blue Bird Corporation, in 2005, after the last state removed its requirement for horizontally hinged windows, the company redesigned all side emergency exit windows. The emergency exit windows now offered are vertically hinged, with release latch tabs that present less intrusion into the area of egress. Although a vertically hinged side emergency exit window may be an improvement, accident scenarios are still possible in which the window may have to be held in place so as not to hinder evacuation. The NTSB concludes that the situation of a single occupant having to manually hold open the emergency exit window could delay school bus evacuation. Therefore, the NTSB recommends that NHTSA modify FMVSS 217 to require that all emergency exits on school buses be easily opened and remain open during an emergency evacuation.

The NTSB has previously addressed potential hindrances due to emergency exits that fail to stay in the open position during evacuation. As the result of an accident field investigation of a pickup and a tour bus collision in Laredo, Texas, in 1984,[124] the NTSB issued the following recommendation to NHTSA:

> Revise Federal Motor Vehicle Safety Standard 217 to require a locking mechanism that would hold open side window emergency exits on intercity-type buses during use. (H-86-61)

Because NHTSA indicated that no rulemaking was planned for this recommendation, it was classified “Closed—Unacceptable Action” in 1987.

In 1999, the NTSB completed a special investigation on selective motorcoach issues based on two motorcoach accidents—one of which occurred in Stony Creek, Virginia, in 1997.[125] It involved a motorcoach that drifted off the road and into the Nottoway River, resulting in 2 people killed and 39 injured. Several passengers reported difficulty evacuating the bus because the emergency window would not remain open. As a result, the NTSB issued the following recommendation to NHTSA:

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[123] *National School Transportation Specifications and Procedures* (Warrensburg, Missouri: Fifteenth National Congress on School Transportation, 2010). This document serves as the national guideline for school bus design specifications, inspection procedures, and out-of-service criteria.

[124] *1982 Eagle Charter Coach Head-on Collision With 1983 Ford Pickup Truck, Near Laredo, Texas, October 20, 1984*, Highway Field Report NTSB FTW-85-H-FR02 (Washington, DC: National Transportation Safety Board, 1986).

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

> Revise the Federal Motor Vehicle Safety Standard 217, "Bus Window Retention and Release," to require that other than floor-level emergency exits can be easily opened and remain open during an emergency evacuation when a motorcoach is upright or at unusual attitudes. (H-99-9)

In November 2009, the DOT published its Motorcoach Safety Action Plan and identified as a priority safety initiative enhancing the ability of passengers to evacuate a motorcoach in a crash. The NTSB was pleased that progress was being made to improve motorcoach safety but expressed concern that decisions on regulatory action were not forthcoming. Accordingly, the NTSB classified Safety Recommendation H-99-9 "Open—Unacceptable Response" in 2010.

FMVSS 217 and the accompanying test procedures also fail to address other emergency exit design characteristics that could affect egress safety, such as the latch plate protrusion found on the lead school bus. The Gray Summit accident did not require an expedited evacuation because the spilled fuel from the GMC pickup was managed by first responders and did not catch fire, and because several people assisted in the evacuation. Although, in this case, the latch plate only snagged clothing, the NTSB is concerned that any protrusion into a space of egress may act as an injury source and delay egress, especially during more urgent evacuation scenarios.

The NTSB concludes that components of emergency exit windows, such as protruding latch plates, could cause delays or injuries during school bus evacuation. Therefore, the NTSB recommends that NHTSA modify FMVSS 217 or the corresponding laboratory test procedure to eliminate the potential for objects such as latch plates to protrude into the emergency exit window opening space even when that protrusion still allows the exit window to meet the opening size requirements. To cover the interim period until FMVSS 217 is modified, the NTSB also recommends that NHTSA provide the states with guidance on how to minimize potential evacuation delays that could be caused by protruding latch mechanisms on emergency exit windows and by exit windows that require additional manual assistance to remain open during egress.

2.7.2 Evacuation Instruction

Under 5 CSR 30-261.010(1)(J), Missouri requires that all students in kindergarten through sixth grade participate in emergency evacuation drills on school buses at least once each semester. In addition, the St. James School District requires emergency evacuation drills for students in seventh and eighth grades. During postaccident interviews, the majority of students said that they had drills at least once while in grade school and that they were aware of where the exits were located, though some students were not familiar with how to operate the window exits. None of the interviewed occupants of either accident bus mentioned ever receiving a pretrip briefing on emergency evacuation prior to traveling to school sports activities or other school-sponsored events. To date, Missouri does not require emergency evacuation briefings prior to school activity trips on either a school bus or a school-chartered bus.

