Truck-Tractor Semitrailer Median Crossover Collision With 15-Passenger Van
Munfordville, Kentucky
March 26, 2010

Accident Report

NTSB/HAR-11/02
PB2011-916202

National Transportation Safety Board

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Highway Accident Report

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National Transportation Safety Board

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

National Transportation Safety Board. 2011. ***Truck-Tractor Semitrailer Median Crossover Collision With 15-Passenger Van, Munfordville, Kentucky, March 26, 2010*****. Highway Accident Report NTSB/HAR-11/02. Washington, DC.**

Abstract: On March 26, 2010, near Munfordville, Kentucky, a truck-tractor semitrailer was traveling south on Interstate 65 (I-65) when it departed the left lane and entered the 60-foot-wide depressed earthen median between the southbound and northbound roadways. The truck traveled across the median and struck and overrode the high-tension median cable barrier adjacent to the left shoulder of northbound I-65. It then crossed the shoulder and entered the lanes of northbound I-65. A 15-passenger van, containing 12 occupants, was traveling northbound in the left lane. As the truck crossed in front of the van, its tractor was struck by the van. As a result of the accident and the truck fire that ensued, the truck driver, the van driver, and nine van passengers died. Two child passengers in the van, who were using child restraints, sustained minor injuries.

Among the safety issues addressed in the report are the need to prohibit the use of cellular telephones by drivers of commercial motor vehicles; the need to provide objective warrants, rather than general guidelines, for the application of median barriers; the need to revise state seat belt laws to include occupants of 15-passenger vans; the need to detect unsafe motor carriers attempting to obtain operating authority by submitting inaccurate or deceptive information to the Federal Motor Carrier Safety Administration (FMCSA); and the need to evaluate the performance of the FMCSA new entrant program. The National Transportation Safety Board is issuing 15 safety recommendations as a result of the investigation.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
BASICs	Behavior Analysis and Safety Improvement Categories
BMI	body mass index
CDL	commercial driver's license
CFR	*Code of Federal Regulations*
CMV	commercial motor vehicle
CSA	Compliance, Safety, Accountability (program)
DOT	U.S. Department of Transportation
ECM	engine control module
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSRs	*Federal Motor Carrier Safety Regulations*
GHSA	Governors Highway Safety Association
Gibraltar	Gibraltar Cable Barrier Systems, L.P.
GVWR	gross vehicle weight rating
I-65	Interstate 65
I-69	Interstate 69
IIHS	Insurance Institute for Highway Safety
ISS	Inspection Selection System
kip	1,000 pounds-force
KRS	Kentucky Revised Statute
KSP	Kentucky State Police
KYTC	Kentucky Transportation Cabinet
MASH	*Manual for Assessing Safety Hardware*
MC	motor carrier (for MC number)
MCMIS	Motor Carrier Management Information System
MCSAC	Motor Carrier Safety Advisory Committee
MCSAP	Motor Carrier Safety Assistance Program
NAS	New Applicant Screening (Program)
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
NPRM	notice of proposed rulemaking

NTSB	National Transportation Safety Board
SafeStat	Safety Status Measurement System
SEA	safety evaluation area
SFD	safety fitness determination
TL-1 (to TL-6)	Test Level One (to Test Level Six)

Executive Summary

On Friday, March 26, 2010, about 5:14 a.m. central daylight time, near Munfordville, Kentucky, a 1999 Freightliner truck-tractor in combination with a 1998 Strick Corporation 53-foot-long van semitrailer, owned by the motor carrier Hester, Inc., and being driven by a 45-year-old male, was traveling south on Interstate 65 (I-65) near milepost 61.5. The truck departed the left lane of southbound I-65 at a shallow angle and entered the 60-foot-wide depressed earthen median between the southbound and northbound roadways. The truck traveled across the median and struck and overrode the high-tension, four-cable, alternating-post median barrier adjacent to the left shoulder of northbound I-65. It then crossed the left shoulder and entered the travel lanes of northbound I-65.

At that time, a 2000 Dodge 15-passenger van, driven by a 41-year-old male and occupied by 11 passengers, was traveling northbound in the left lane. As the truck crossed in front of the van, its tractor was struck by the van. The van rotated clockwise and became engaged with the truck's trailer; the two vehicles continued across both travel lanes and the right shoulder of northbound I-65. As the truck and van traveled across the right shoulder, the van separated from the truck, struck the cut rock wall beyond the shoulder, and rebounded back into the travel lanes, coming to rest in the left lane of northbound I-65, facing south. The truck's tractor struck the cut rock wall, and the vehicle rolled onto its right side. As the truck came to rest across both northbound lanes, a fire ensued that destroyed the tractor and the sides and roof of the semitrailer.

As a result of the accident and subsequent truck fire, the truck driver, the van driver, and nine van passengers died. Two child passengers in the van, who were using child restraints, sustained minor injuries.

The National Transportation Safety Board (NTSB) determines that the probable cause of this accident was the truck driver's failure to maintain control of the truck-tractor combination vehicle because he was distracted by use of his cellular telephone. Contributing to the severity of the accident were a median barrier that was not designed to safely contain or redirect the heavy vehicle and the lack of adequate guidance to the states in the form of high-performance median barrier warrants.

The following safety issues are discussed in this report:

- The need to prohibit the use of cellular telephones by drivers of commercial motor vehicles;
- The need to provide objective warrants, rather than general guidelines, for the application of median barriers;
- The need to revise state seat belt laws to include occupants of 15-passenger vans;

- The need to detect unsafe motor carriers attempting to obtain operating authority by submitting inaccurate or deceptive information to the Federal Motor Carrier Safety Administration (FMCSA); and
- The need to evaluate the performance of the FMCSA new entrant program.

As a result of the investigation, the NTSB makes recommendations to the Federal Highway Administration, the FMCSA, the National Highway Traffic Safety Administration, the 50 states and the District of Columbia, the Commonwealth of Kentucky, the American Association of State Highway and Transportation Officials (AASHTO), and the Governors Highway Safety Association.

The NTSB also reiterates two previous recommendations to the FMCSA and reclassifies one recommendation each to the FMCSA, the 50 states and the District of Columbia, and AASHTO.

1. Factual Information

1.1 Accident Narrative

1.1.1 Synopsis

The accident occurred on Friday, March 26, 2010, near Munfordville, Kentucky. About 5:14 a.m. central daylight time,[1] a 1999 Freightliner truck-tractor in combination with a 1998 Strick Corporation 53-foot-long van semitrailer, owned by the motor carrier Hester, Inc., and being driven by a 45-year-old male, was traveling south on Interstate 65 (I-65) near milepost 61.5. The truck departed the left lane of southbound I-65 at a shallow angle and entered the 60-foot-wide depressed earthen median between the southbound and northbound roadways. The truck traveled across the median and struck and overrode the high-tension, four-cable, alternating-post median barrier adjacent to the left shoulder of northbound I-65. It then crossed the left shoulder and entered the travel lanes of northbound I-65.

At that time, a 2000 Dodge 15-passenger van, driven by a 41-year-old male and occupied by 11 passengers, was traveling northbound in the left lane. As the truck crossed in front of the van, its tractor was struck by the van. The van rotated clockwise and became engaged with the truck's trailer; the two vehicles continued across both travel lanes and the right shoulder of northbound I-65. As the truck and van traveled across the right shoulder, the van separated from the truck, struck the cut rock wall beyond the shoulder, and rebounded back into the travel lanes, coming to rest in the left lane of northbound I-65, facing south. The truck's tractor struck the cut rock wall, and the vehicle rolled onto its right side. As the truck came to rest across both northbound lanes, a fire ensued that destroyed the tractor and the sides and roof of the semitrailer.

1.1.2 Preaccident Information

Three days earlier, the accident truck-tractor combination unit had been traveling from Sunfield, Michigan, to Cullman, Alabama, a distance of approximately 682 miles, carrying a load of truck brake drum parts. The truck departed an iron works facility in Sunfield at 12:56 p.m. on Tuesday, March 23, 2010, and traveled 21 miles to Charlotte, Michigan, where it broke down and was towed to a repair facility near Dimondale, Michigan.[2] The truck driver checked into a motel in Dimondale, where he stayed for 2 nights while a drive shaft, brake lines, and antilock brake system valves on the truck were replaced. On Thursday morning, March 25, the driver checked out of the motel and, according to the manager of the repair shop, stayed in or near the shop's waiting room until repair work was completed, departing about 3:45 p.m.

[1] Unless otherwise noted, times are given in central daylight time.

[2] Dimondale is a southwest suburb of Lansing, Michigan.

Based on the geographic locations of the cellular towers used by the truck driver's telephone,[3] the driver traveled south on Interstate 69 (I-69), stopping about 7:00 p.m. for approximately 1 hour 22 minutes[4] between Fort Wayne and Muncie, Indiana. He then drove until approximately 11:15 p.m.,[5] to a location where he remained until about 4:00 a.m., Friday, March 26. Both of these stopping locations can be associated with nearby truck stop rest areas.[6]

Before sunrise on March 26, 2010,[7] the truck was traveling southbound on I-65 through rural western Kentucky. (Figure 1, below, shows the accident location.) It had rained earlier in the night, and the pavement was wet; however, local weather records show no precipitation in the hours immediately preceding the accident, and witness and police records indicate no standing water in the area of the accident.[8] Weather data obtained from the Bowling Green Warren County Airport (about 30 miles from the accident site) indicated that, for March 26, 2010, at 6:15 a.m., the temperature was 35° F, and the wind was 5–13 mph.

[3] The frequency of the truck driver's cellular telephone use made it possible to determine periods of time when the driver remained in the same location.

[4] Between 6:56 p.m. and 8:18 p.m., the driver's cellular telephone used the same Huntington County cellular tower location.

[5] Between 11:15 p.m. and 12:45 a.m., the driver's telephone received 10 incoming text and data messages relayed through the same cellular tower. There was no outgoing activity until a voice call on the same tower at 4:28 a.m.

[6] For a more detailed account of trip activity based on cellular carrier records, see section 1.5.3, "Work/Rest History," of this report.

[7] Sunrise at Munfordville (Hart County), Kentucky, on the morning of the accident took place at 5:38 a.m. local time.

[8] Because of the grade of road, the road design near the accident would not have held standing water.

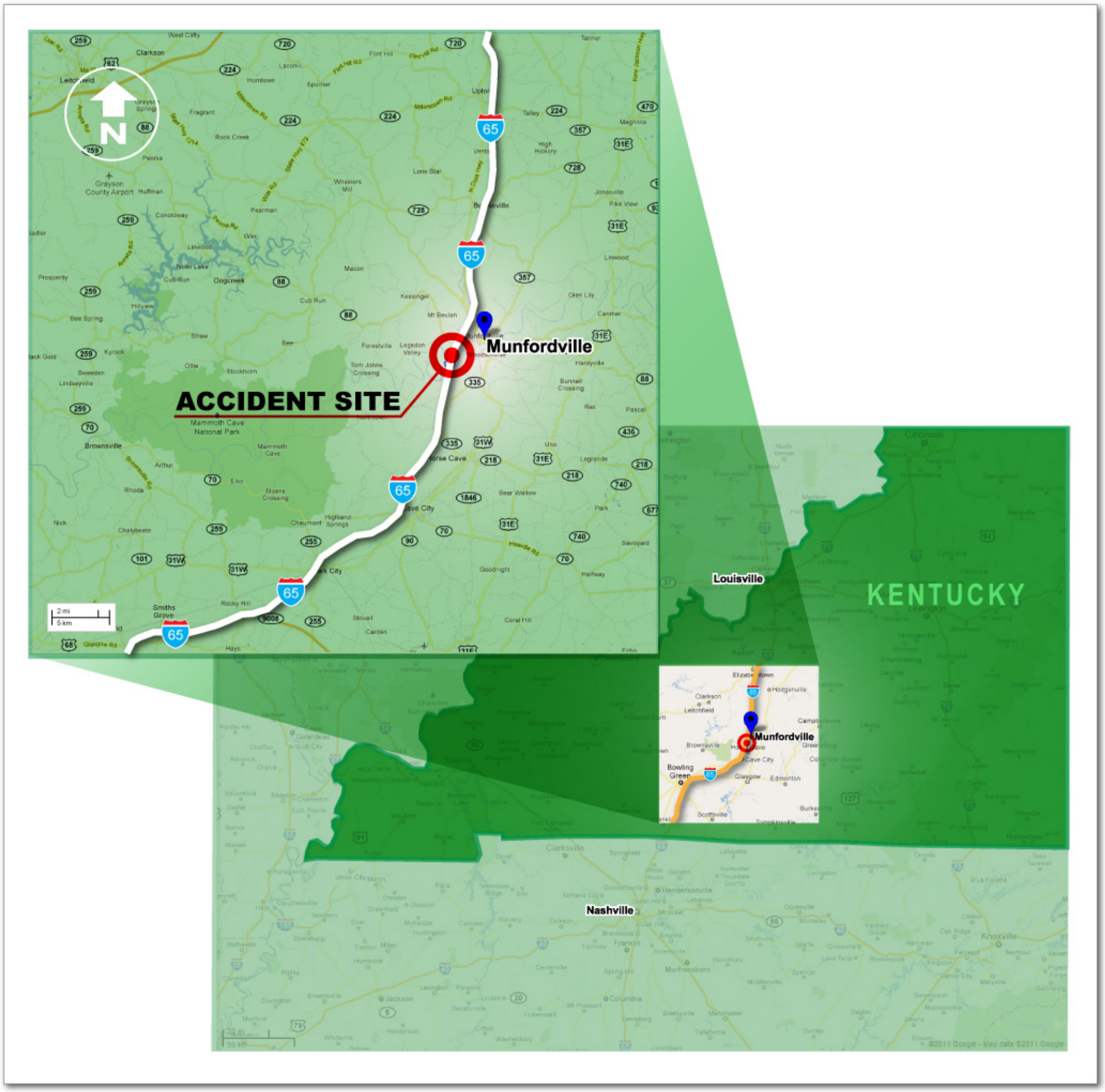


Figure 1. Accident location map.