Despite the mandatory evacuation training required by the state and the St. James School District, students who do not normally ride a bus may not pay attention to the information because they feel that it does not apply to them. Instituting evacuation training prior to school activity trips would ensure that both regular bus riders and occasional bus riders alike obtain training at an applicable time. In an emergency evacuation situation, the success of any one person in unlatching an exit window affects how quickly and safely others can exit the bus. The NTSB concludes that the lack of school bus evacuation briefings prior to activity trips may hinder evacuation and pose a risk for all students. Accordingly, the NTSB recommends that the state of Missouri revise its bus evacuation regulations to require that pupils traveling to an activity or on a field trip in a school bus or a school-chartered bus be instructed in safe riding practices and on the location and operation of emergency exits prior to starting the trip.

Resources are available to assist Missouri in revising its regulations on school bus evacuation training. In October 2001, the NTSB began an investigation of an Omaha, Nebraska, accident involving a school bus that plunged off a bridge and fell 49 feet into a creek.[126] NTSB investigators learned that very few of the 27 high school students on the bus had ever received emergency evacuation training. Most of the students did not ride a school bus to or from school and, therefore, did not receive the mandated evacuation training. The NTSB issued the following recommendation to NASDPTS:

> Prepare a report that can be used by the State Directors to influence their States to require pretrip briefings before school-related activity trips on school buses or school-chartered buses and subsequently assist the States in developing criteria for such briefings, to include training all students regarding the location and use of emergency exits. (H-04-6)

In response to the NTSB recommendation, NASDPTS completed and distributed an information paper on the importance of pretrip briefings before school-related activity trips.[127] The report encouraged state directors of pupil transportation to require that all students transported on such trips receive instruction about the location of all emergency exits, as well as a demonstration of their operation. In addition, the report discussed the importance of maintaining clear aisles and access to emergency exits and of being aware of hazardous highway conditions and other aspects of bus safety. Because this response surpassed NTSB expectations, Safety Recommendation H-04-6 was classified "Closed—Exceeds Recommended Action" in 2004.

In May 2010, the NCST updated the *National School Transportation Specifications and Procedures* to discuss the need for emergency evacuation drills under "Evacuation Procedures for Activity and Field Trips." This document provides detailed guidance on pretrip emergency evacuation training procedures.

In its 1999 special investigation report,[128] the NTSB addressed the need for pretrip briefings for other types of buses and made the following recommendations to the FMCSA:

[126] *School Bus Run-off-Bridge Accident, Omaha, Nebraska, October 13, 2001*, Highway Accident Report NTSB/HAR-04/01 (Washington, DC: National Transportation Safety Board, 2004).

[127] *Information Paper: Emergency Evacuation Training, School Activity Trips*, <http://www.nasdpts.org/Documents/EmergEvacOmaha2004.pdf>, accessed August 4, 2011.

[128] NTSB/SIR-99/01.

> Provide guidance on the minimum information to be included in safety briefing materials for motorcoach operations. (H-99-7)

> Require motorcoach operators to provide passengers with pre-trip safety information. (H-99-8)

Safety Recommendation H-99-7 was classified “Closed—Acceptable Action” in 2007 after the FMCSA published a basic plan for motorcoach passenger safety awareness, recommending that motorcoach companies inform passengers of such safety topics as emergency exits, emergency contact information, driver direction, fire extinguishers, restroom emergency information, and information pertaining to slips and falls. In response to Safety Recommendation H-99-8, the FMCSA stated that it believed that voluntary adoption of the plan was the best approach so as to allow each carrier to develop an appropriate passenger safety awareness program for its operations. The FMCSA stated that it had developed and distributed 30,000 brochures, 6,000 posters, and 20,000 audio CDs to bus/motorcoach associations, bus/motorcoach companies, and FMCSA division offices. Safety Recommendation H-99-8 is classified “Open—Acceptable Alternate Response.”

The NTSB recognizes that the school bus-related issues identified in this report are not unique to Missouri and that it would be beneficial to disseminate, discuss, and resolve these issues. In addition to pretrip evacuation briefings, this accident investigation addresses driver distraction, proper driver scanning behavior, and the importance of maintaining a sufficient following distance at all times; emergency evacuation issues that might occur with certain emergency exit window designs; vehicle inspection issues due to insufficient oversight and procedures; and the potential safety benefits of technologies such as VER and FCW systems. Therefore, the NTSB recommends that NASDPTS, the National Association for Pupil Transportation, and the National School Transportation Association inform their members of the circumstances and events that contributed to the Gray Summit accident; discuss solutions for the driver, pretrip evacuation briefing, and vehicle, inspection, and technological issues presented in the report; and urge the implementation of these solutions among their members.

3 Conclusions

3.1 Findings

1. The following were not factors in this accident: (1) weather; (2) driver qualifications or familiarity with the accident location; (3) alcohol or illicit drug use by any of the four drivers; (4) mechanical condition of the Volvo tractor, the GMC pickup, or either of the two school buses; (5) emergency response; or (6) highway design, work-zone signage, or work-zone policies.