1.1.3 Accident Sequence

Approximately 5:14 a.m., on March 26, the truck was traveling southbound at highway speed on I-65, which had a posted speed of 70 mph.[9] After cresting a hill, the truck was traveling on a 2.6-percent downward grade[10] along a straight roadway near milepost 61.5 when it departed the roadway to the left, went over a rumble strip and off the paved surface, and entered a 60-foot-wide earthen median that separated the north and south travel lanes. Tire tracks in the median indicated that the truck departed the highway at about a 5° angle. At a point

[9] The estimated truck speed was based on a calculated range that placed it near the speed limit.

[10] It was 3,900 feet, or approximately .75 mile, from the crest of the vertical curve to the accident site.

approximately 96 feet after the truck left the roadway, evidence of braking began,[11] and it continued for 173 feet as the vehicle traveled across the depressed median. After crossing the median, the truck struck a four-strand, high-tension cable barrier located 8 feet from the edge line markings of the northbound travel lanes. One of the six high-tension cable barrier posts that the truck struck punctured the vehicle's right saddle fuel tank, resulting in a 2-foot-long tear, which leaked fuel as the truck exited the median. The truck overrode the barrier and entered the northbound lanes at approximately a 15° angle. (Figures 2 and 3 show the truck's median crossover path.)

Figure 2. Looking southbound along the truck's cross-median path.

[11] Brake marks in the median were associated with the rear axle of the trailer. Considering the length of the combination vehicle, the front of the tractor would have traveled approximately 170 feet from the rumble strips on the left side of the travel lane to where evidence of braking began.

Figure 3. Truck's oncoming crossover path, viewed from the edge of the northbound passing lane.

At that time, a 2000 Dodge 15-passenger van, containing a driver and 11 passengers, which was traveling northbound in the left (passing) lane, struck the truck between the right fuel tank and the right drive axle tires. Upon impact with the truck, the van rotated more than 90° clockwise, and its driver side struck the right drive axle tires and right front side of the semitrailer. The 7,700-pound van rotated underneath the 76,660-pound truck-tractor combination unit moving across the travel lanes.

The truck hit a cut rock wall[12] located 26 feet to the right of the travel lanes, causing significant crush to the front driver (left) side of the tractor. The semitrailer overturned onto its right side, blocking the northbound travel lanes and spilling its cargo of brake drum parts out of its roof and side along several hundred feet of a roadside drainage ditch. A postaccident fire engulfed the tractor and semitrailer. (See figure 4.)

[12] The wall was not a constructed feature; it was rock face left standing by the roadside when the solid stone of the location's terrain was cut through during the building of the highway.

Figure 4. Postaccident scene.

As the truck traveled off the edge of the paved shoulder of the northbound traffic lanes and into the 8-foot-wide drainage ditch, the van spun clockwise away from the larger vehicle and struck the cut rock wall south of the truck. The rear left corner of the van hit the cut rock wall 87 feet southeast from the point of its initial impact with the truck. When the van struck the cut rock wall, it was redirected back into the travel lanes, where it came to rest facing south/southwest in the northbound travel lanes 107 feet south from the location of its impact with the rock wall. (For a representation of the overall accident scene and final rest dispositions of both vehicles, see figure 5.)

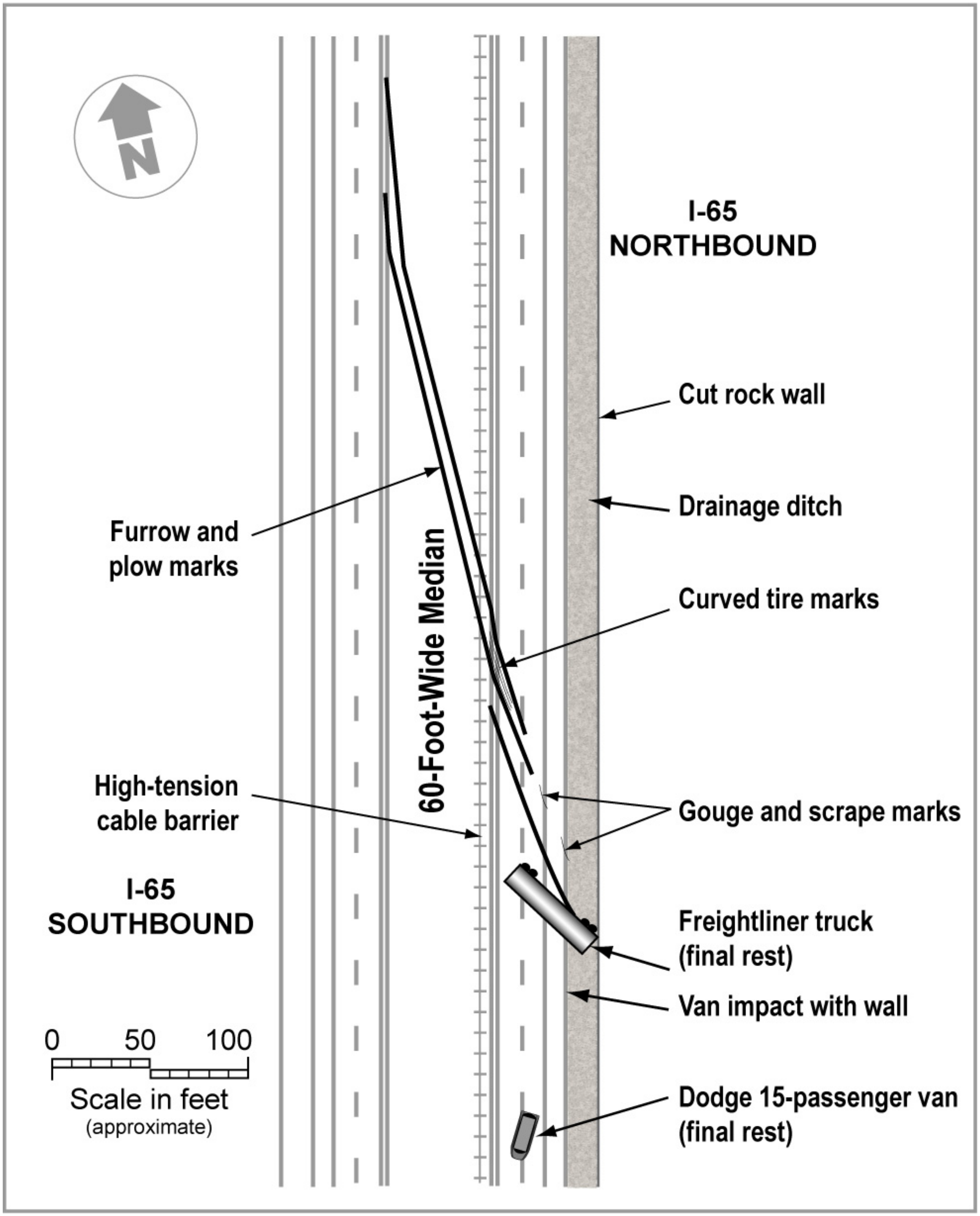


Figure 5. Accident scene diagram.

1.2 Injuries

As a result of the accident, the truck driver, the van driver, and 9 of the 11 van passengers died. According to the autopsy report, the truck driver died due to “multiple injuries and smoke inhalation.” According to the Kentucky state medical examiner and the Hart County coroner, the fatalities in the van were the result of traumatic blunt force injuries to the head, torso, and extremities. (See the table below for injury information.)

Table. Injuries.

Injury Severity[a]	Truck Driver	Van Driver	Van Passengers	Total
Fatal	1	1	9	11
Serious	0	0	0	0
Minor	0	0	2	2
None	0	0	0	0
Total	1	1	11	13

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

The van had three-person bench seating for the second, third, and fourth rows of seats; the fifth row contained four seating positions. The front passenger of the van was ejected. Two more van occupants, who had been seated on the rightmost seats of the third and fourth rows of bench seats, were ejected through the right front door opening. When the van reached its final rest, the adult passenger from the back (fifth) row and the left and center seat adult passengers from the fourth row were located behind the right front bucket seat. None of these passengers were wearing seat belts.

Three children were in the van. A 4-month-old male infant seated behind the driver in a rear-facing child restraint sustained fatal injuries. Two other male children, ages 3 and 5, seated in forward-facing child restraints attached to the third row bench seat in the left and center seat positions, survived with only minor injuries, including seat belt abrasions to their left shoulders.[13] The 5-year-old had a contusion to his forehead and the outer aspects of his left ear. Scans for head and spine injuries were negative for both of the surviving children.

1.3 Survival Factors

A substantial portion of the truck cab was destroyed by impact with the cut rock wall and damage caused by the postaccident fire. The only major remaining components were the frame, drive train, and axles. Due to the fire damage, investigators were unable to determine whether the driver’s seat belt was in use at the time of the accident.

[13] For purposes of this report, the van driver and front passenger seats are considered row 1, followed by bench seat rows 2 through 5. The surviving children were seated in row 3, midway back in the van.

The van sustained significant damage from the impact with the truck and the subsequent impact with the cut rock wall. The collision with the truck was a full frontal impact with underride characteristics. The van body and engine compartment components were initially engaged as they collided with the right side of the truck and were displaced rearward a greater distance than the mainframe structure. The underride impact damage extended vertically from just above the front bumper to the roof. The van's original wheelbase length of 127.3 inches was reduced to 118.5 inches on the driver side and extended to 144.0 inches on the passenger side.

The van's front left bumper was crushed inward approximately 24.0 inches and its hood was torn off. The driver's door was crushed inward and rearward, and the right front door was crushed rearward and nearly separated. Both the left and right A-pillars[14] of the van were crushed rearward and downward during the underride. The right front A-pillar was torn away from the dash and separated from the floor joint by a distance of 68.0 inches. Damage down the left side extended 75.0 inches rearward from the front. Damage to the roof of the van angled back 75.0 inches to the left C-pillar.[15]

The van also struck the cut rock wall, causing damage to the van's left rear side and rear cargo door.[16] The impact damage from striking the wall started at about the height of the wheel well and extended upward, contacting the roof. Damage to the roof extended 36.0 inches along the side and 8.5 inches across the back. The rear cargo door opened during impact and sustained direct damage along its width of 48.5 inches. All the van's windows, including the windshield, were broken during the accident.

The unrestrained van occupants experienced extreme deceleration forces when the van hit the truck, followed by rotational acceleration as the van spun clockwise (rotating more than 90°) before striking the cut rock wall. All 15 seat positions in the van were equipped with either lap belts or lap/shoulder belts. The outboard seat positions for all rows were equipped with lap/shoulder belts.[17] The center positions of each row were equipped with lap-only belts. Examination of the seat positions in the van indicated that eight of the nine adult occupants were unbelted at the time of the accident. Inspection of the belts at both the driver and front passenger seat positions revealed no stretching or abrading of the webbing, and the buckles remained attached to the webbing and not attached to the latch, indicating that these belts were not in use at the time of the accident. The driver and front passenger seating had supplemental restraint systems (air bags) that deployed upon the initial impact.

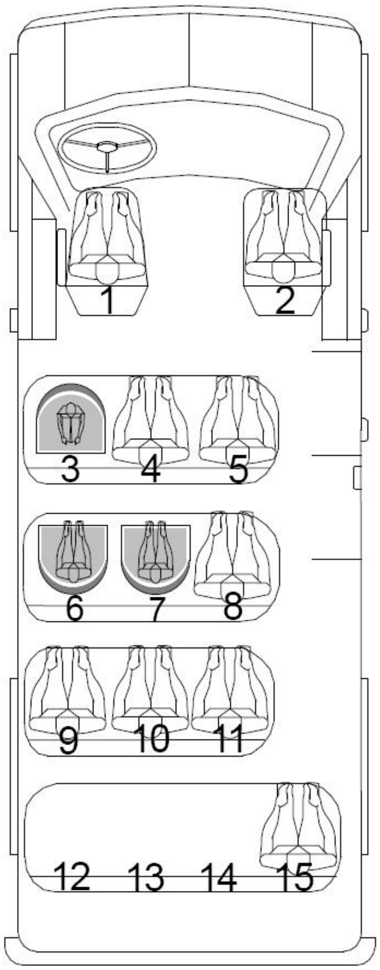
[14] The pillars referenced in this paragraph are the support structures for the vehicle roof; the A-pillars are nearest the front of the vehicle and, moving rearward, the C-pillars are third from the front.

[15] The roof was removed during extrication of the victims.

[16] This lateral damage extended 52.0 inches.

[17] First responders cut the seat belts of those in the outboard seat positions when they removed the roof of the van.

Three passengers were seated in each of rows 2, 3, and 4 of the van, and one passenger was seated in row 5. Three of the passengers were children; they were seated in child safety restraints located in the left position of row 2, and the left and center positions of row 3. One adult, a female seated in the center position of row 2, was wearing a lap belt. An inspection of the center seat lap belt revealed extensive stretching, with marks on the webbing where the latch was positioned. (See figure 6 for more information on the van occupants.)



Seat	Sex	Age	Injury	Eject.	Restraint use
1	M	41	Fatal	N	N
2	M	64	Fatal	Y	N
3	M	4 mos.	Fatal	N	Y
4	F	33	Fatal	N	Y
5	F	40	Fatal	N	N
6	M	3	Minor	N	Y
7	M	5	Minor	N	Y
8	F	33	Fatal	Y	N
9	F	20	Fatal	N	N
10	F	62	Fatal	N	N
11	F	22	Fatal	Y	N
12	[seats unoccupied]				
13					
14					
15	M	22	Fatal	N	N

Figure 6. 15-passenger van occupant information. (Note: Human figure images indicate occupation of a seat; shaded images indicate occupation by a child using a child restraint.)

The infant who died in the accident was in the left outboard position behind the van driver in a 5-point rear-facing Graco infant seat; this seating location was within the intrusion area. The two children who survived (receiving minor injuries) were in forward-facing child restraints in the left and center seat positions of the third row. The 3-year-old boy seated in the left outboard position was in a 5-point Aprica child restraint,[18] which exhibited stress marking to its plastic frame. The 5-year-old boy seated in the center position of row 3 was in a 3-point EvenFlo child restraint,[19] which had an 8-inch crack to its plastic back support. Postaccident examination found both forward-facing child restraints and the rear-facing infant seat securely fastened by seat belts to the bench seat.