2. Had the Volvo tractor, the two school buses, and the motorcoach been required to have video event recorders, the events leading up to this accident could have been more definitively assessed.

3. The use of video event recorder data for managing driver behavior could assist school bus operators in identifying driver performance issues before they lead to accidents.

4. The absence of a timely brake application, the cellular provider records indicating frequent texting while driving, the temporal proximity of the last incoming text message to the collision, and the witness statement regarding the driver's actions indicate that the GMC pickup driver was most likely distracted from the driving task by a text messaging conversation at or near the time of the accident.

5. A combination of enforceable state laws, high visibility enforcement, and supporting communication campaigns can reduce the number of accidents caused by drivers distracted by the use of portable electronic devices.

6. Manufacturers and providers of portable electronic devices known to be frequently used while driving should reduce the potential of these devices to distract drivers by developing features that discourage their use or that limit their nondriving- or nonemergency-related functionality while a vehicle is in operation.

7. The collision between the lead school bus and the GMC pickup was the result of the bus driver's attention being drawn away from the forward roadway by the motorcoach parked on the shoulder.

8. Had the driver of the following school bus maintained the recommended minimum distance from the lead school bus, she would have been able to avoid the accident.

9. The GMC pickup driver was fatigued at the time of the accident due to cumulative sleep debt and acute sleep loss, which could have resulted in impaired cognitive processing or other performance decrements.

10. The medical condition of the Volvo tractor driver did not cause or contribute to the accident.

11. The state of Missouri had no effective oversight of the operations of Copeland Bus Services.

12. The *Missouri Motor Vehicle Inspection Regulations* “School Bus Inspection” section does not adequately delineate the bus systems to be included in an inspection.

13. The state’s current inspection procedures do not allow for the identification of all school bus brake defects included in the *Missouri Motor Vehicle Inspection Regulations*.

14. The MVI–2 vehicle inspection form is insufficient because it does not effectively prompt state inspectors to evaluate all of the safety-critical items listed in the *Missouri Motor Vehicle Inspection Regulations*.

15. Both the Missouri State Highway Patrol and a state inspection facility conducted inadequate vehicle inspections of buses operated by Copeland Bus Services.

16. Forward collision warning systems on the two accident buses—and possibly on the GMC pickup—could have prevented the accident or at least mitigated its severity.

17. The situation of a single occupant having to manually hold open the emergency exit window could delay school bus evacuation.

18. Components of emergency exit windows, such as protruding latch plates, could cause delays or injuries during school bus evacuation.

19. The lack of school bus evacuation briefings prior to activity trips may hinder evacuation and pose a risk for all students.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the initial Gray Summit collision was distraction, likely due to a text messaging conversation being conducted by the GMC pickup driver, which resulted in his failure to notice and react to a Volvo tractor that had slowed or stopped in response to a queue that had developed in a work zone. The second collision, between the lead school bus and the GMC pickup, was the result of the bus driver’s inattention to the forward roadway due to excessive focus on a motorcoach parked on the shoulder of the road. The final collision was due to the driver of the following school bus not maintaining the recommended minimum distance from the lead school bus in the seconds preceding the accident. Contributing to the severity of the accident was the lack of forward collision warning systems on the two school buses.

4 Recommendations

4.1 New Recommendations

As a result of its investigation of this accident, the National Transportation Safety Board makes the following recommendations.

To the National Highway Traffic Safety Administration:

> Modify Federal Motor Vehicle Safety Standard 217 to require that all emergency exits on school buses be easily opened and remain open during an emergency evacuation. (H-11-36)
>
> Modify Federal Motor Vehicle Safety Standard 217 or the corresponding laboratory test procedure to eliminate the potential for objects such as latch plates to protrude into the emergency exit window opening space even when that protrusion still allows the exit window to meet the opening size requirements. (H-11-37)
>
> To cover the interim period until Federal Motor Vehicle Safety Standard 217 is modified as specified in Safety Recommendations H-11-36 and -37, provide the states with guidance on how to minimize potential evacuation delays that could be caused by protruding latch mechanisms on emergency exit windows and by exit windows that require additional manual assistance to remain open during egress. (H-11-38)

To the 50 states and the District of Columbia:

> (1) Ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers; (2) use the National Highway Traffic Safety Administration model of high visibility enforcement to support these bans; and (3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving. (H-11-39)

To the state of Missouri (addressed to the Governor):

> Revise state regulations to require a periodic safety review of motor carrier operations for those carriers involved in pupil transportation. (H-11-40)
>
> Modify the *Missouri Motor Vehicle Inspection Regulations* so that all inspection areas and procedures that apply to school buses are contained within the “School Bus Inspection” section. (H-11-41)

Modify your school bus inspection procedures so that all brake defects specified in the *Missouri Motor Vehicle Inspection Regulations* can be identified during biannual inspections. (H-11-42)