1.4 Emergency Response

A northbound commercial truck driver who had been following the 15-passenger van placed the first 911 call at 5:16:29 a.m. This truck driver witnessed the accident and dialed 911 as he stopped his truck short of the postaccident fire. The Kentucky State Police (KSP) dispatch center recorded 911 notification of the accident at 5:17 a.m.[20] The KSP dispatcher called the Hart County dispatcher at 5:19 a.m.[21] The Hart County dispatcher called the Hart County Ambulance Service at 5:20 a.m. and the Munfordville Volunteer Fire Department at 5:21 a.m. The Hart County Ambulance Service, which is staffed 24 hours a day and located 5 miles from the accident site, was the first responder agency to arrive on scene, 9 minutes after dispatch, at 5:29 a.m. A Hart County paramedic assumed incident command on scene[22] and reported to dispatch that the truck-tractor semitrailer was totally engulfed in flames.

The KSP dispatched its first unit at 5:24 a.m., but the unit encountered northbound traffic backed up on I-65, requiring it to take an alternate route; that unit did not arrive until 6:03 a.m. A second KSP unit arrived at 6:04 a.m. Traffic stopped on the interstate due to the accident reached the I-65 Green River Bridge to the south of the accident scene. The restricted apron width of that bridge blocked emergency response travel from the south. The KSP responders turned around and took an alternate route, accessing I-65 north of the accident location and traveling south to the scene using the northbound lanes.

At 5:56 a.m., a second ambulance, with Hart County Office of Emergency Management personnel and a Hart County deputy sheriff, arrived on scene. Munfordville Volunteer Fire Department responders also arrived at 5:56 a.m., followed by Horse Cave Volunteer Fire

[18] The Aprica unit had a manufacture date of "01-03-2002." It carried markings in Japanese with no model or serial number.

[19] The EvenFlo Trooper unit, model OH2154, had been manufactured in 1997 and had no recalls.

[20] According to the KSP dispatch supervisor, 911 calls prompt the dispatcher to gather standard information by asking a series of 12 or more questions. The call is not time-stamped until all the information is typed into the computer-aided dispatch system and the dispatcher presses the "send" key. A call time-stamped 5:17 a.m. would have been placed earlier than that time. A single dispatcher staffs the center during the evening hours (10:00 p.m. to 6:00 a.m.). The dispatcher received more than one notification call concerning this accident.

[21] Investigators synchronized the recorded times from the call centers and all cellular records with U.S. Coordinated Universal Time, as maintained by the National Institute of Standards and Technology and the U.S. Naval Observatory.

[22] The chief of the Munfordville Volunteer Fire Department subsequently assumed the function of incident commander, when he arrived on scene.

Department responders at 5:59 a.m. The Munfordville Volunteer Fire Department, responding to the scene from the north along southbound I-65, was denied ready access to the accident by the median cable barrier. Like the KSP, these responders had to take an alternate route to the scene, accessing I-65 north of the accident and traveling south, using the northbound lanes.

Based on initial scene evaluation, the incident commander requested that dispatch put an air medical service helicopter on standby. That service was later cancelled but then re-requested. Ultimately, an emergency medical services helicopter arrived on scene but did not transport any patients.

At 5:34 a.m., the incident commander requested that the Hart County coroner be sent to the scene. The coroner pronounced the truck driver, the van driver, and nine van passengers dead at the scene. The truck driver was taken to the Urban County Government Center for autopsy. The Hart County Ambulance Service transported the two surviving children to Caverna Memorial Hospital in Horse Cave, Kentucky, where they were treated and released to the custody of a family member.

According to the mass fatality emergency operations plan of the Hart County Coroner's Office, the Kentucky State Medical Examiner's Office should be called to support the local coroner, as it was in this event. The following are the emergency response agencies, organizations, and services that responded to the scene:

- Hart County Ambulance Service
- Hart County Volunteer Fire Department
- Hart County Office of Emergency Management
- Hart County Coroner's Office
- Munfordville Volunteer Fire Department
- Munfordville Police Department
- Horse Cave Police Department
- Kentucky Division of Emergency Management
- Kentucky State Medical Examiner's Office
- Kentucky State Police
- Kentucky Department of Natural Resources
- Kentucky Department of Transportation
- American Red Cross

The responding agencies held a debriefing and critique of the emergency response on March 30, 2010. At that meeting, they discussed the command structure and its implications for a larger-scale event, the need for first responders to preserve scene evidence, the management of traffic with detour routes and signs, and the need for first responders to coordinate with dispatch if they encounter problems when trying to reach the scene.

1.5 Truck Driver

1.5.1 Licensing and Driving History

The truck driver possessed an Alabama class "A" commercial driver's license (CDL)[23] issued in March 2007 and expiring in March 2011. He was required to use corrective lenses. He held a current medical certificate, issued on January 18, 2010, and expiring in January 2012.

Alabama Department of Public Safety records indicated that the driver had one traffic citation in the past year. That citation resulted in a November 2009 conviction for failing to stop at a stop sign; the incident occurred while the driver was operating a privately owned vehicle. His driving record indicated that he had a traffic accident in a commercial motor vehicle (CMV) on August 1, 2008.[24] The driver's public safety history showed a number of traffic offenses and license suspensions that took place when the driver was in his 20s and 30s, including having his license revoked from 1986–1988.[25] He was convicted of speeding 15 mph or more above the speed limit in a CMV in 1999.

According to the motor carrier, Hester, Inc., the driver had been employed by Hester less than 3 months (since January 18, 2010). His job application stated that a company in Birmingham, Alabama, had employed him for 4 months in 2009. On his job application with Hester, he indicated that his reason for leaving the Birmingham company was an accident.[26] The driver listed four other places of employment as a truck driver in the previous 10 years; for 2006–2008, he listed his position as "driving instructor."

The employment application the accident driver provided to Hester stated that he had 21 years of experience driving CMVs. According to the Hester company president, the carrier did not have a formal training program; however, he indicated that company drivers in the office on Fridays were to watch short training videos provided by the company's insurance carrier.

The company communicated with its drivers through the drivers' personal cellular telephones. According to the driver's wife, her husband's telephone was a Samsung brand with a sliding face cover that revealed the keyboard. She said that the driver had a headset that allowed him to use the Bluetooth hands-free capability of the telephone, and the driver typically used his telephone in that manner while driving. His telephone did not have voice dial capability.

[23] A class "A" CDL permits the operation of a vehicle with a gross combination vehicle weight rating of 26,001 pounds or more, provided the gross vehicle weight rating (GVWR) of the vehicle(s) being towed is in excess of 10,000 pounds. Holders of a class "A" CDL may operate all vehicles within groups "B" and "C," provided they have the appropriate endorsements. The driver also held a class "V" Alabama driver's license endorsement, which indicated he was authorized to operate motorized watercraft.