Revise your MVI–2 vehicle inspection form so that it lists all items to be inspected, as required by the *Missouri Motor Vehicle Inspection Regulations*; and include on the form a means of succinctly describing whether each of those items passes inspection. (H-11-43)

Audit your vehicle inspection program to ensure that inspections conform to requirements of the *Missouri Motor Vehicle Inspection Regulations*. (H-11-44)

Revise your bus evacuation regulations to require that pupils traveling to an activity or on a field trip in a school bus or a school-chartered bus be instructed in safe riding practices and on the location and operation of emergency exits prior to starting the trip. (H-11-45)

To the Missouri Department of Elementary and Secondary Education:

Incorporate into school bus driver training the risk of driver inattention, the need for proper scanning behavior, and the necessity of keeping a safe following distance. (H-11-46)

To CTIA–The Wireless Association and the Consumer Electronics Association:

Encourage the development of technology features that disable the functions of portable electronic devices within reach of the driver when a vehicle is in motion; these technology features should include the ability to permit emergency use of the device while the vehicle is in motion and have the capability of identifying occupant seating position so as not to interfere with use of the device by passengers. (H-11-47)

To the National Association of State Directors of Pupil Transportation Services, the National Association for Pupil Transportation, and the National School Transportation Association:

Inform your members of the circumstances and events that contributed to the Gray Summit accident; discuss solutions for the driver, pretrip evacuation briefing, and vehicle, inspection, and technological issues presented in the report; and urge the implementation of these solutions among your members. (H-11-48)

4.2 Previously Issued Recommendations Reiterated and Reclassified in This Report

As a result of its investigation, the National Transportation Safety Board reiterates and reclassifies the following safety recommendations:

To the Federal Motor Carrier Safety Administration:

> Require all heavy commercial vehicles to be equipped with video event recorders that capture data in connection with the driver and the outside environment and roadway in the event of a crash or sudden deceleration event. The device should create recordings that are easily accessible for review when conducting efficiency testing and systemwide performance-monitoring programs. (H-10-10)
>
> Require motor carriers to review and use video event recorder information in conjunction with other performance data to verify that driver actions are in accordance with company and regulatory rules and procedures essential to safety. (H-10-11)

Safety Recommendations H-10-10 and -11 are classified "Open—Unacceptable Response" in section 2.3, "Video Event Recorders," of this report.

To the National Highway Traffic Safety Administration:

> Complete rulemaking on adaptive cruise control and collision warning system performance standards for new passenger cars. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-8)
>
> Determine whether equipping commercial vehicles with collision warning systems with active braking and electronic stability control systems will reduce commercial vehicle accidents. If these technologies are determined to be effective in reducing accidents, require their use on commercial vehicles. (H-08-15)

Safety Recommendations H-01-8 and H-08-15 are classified "Open—Unacceptable Response" in section 2.6.2, "Forward Collision Avoidance Systems," of this report.

4.3 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following previously issued safety recommendations.

To the Federal Motor Carrier Safety Administration:

Develop a comprehensive medical oversight program for interstate commercial drivers that contains the following program elements: the review process prevents, or identifies and corrects, the inappropriate issuance of medical certification. (H-01-21)

Develop a comprehensive medical oversight program for interstate commercial drivers that contains the following program elements: mechanisms for reporting medical conditions to the medical certification and reviewing authority and for evaluating these conditions between medical certification exams are in place; individuals, health care providers, and employers are aware of these mechanisms. (H-01-24)

To the National Highway Traffic Safety Administration:

Complete rulemaking on adaptive cruise control and collision warning system performance standards for new commercial vehicles. At a minimum, these standards should address obstacle detection distance, timing of alerts, and human factors guidelines, such as the mode and type of warning. (H-01-6)

After promulgating performance standards for collision warning systems for commercial vehicles, require that all new commercial vehicles be equipped with a collision warning system. (H-01-7)

To the American Association of Motor Vehicle Administrators:

Urge your member states to develop a comprehensive medical oversight program for intrastate commercial drivers that contains the following program elements: Individuals performing medical examinations for drivers are qualified to do so and are educated about occupational issues for drivers; a tracking mechanism is established that ensures that every prior application by an individual for medical certification is recorded and reviewed; medical certification regulations are updated periodically to permit trained examiners to clearly determine whether drivers with common medical conditions should be issued a medical certificate; individuals performing examinations have specific guidance and a readily identifiable source of information for questions on such examinations; the review process prevents, or identifies and corrects, the inappropriate issuance of medical certification; enforcement authorities can identify invalid medical certification during safety inspections and routine stops; enforcement authorities can prevent an uncertified driver from driving until an appropriate medical examination takes place; mechanisms for reporting medical conditions to the medical certification and reviewing authority and for evaluating these conditions between medical certification exams are in place; individuals, health care providers, and employers are aware of these mechanisms. (H-01-26)

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: December 13, 2011

Chairman Hersman filed the following concurring statement on December 22, 2011. Vice Chairman Hart and Member Sumwalt filed the following concurring statements on December 21, 2011, and December 13, 2011, respectively.