[24] This accident occurred in Marshall County, Alabama. Information the driver provided on a job application indicated that the event involved no injuries.

[25] His driving history since 2000 showed that the driver was convicted of operating an unsafe CMV without proper documents on January 11, 2000; operating an overweight CMV on August 8, 2000; operating an unsafe CMV on May 3, 2001; and having an improper tag for a private vehicle on January 12, 2003. The record showed no offenses between 2003 and 2009. (The dates listed are the offense dates, not the conviction dates.)

[26] This accident did not appear on the driver's official driving record. According to the job application account, a car hit the rear of the driver's trailer in Oglethorpe, Georgia, on September 24, 2009. The accident involved no injuries.

1.5.2 Medical History, Autopsy, and Toxicology

The 45-year-old truck driver was 5 feet 10 inches tall and weighed 221 pounds.[27] The driver's most recent medical examination report for commercial driver fitness determination, dated January 18, 2010, reported "no" to all conditions under "Health History," including "any illness or injury in the last 5 years;" "muscular disease;" "lung disease, emphysema, asthma, chronic bronchitis;" "digestive problems;" "spinal injury or disease;" and "chronic low back pain." Under "list all medications," he noted "none." The driver's medical records were unremarkable, with the exception of a recent history of low back pain. In the months preceding the accident, the driver had four medical visits and a magnetic resonance imaging study for symptoms of back pain radiating into his lower right leg.[28] Medical records indicate that he had prescriptions for a non-narcotic pain reliever (tramadol) and medications for nausea and diarrhea.[29]

Postaccident, the KSP conducted toxicology testing of the driver covering 10 types of prohibited substances; the report was negative.[30] At the National Transportation Safety Board's (NTSB) request, the Civil Aerospace Medical Institute conducted a more extensive forensic toxicology analysis, which detected no drugs or alcohol. The driver's wife told investigators that the driver smoked cigarettes and had recently been diagnosed with emphysema.[31] He had two bulging discs that caused lower leg pain, for which he took Advil and tramadol. According to his wife, the driver had tramadol with him in the truck, but due to the postaccident fire, this could not be confirmed. The driver was an independent wrestler and had competed on each of the three weekends preceding the accident, even though the activity aggravated his leg pain. According to his wife, he did not drink alcohol, take illicit drugs, or use herbal supplements. She said he did not have trouble sleeping, he did not snore, and he typically arose about 5:00 a.m.

1.5.3 Work/Rest History

The accident truck driver left his home in Nauvoo, Alabama, on Monday morning, March 22, 2010, and drove in his personal vehicle to the Hester facility in Fayette, Alabama, to pick up his truck for a delivery north.[32] On March 23, he picked up a load of brake drum parts in Sunfield, Michigan,[33] for transport to Cullman, Alabama, a one-way trip distance of approximately 682 miles.[34] The truck driver drove 21 miles to Charlotte, Michigan, where the

[27] The driver's height and weight indicate a body mass index (BMI) of 31.7. A BMI above 30 is considered obese. The Federal Motor Carrier Safety Administration (FMCSA) Medical Expert Panel and the Motor Carrier Safety Advisory Committee (MCSAC) were originally scheduled to meet on August 29, 2011, to discuss BMI markers for medical evaluation of sleep disorders. This meeting has been rescheduled to October 2011.

[28] The visits took place on August 15, 2009; September 12, 2009; December 10, 2009; and January 11, 2010.

[29] Pharmacy records showed that these prescriptions were filled on January 15, 2010.

[30] Test results were negative for amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine/metabolites, methadone/metabolites, opiates, oxycodone/metabolites, phencyclidine, and alcohol.

[31] Physician's records dated December 10, 2009, noted tobacco abuse with radiographic findings consistent with emphysematous lung disease.

[32] The distance from the driver's home to the Hester facility is about 40 miles.

[33] Sunfield is approximately 30 miles west of Lansing, Michigan.

[34] The total trip distance from Fayette, Alabama, to Sunfield, Michigan, to Cullman, Alabama, is 1,459 miles.

driveshaft on the tractor failed, and he had the vehicle towed to Dimondale, Michigan. The driver checked into a motel at 4:31 p.m. on March 23 and checked out at 8:48 a.m. on March 24. He checked back into that same motel at 12:44 p.m. on March 24 and checked out again at 8:50 a.m. on March 25. The driver had the opportunity to obtain a full night's sleep during those 2 nights.

The foreman at the repair facility reported that the driver stayed in or near the garage waiting area for most of the 2 days while the vehicle was being repaired. While he was waiting at the garage for the completion of the repairs, the driver's work status was on duty, not driving.

For March 25, the available recorded information concerning the driver's activities indicates that he made a cellular telephone call at 7:29 a.m., and he checked out of his motel at 8:50 a.m. While the driver waited at the repair facility that day, cellular records show three time periods during which his cellular telephone was inactive; the durations of those periods were 37, 31, and 45 minutes. Recorded information also shows that he purchased fuel at 3:36 p.m.

Receipts from the repair facility and an interview with the service manager indicated that the truck driver departed the garage at 3:45 p.m. on March 25. He drove on I-69 until 6:56 p.m. to a location between Fort Wayne and Muncie, Indiana; cellular telephone records then indicate that the driver's telephone remained in the vicinity of the same cellular tower for about 1 hour 22 minutes. The driver's activity for the period is unknown, although the location is near a truck stop/restaurant. Approximately 8:15 p.m., the driver resumed travel south, driving until 11:15 p.m., when he apparently stopped. Telephone carrier records show that the driver's telephone received 10 incoming text and data messages between 11:15 p.m. and 12:45 a.m., all handled by the same cellular tower. A truck stop was in the area covered by that cellular tower.

The next activity on the driver's telephone took place at 4:28 a.m. on March 26, on a cellular tower approximately 45 miles south of the overnight stop (as identified by the cellular tower that handled the text messages earlier in the night). Factoring in the drive time from the location of the 11:15 p.m. tower and the time necessary for post- and pretrip vehicle inspections, the driver had a maximum of 4 hours 15 minutes (about 11:15 p.m.–3:30 a.m.) available in which to sleep in the night before the accident.[35] (See figure 7 for more information on the driver's work/rest history.)

[35] This estimate of the available sleep time allows approximately 30 minutes for the driver to awaken and complete his pretrip inspection. An interview with the driver's wife indicated that he did not typically eat when he first arose in the morning. It is possible that if the driver only got coffee, lit a cigarette, and completed a limited inspection, he could have slept as long as 4 hours 30 minutes.