Board Member Statements

Notation 8245B

Chairman Deborah A.P. Hersman, Concurring:

On December 13, 2011, the Board called for the 50 states and the District of Columbia to ban the nonemergency use of portable electronic devices (PED) while driving. The safety recommendation also urges using targeted education and enforcement campaigns to support these bans.

This recommendation is the culmination of a decade of accident investigations involving distractions in all modes of transportation. And, while in some respects a national ban could represent the end of our efforts, in other ways it marks just the beginning of the NTSB's work on distraction.

The NTSB has issued almost 20 recommendations regarding prohibiting PED use by operators including aviators, railroaders, mariners, young drivers, and bus and truck drivers. Now we address our recommendations to all drivers.

As we proceed, we do so with 10 years of compelling firsthand investigatory experience and the known risks of distracted driving. Our charge is straightforward: Improving safety.

We recognize that distraction is complicated and we are still learning what the human brain can—and cannot—handle. What we do know is that the risk of a crash increases if a driver is texting.[1] Likewise reaching for a phone and dialing are dangerous behind the wheel.[2] And talking on a phone, whether hand-held or hands-free,[3] increases crash risk.

In the past, the NTSB did not start an investigation looking at distraction. But it is now standard practice for our investigators to review wireless records and obtain any electronic devices that might have been a factor in an accident because their use is so pervasive.

It is imperative that we develop a greater understanding of how distraction affects the driving task and identify ways to combat distraction behind the wheel. This is why we have called for a forum in 2012 to focus on distraction; its varying degrees; the myriad devices; and the opportunities to improve safety and prevent transportation accidents.

[1] (a) *Distraction in Commercial Trucks and Buses: Assessing Prevalence and Risk in Conjunction With Crashes and Near-Crashes*, FMCSA-RRR-10-049 (Washington, DC: Federal Motor Carrier Safety Administration, September 2010). (b) N. Reed and R.Robbins, *The Effect of Text Messaging on Driver Behaviour* (London, UK: RAC Foundation, September 2008).

[2] *Driver Distraction in Commercial Vehicle Operations*, FMCSA-RRR-09-042 (Washington, DC: Federal Motor Carrier Safety Administration, September 2009).

[3] (a) D. Redelmeier and R. Tibshirani, "Association Between Cellular-Telephone Calls and Motor Vehicle Collisions," *New England Journal of Medicine*, vol. 336, no. 7 (February 13, 1997). (b) S. McEvoy and others, "Role of Mobile Phones in Motor Vehicle Crashes Resulting in Hospital Attendance: A Case-Crossover Study," *BMJ* (London, UK: BMJ Group, July 2005).

NTSB Accident Investigations

We have identified distraction in several aviation investigations. In 2009, two airline pilots were out of radio communication with air traffic control for more than an hour because they were distracted by their personal laptops. They overflew their destination by more than 100 miles. Their distraction was the cause of the incident.

During our investigation of the 2009 Continental Connection flight 3407 crash, which killed all 49 on board and one on the ground, we identified that the first officer had been texting on the taxiway prior to takeoff. While texting did not play a role in the crash, it was in conflict with the sterile cockpit rule and introduced risk into the cockpit. The NTSB recommended that a checklist item be added to ensure that all wireless devices be turned off on the flight deck.

It was not the number of fatalities that led us to this recommendation, but the unsafe behavior that introduced risk into the cockpit.

We have investigated several marine accidents involving distractions. In 2009, in San Diego, California, a U.S. Coast Guard patrol boat collided with a recreational vessel during an annual holiday boat parade in San Diego Bay, killing one and seriously injuring four. And in Charleston, South Carolina, in 2009, a Coast Guard patrol boat collided with a passenger vessel on a holiday tour, injuring eight. In both accidents, personnel on the Coast Guard vessels were using portable wireless devices just prior to the accident, indicating a failure to maintain an adequate lookout.

In Philadelphia in 2010, a barge being pushed by a tugboat ran over an amphibious DUKW boat in the Delaware River, killing two Hungarian exchange students. The tugboat mate failed to maintain a proper lookout due to distraction by repeated use of a cell-phone and laptop computer. We also determined that the deckhand who was serving as a lookout on the DUKW boat was sending or receiving text messages immediately prior to the collision, even though it was prohibited by company policy.

It was not the number of fatalities that led us to make recommendations to the Coast Guard, but the loss of situational awareness that occurred due to PEDs.