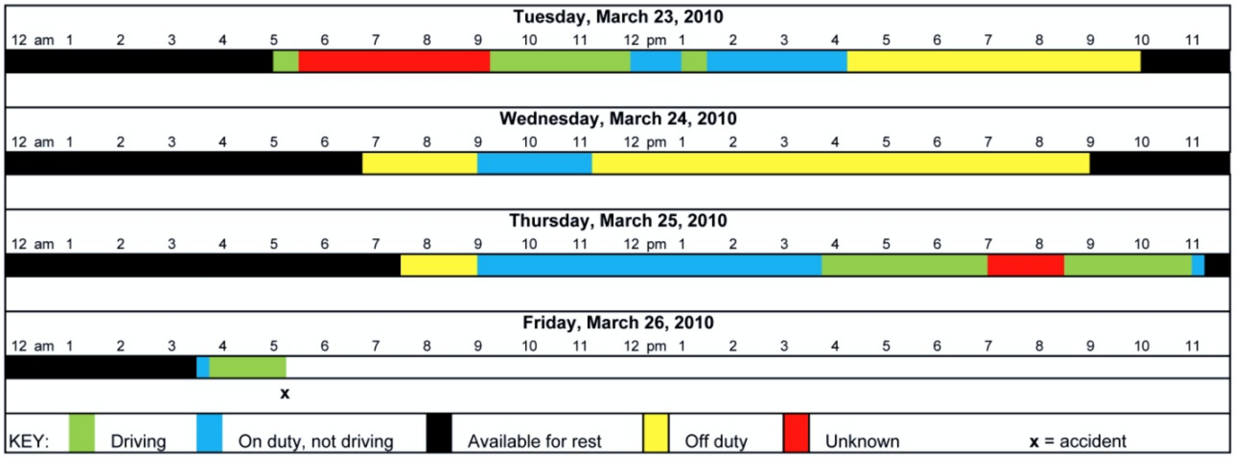


Figure 7. Truck driver's 72-hour work/rest history. [Note: Investigators were unable to confirm the driver's off-duty activity.]

Based on records from the driver's cellular telephone carrier and estimates of driving activity, the driver used his telephone to make 161 telephone connections (8 data, 101 text, and 52 voice) in the 24 hours preceding the accident. Of these connections, investigators determined that about one-third of the text activity[36] and about two-thirds of the voice activity occurred during times when the driver's vehicle was moving.[37] In total, 69 connections occurred while the truck driver was in "driving" status.

On the morning of the accident, March 26, as the driver continued to drive, he made a cellular telephone call at 4:28 a.m., he received a call at 4:51 a.m., and he made calls at 5:03 a.m., 5:07 a.m., and 5:14 a.m.[38] His telephone also received calls at 5:15 a.m., 5:16 a.m., 5:17 a.m., 5:19 a.m., 5:26 a.m., and 5:31 a.m.; all these calls were from a friend the driver had called at 5:14 a.m.

The driver's friend told investigators that the driver called him at 5:14 a.m. on March 26. The friend recalled that he had a short conversation with the driver about what he was doing and weekend plans. He reported that the 5:14 a.m. call ended abruptly when the telephone "went dead." According to the truck driver's cellular provider, the network connected the two telephones and recorded the location of the cellular towers involved; the call duration was 00:00 minute. Also according to the cellular provider for the driver's telephone, a call duration of 00:00 minute means that the 5:14 a.m. call lasted less than 1 second.[39] According to the cellular

[36] Michigan, Kentucky, and Indiana currently ban texting while driving by all drivers; none of the bans were in effect at the time of the accident.

[37] For investigators to consider the cellular activity to have taken place while the driver was driving, the cellular connection had to occur between 3:45 p.m. and 7:00 p.m. on March 25; 8:30 p.m. and 11:00 p.m. on March 25; and 3:30 a.m. and 5:14 a.m. on March 26. Some, but not all, calls placed from a vehicle in motion show up in cellular telephone records as passing along a sequence of cellular towers.

[38] Investigators could not determine whether the driver was using handheld or hands-free capability when he placed these calls.

[39] Investigators obtained a written explanation of the cellular provider's network timing system.

provider of the friend's telephone, the call duration was 3 seconds.[40] After the 5:14 a.m. call was disconnected, the friend made six calls to the driver's telephone in the next 16 minutes, none of which was answered.

1.6 Vehicles

1.6.1 Truck-Tractor Semitrailer

General. The truck consisted of a 1999 Freightliner truck-tractor in combination with a 1998 Strick Corporation 53-foot-long van semitrailer. The vehicle was equipped with a DDEC III engine control module (ECM).[41]

The 1999 Freightliner truck-tractor was equipped with a Rockwell/Meritor RMX10-155C 10-speed manual transmission and a Detroit Diesel Series 60 430-hp diesel engine. The engine had a governed engine speed of 1,800 rpm. Given the rear drive axle ratio of 3.58:1 and the 19-inch rolling radius of the drive tires on the truck, the maximum speed of the vehicle (in 10th gear at 1,800 rpm) was 77.9 mph.

The examination of the truck-tractor's transmission was inconclusive for evidence of gear position at the time of the accident. The attachment plate for the gearshift lever had broken away from the transmission during the collision sequence, and there was evidence of misalignment of the numerous gear sets within the transmission.

According to the owner of Hester, the carrier's entire fleet of trucks was speed-limited, by means of ECM programming, to 65 mph if the driver used the cruise control feature and to 70 mph if the driver used the accelerator pedal. The owner and head mechanic of the service garage that worked on Hester's fleet confirmed that this was the standard ECM programming for Hester vehicles. The governed speed reflects the highest speed possible on level grades; faster speeds could be achieved on downhill grades, due to the effect of gravity.

Truck Vehicle Systems. The impacts and the postaccident fire destroyed much of the truck. The only major remaining components were the frame, drive train, and axles.

Damage to the vehicle from the collision and the postaccident fire prevented investigators from obtaining an accurate weight directly. Based on copies of the shipping documents, the weight of the truck prior to loading was 32,120 pounds. Following the loading of the cargo of brake drums, the gross weight of the vehicle was 76,660 pounds. A combination unit configured and loaded similarly to the accident truck would typically have a front axle weight between 10,500 and 11,500 pounds. Distributing the remaining vehicle weight evenly across the remaining axles would result in about 16,275–16,525 pounds on each of axles 2 through 5.

[40] The friend's cellular provider indicated that the slightly longer call duration from the friend's telephone was due to system disconnect processing.

[41] An ECM captures some vehicle information, but it is not intended to capture the full set of information available from an event data recorder.

Due to the extent of the fire damage to the tires, only the left inside and outside tires remained on axle 3; both tires sustained some fire damage and were deflated. All eight tires on axles 4 and 5 survived the fire and remained inflated. Investigators visually examined the tires, and all of those surviving appeared to have adequate tread depth.

At the NTSB's request and under NTSB supervision, an engineer from TRW Automotive, the manufacturer of the truck's steering gear and a party to the investigation, examined the steering components on March 31, 2010.[42] According to the TRW report, a postaccident internal inspection of the steering gear revealed that the center tooth on the pinion, or output, shaft had an overload torsional shear fracture. The input shaft on the worm screw assembly had corresponding damage to the right-hand side of the helix. Both damaged areas indicated that the wheels were pointing straight ahead on the tractor when the steering gear sustained impact damage. No preaccident defects were noted.