We have also investigated accidents in rail operations where distraction was an issue. In 2002, a coal train collided with an intermodal train near Clarendon, Texas. The coal train engineer was using his cell-phone during the time he should have been attending to the requirements of his duties. The coal train conductor had also used his cell-phone while on duty. The engineer of the intermodal train was killed, three others were injured, and both trains were destroyed.

In the 2008 collision of a commuter train with a freight train in Chatsworth, California, the commuter train engineer, who had a history of using his cell-phone for personal communications while on duty in violation of company policy (for example, in the 3 days leading up the accident, he sent 136 and received 114 text messages while on duty), ran a red signal while texting. That train collided head on with a freight train—killing 25 and injuring dozens. The conductor on the freight train that was struck had also been using his portable electronic device while on duty even though it was prohibited by company policy.

Again, following these accidents, our recommendations were based on the unsafe behavior that diverted attention away from the primary task: safe operation of the train.

In 2008, the Federal Railroad Administration established an Emergency Order restricting on-duty railroad operating employees from improperly using cellular telephones and other distracting electronic and electrical devices.

The NTSB has investigated four highway accidents in which distraction (handheld or hands-free) has been a factor.

In 2002, a novice driver, distracted by a cell-phone conversation, crossed the highway median near Largo, Maryland, flipped over, and landed on a minivan, killing five. As a result of the investigation, in 2003, we recommended that the 50 states and the District of Columbia prohibit novice drivers from using interactive wireless communication devices while driving. Today, 30 states and the District of Columbia ban the use of PEDs by novice drivers.

In 2004, an experienced motorcoach driver, distracted on his hands-free cell-phone, failed to move to the center lane and struck the underside of an arched stone bridge on the George Washington Parkway in Alexandria, Virginia. Eleven of the 27 high school students on the bus were injured. As result of this accident, we recommended that the states and the District of Columbia ban commercial drivers with school bus or passenger endorsements from cellular telephone use except in emergencies. Today, 19 states and the District of Columbia have such a ban.

In 2004, in Sherman, Texas, a tractor trailer crossed the median and collided with a sport utility vehicle and a pickup truck, killing ten people. In the 24 hours preceding the accident, the driver of the tractor trailer had made 97 calls and received 26 calls. In the half hour preceding the crash, the driver spent 14 minutes—nearly half his time—on the phone.

In 2010, near Munfordville, Kentucky, a truck-tractor in combination with a 53-foot-long trailer, left its lane, crossed the median, and collided with a 15-passenger van. The truck driver failed to maintain control of his vehicle because he was distracted by use of his cell-phone. The accident resulted in 11 fatalities.

In October 2011, the NTSB issued a recommendation that all commercial driver's license (CDL)-holders be prohibited from the use of both hand-held and hands-free cellular telephones while operating a commercial vehicle, except in emergencies.

On December 22, 2011, the DOT published its final rule prohibiting hand-held calling for all interstate CDL holders and all CDL holders transporting hazardous materials, including those operating intrastate. This follows action by the DOT in 2010 banning CDL holders from texting.

Again, we did not issue our recommendations for restricting PED use for novice drivers, bus drivers, or truck drivers based on the number of fatalities, but because we know that distractions can directly lead to accidents.

A review of NTSB's prior accident investigations may put our recommendation for a national ban for all drivers into perspective. In this accident, the driver of the pickup truck had sent and received 11 text messages in the 11 minutes prior to the accident. The pickup truck collided with a tractor-tractor slowed in a work zone, setting off multivehicle collisions that killed two and injured 38. Yes, the bus drivers were also responsible for their part in the accident, as cited in the probable cause, and we issued 13 recommendations in the report, including several focused on driver inattention and additional training for school bus drivers, but what set the accident into motion was distraction.

This recommendation was not reached lightly. As PEDs have become more pervasive so too have the deadly accidents caused by distraction.

The Focus on PEDs

In recent years, we made recommendations to reduce distractions involving phones, laptops, and wireless devices in airplanes, locomotives, ships, and commercial vehicles. We did so because it reduced risk. It was the safe thing to do.

We relied on our investigations, as well as on research, data, and studies conducted by others. In the last decade, we have issued almost 20 safety recommendations to eliminate distraction due to PEDs. There was little opposition to these recommendations because the public recognized the risk and did not want their pilot, engineer, or bus driver to be distracted. They appreciated these common-sense recommendations to improve safety.

Most drivers recognize the dangers of distraction. Nationwide Insurance conducted a Driving While Distracted technology survey in 2010 which revealed that four out of 10 Americans say they have been hit or nearly hit by a driver distracted by their cell phone.[4] A recent AAA Mid-Atlantic survey[5] found that although 99 percent of drivers surveyed believe that reading or writing a text presents a threat to other drivers, 21 percent admitted to recently texting behind the wheel.

We know there are four types of driver distraction—visual, aural, manual, and cognitive—and the use of PEDs involves several, or all, of these. Studies show that it is more distracting to engage in a cell-phone conversation than it is to talk with a passenger.[6] Studies have generally reported that driver distraction occurs during both handheld and hands-free cellular phone conversations;[7] the most noteworthy exceptions are results of studies of commercial drivers authored by researchers at Virginia Tech.[8] Most recently, the Swedish National Road and Transport Research Institute (VTI) showed longer reaction times with cell

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[4] See <http://www.nationwide.com/newsroom/dwd-surveys.jsp>.

[5] See <http://virginiahotlanes.com/documents/Distracted-Driving-Fact-Sheet.pdf>.

[6] F. Drews, M. Pasupathi, and D. Strayer, "Passenger and Cell Phone Conversations in Simulated Driving," *Journal of Experimental Psychology: Applied*, vol. 14, no. 4 (2008), pp. 392–400.

[7] A. McCartt, L. Hellinga, and K. Braitman, "Cellphones and Driving: Review of Research," *Traffic Injury Prevention*, vol. 7, no. 2 (2006), pp. 89–106.

[8] R. Olson and others, *Driver Distraction in Commercial Vehicle Operations*, Report No. FMCSA-RRR-09-042 (Washington, DC: Federal Motor Carrier Safety Administration, 2009).

phone use regardless of whether it is handheld or hands-free.[9] Likewise, reviews conducted by researchers at Monash University[10] and at the University of Calgary[11] concluded that performance was degraded using both handheld and hands-free cellular phones.

Here's the one-two punch when it comes to distraction and transportation.

First, portable devices are ubiquitous. Twenty years ago, 0.25 percent of the world population had cell phone service.[12] Today, worldwide, there are 5.3 billion mobile phone subscribers—77 percent of the earth's population. In the United States, the percentage is higher. It *exceeds* 100 percent—meaning many of us have more than one electronic device.[13]

Second, portable electronic devices are omnipresent in our automobiles, and worse, they are in the driver's seat.

The level of distraction is only going to grow as new hand-held devices are released each year and as the automotive industry develops ever more sophisticated in-vehicle infotainment systems. One partnership says it is exploring "ways to integrate vehicles with the home to provide a seamless connection across all areas of people's lives."[14]

More and more, people are trying to multi-task by making phone calls, responding to e-mails, tweeting, posting, and surfing the web while they drive. Maybe someday we will have cars that can do the driving for us or devices that will shut down when safety is compromised. But, until that time comes, we know that electronic devices that take a driver's attention away from the primary task of driving create an unnecessary safety risk.

Societal Change

The second half of the 20th century saw changing societal norms about the dangers of smoking and health. The first half of this century must address distraction and safety.

In the last thirty years we have changed the way we think about drinking and driving because of strong laws, strong education, and strong enforcement. It is past time to face the fact that distracted driving is a serious safety risk and it's not just about the distracted drivers— it's about the safety of everyone else on the road.

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[9] K. Kircher, C. Patten, and C. Ahlström, *Mobile Telephones and Other Communication Devices and Their Impact on Traffic Safety: A Review of the Literature* (Linköping, Sweden: Swedish National Road and Transport Research Institute [VTI], 2011).

[10] K. Young and M. Regan, "Driver Distraction: A Review of the Literature," in I. Faulks and others, eds., *Distracted Driving* (Sydney, NSW: Australasian College of Road Safety, 2007), pp. 379–405.

[11] J. Caird and others, "A Metaanalysis of the Effects of Cell Phones on Driver Performance," *Accident Analysis and Prevention*, vol. 40, no. 4 (2008), pp. 1282–1293.

[12] See <http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html>.

[13] See <http://www.ctia.org/advocacy/research/index.cfm/aid/10323>.

[14] See <http://www.marketwatch.com/story/intel-toyota-drive-joint-research-on-next-generation-in-vehicle-infotainment-systems-2011-11-09>.

There is no doubt that the adoption of "PED-free" safe driving behavior will require a cultural shift. If we are to bring about change—like the widespread use of seatbelts, child restraints, and curbing drunk and drugged driving—it will take time, commitment, and require three things: good laws, good education, and good enforcement.

Although our recommendation is focused on state bans, organizations, families, and individuals all play a role in changing societal norms.

According to the National Safety Council[15] many Fortune 500 companies and companies with large vehicle fleets have already instituted safety policies prohibiting PED-use behind the wheel to protect their employees. Surveys conducted by NSC in 2009 and 2010 determined that organizations can lead the charge without adversely impacting the bottom line or productivity. As expected, strong company cell phone policies translate into strong safety performance; preliminary information indicates that full bans may lead to decreased accident rates.

At the NTSB, we recognized the risks associated with PEDs based on our accident investigations and knew that we needed to lead by example. In 2009, we prohibited our employees from texting or talking (hand-held or hands-free) on PEDs while on government travel, in a government-issued vehicle, or while using a government-issued device.

Families can model the right behavior for their children who will be drivers by putting their PEDs away when they are behind the wheel. When it comes to talking on the phone or texting, your children may do as you say but they are more likely to do what you do.

Finally, each of us, have to ask ourselves whether we can take a break from being connected while we are behind the wheel and what it will take to change this risky behavior. It could well be a life or death decision. For you or someone else.

At the NTSB, our charge is to investigate accidents, learn from them, and recommend changes.

The one constant: crashes happen fast, sometimes in the blink of an eye. That's what happened at Gray Summit and to countless others on highways across the U.S. last year. Lives lost. In the blink of an eye. In the typing of a text. In the push of a send button.

Simply because we can stay connected when we drive does not mean we should.

No call, no text, no update is worth a human life.

December 22, 2011

[15] See <http://www.nsc.org/safety_road/Distracted_Driving/Pages/EmployerPolicies.aspx>.

Vice Chairman Hart, Concurring:

I agree with most of the findings and recommendations, as well as the probable cause, but I have a concern about how we addressed the issue of driver distraction.

The probable cause for this accident includes, correctly in my view, distraction of the GMC pickup driver. It is bad enough that his distraction led to the loss of two lives, including his own, and injuries for many more, but it is far worse that it was a type of distraction that we are seeing with increasing frequency in all modes of transportation – distraction by a portable electronic device. This type of distraction is becoming so widespread, and is resulting in so many fatalities and injuries, that it demands a massive and immediate response before more are killed and injured.

Our investigation of this accident revealed that the GMC pickup truck driver was at some stage in the texting process when the accident occurred – he was probably either reading or in the process of responding to an incoming text. We have already recommended that holders of learner's permits and intermediate licenses be prohibited from using wireless communications devices while driving, and we have also recommended a prohibition against the use of handheld and hands-free cellular telephones by commercial drivers; this accident clearly indicates a need to extend those prohibitions to all drivers. For two reasons, however, our recommendation to ban the nonemergency use of portable electronic devices (other than those that are designed to support the driving task) for all drivers may be scoped too narrowly.

Our challenge is driver distraction. Drivers can be distracted just as much by installed electronic devices as by portable electronic devices, so our limitation to portable devices does not fully respond to the problem. Moreover, portable electronic devices that are designed to support the driving task can be just as distracting as those that are not. Consequently, I believe we should follow up on a suggestion that was mentioned in our Sunshine Meeting for this accident, which is to convene a forum that would look more broadly at the issue of distraction of drivers by electronic devices, both portable and installed.

A forum that addresses the broad issues, and that considers the viewpoints of a variety of experts, *e.g.*, in human factors, design, enforcement, and other pertinent areas, as well as the viewpoints of manufacturers, commercial vehicle operators, and drivers, could provide a solid foundation for us to make additional recommendations that more fully and directly focus on the target of driver distraction without creating unintended consequences and without resulting in undue or unnecessary burdens. Driver distraction is an issue that is clearly getting worse, and I hope that we will expeditiously pursue it in a more comprehensive way.

December 21, 2011

Member Sumwalt, Concurring:

The Safety Board determined the cause of this accident to be, in part, the GMC pickup driver's distraction, likely due to his text messaging. The issue of texting while driving, as well as the broader issue of using portable electronic devices such as cell phones while driving, has enormous safety implications. The National Highway Traffic Safety Administration (NHTSA) determined that more than 3,000 people lost their lives last year in distraction-related highway/roadway accidents. The problem is not getting better, either: NHTSA found that texting while driving increased 50% last year.

In today's board meeting, the Safety Board adopted sweeping recommendations aimed at curtailing use of portable electronic devices while driving. I realize these recommendations will be unpopular with many. However, considering the NTSB's mission is to issue safety recommendations when safety issues or unsafe conditions are identified, I am confident we did the right thing by issuing these recommendations.

That said, I hope the NTSB will not stop here. There is much yet to be learned about how this epidemic can be curtailed. In today's board meeting, there was mention of the NTSB holding a forum or symposium on distractions in transportation. Through this concurring statement, I urge staff to proceed in an expeditious manner in planning and executing such an event.

December 13, 2011

Appendix A: Investigation

The National Transportation Safety Board (NTSB) received notification of this accident on August 5, 2010. The NTSB launched a team of investigators to address motor carrier, survival factors, human factors, vehicle, and highway issues. The NTSB team also included staff from the transportation disaster assistance office. Vice Chairman Christopher Hart and Member Earl Weener were present on scene. Parties to the investigation were the Federal Motor Carrier Safety Administration, the Missouri Department of Transportation, the Missouri State Highway Patrol, the St. James School District, the Boles Fire Protection District, the Meramec Ambulance District, Blue Bird Corporation, General Motors Company, and Fred Weber, Inc. No public hearing was held in connection with this accident, and no depositions were taken.