In the postaccident inspection of the semitrailer brakes, investigators used an auxiliary air compressor (100 pounds per square inch pressure) to release the emergency/parking brakes and apply the service brakes. All four semitrailer brakes were equipped with type 30/30 long-stroke clamp-type brake chambers. The inspection showed that both brakes on axle 4 had pushrod strokes of 1.5 inches, and both brakes on axle 5 had pushrod strokes of 2 inches. The adjustment limit for type 30/30 long-stroke brake chambers is 2.5 inches, so the pushrod stroke measurements for these brakes were within the adjustment limits.[43] Postaccident inspection of the brakes indicated that all 10 brakes on the 5 axles of the truck had brake lining thicknesses that exceeded the required .25-inch minimum thickness standard.[44]

Recent Repairs. On January 16, 2010, major repairs were performed on the truck, including swapping the engine from another Hester unit into the accident vehicle, replacing both steer axle tires, recapping all eight drive tires, and repairing four of the six brakes. Following the repairs, the truck underwent an annual vehicle inspection later the same day to obtain an inspection sticker, as required for highway travel; no defects were noted on the inspection form.[45]

During the repair work conducted on March 23–24, 2010, the truck's driveline between both differentials was replaced, as well as the rear antilock braking system valve.

[42] A TRW Automotive Steering Gear Analysis Report was placed in the docket for this investigation.

[43] See 49 CFR 396.17(c), appendix G, and the Commercial Vehicle Safety Alliance *North American Standard Vehicle Inspection Guide*.

[44] See 49 CFR 393.47(d)(1)(2).

[45] Title 49 CFR 396.17 requires commercial vehicles to receive annual inspections using criteria set forth in appendix G of subchapter B of the *Federal Motor Carrier Safety Regulations* (FMCSRs). Under 49 CFR 396.23(b)(1), a motor carrier may meet the regulatory inspection requirements if the vehicle is subject to a mandatory state inspection program. Alabama's state inspection program qualifies under this provision.

1.6.2 15-Passenger Van

General. The second vehicle involved in this accident was a 2000 Dodge 15-passenger van. Immediately before the accident, the van was northbound on I-65 traveling up a 2–3 percent grade while loaded with 12 people. (Damage to the van was discussed earlier in the report; see section 1.3, "Survival Factors.") A commercial truck driver said he was driving a heavily loaded truck-tractor semitrailer traveling 55–60 mph in the right lane northbound on I-65 when the van passed him in the left lane about 20–30 seconds before the accident.

Seat Belt Law. Kentucky's law on occupant protection restraints is Kentucky Revised Statute (KRS) 189.125—*Requirements of use of seat belts, child restraint systems, and child booster seats*. Effective July 12, 2006, it became a primary enforcement law, meaning that law enforcement officers have the authority to stop a vehicle solely for an occupant restraint violation.[46] The law applies only to vehicles designed to carry 10 or fewer passengers.[47]

The NTSB has issued more than 150 recommendations on seat belts for highway vehicles since 1968, when it issued its first, calling for the study of the need for seat belts on buses. The Board's seat belt recommendations have covered a variety of seat belt issues, including requirements for the installation of seat belts, mandatory seat belt laws, requirements for seat belts, improvements in seat belt technology, child restraints, seat belt education campaigns, and seat belt use enforcement. The most recent recommendation regarding seat belts and 15-passenger vans was issued in 2003 as a result of the NTSB's investigation of two 15-passenger van accidents.[48] Safety Recommendation H-03-15 to the National Highway Traffic Safety Administration (NHTSA) read as follows:

> Include 12- and 15-passenger vans in your upcoming rulemaking that will require lap/shoulder belts at all center seats. (H-03-15)

The status of this recommendation is "Closed—Acceptable Action."

[46] During 2005–2007, Kentucky participated in a demonstration program to increase seat belt use. During that period, Kentucky transitioned from having secondary to primary seat belt laws. Seat belt use in Kentucky increased from 67 percent under secondary enforcement to 76 percent as a primary enforcement state. See R.D. Blomberg, F.D. Thomas, and A.M. Cleven, *Innovative Seat Belt Demonstration Programs in Kentucky, Mississippi, North Dakota, and Wyoming*, Report NHTSA DOT HS 811 080 (Washington, DC: National Highway Transportation Safety Administration, March 2009).

[47] Specifically, the law defines a motor vehicle as "a vehicle designed to carry ten (10) or fewer passengers and used for the transportation of persons (excluding motorcycles, motor-driven cycles, and farm trucks weighing less than one ton)."

[48] *15-Passenger Van Single-Vehicle Rollover Accidents, Henrietta, Texas, May 8, 2001, and Randleman, North Carolina, July 1, 2001*, Highway Accident Report NTSB/HAR-03/03 (Washington, DC: National Transportation Safety Board, 2003).

1.7 Highway

1.7.1 General

I-65 is functionally classified as a principal rural arterial controlled-access highway, serving as a major north-south transportation route from Mobile, Alabama, on the Gulf Coast through Tennessee, Kentucky, and Indiana. The area between Bowling Green and Louisville, Kentucky, along I-65 has generally rolling terrain, and the highway goes through excavated cut slopes with many changes in the vertical and horizontal alignment. The accident occurred along this section of I-65 in the northbound travel lanes at mile marker 61.5. The site is identified locally as south of Munfordville and north of Horse Cave, Kentucky.

In the area of the accident, I-65 is a four-lane highway separated by a 60-foot-wide depressed earthen median that has a 1:4 traversable slope.[49] The median is lowest at its center, where it is approximately 4 feet below the paved travel lanes.[50] The dual 12-foot-wide travel lanes in each direction are separated by dashed, white pavement stripes. The 11-foot-wide, right-side shoulders are delineated from the travel lanes by solid, white pavement stripes. The left-side shoulders, 4 feet wide on the northbound side and 3.5 feet wide on the southbound side, are delineated from the travel lanes by yellow pavement stripes. Rumble strips are located on the shoulders on both sides of the travel lanes. There was no roadside lighting in the vicinity of the accident site.

In the immediate vicinity of the accident, the interstate cuts through rock on both sides of the road. To the right of the northbound right-side lane shoulder, there is a downward-sloping drainage ditch adjacent to the cut rock wall, which is approximately 26 feet from the travel lane. Eight feet to the left of the northbound left-side lane is a longitudinal high-tension median cable barrier.[51] (See figure 8.) The alignment of the southbound travel lanes is straight for approximately 700 feet approaching the accident location on a slight downhill grade. The crest of the downhill grade is 3,940 feet north of the point of the accident truck's departure from the road; for 640 feet before this point, the southbound roadway has a 2.6-percent downgrade, prior to that, the downgrade is approximately 1.9 percent.

[49] A 1:4 slope means that for every 4 feet of horizontal distance, the elevation drops 1 foot. In the sloping areas adjacent to both the north and south shoulders, the median has a 1:4 profile. The central 30 feet of the median leveled to a 1:12 slope.

[50] From the median center, a 15-foot width distance to either side is on a 1:12 slope, resulting in a vertical drop of 1.25 feet. The elevation then transitions to a 1:4 slope for a distance of 9 feet, resulting in a vertical drop of 2.25 feet. The elevation then transitions over a distance of 6 feet from a 4.17-percent cross slope to the level apron of the highway. This configuration yields a total vertical drop from the highway to the center of the median of approximately 4 feet.

[51] The barrier system will be discussed in detail in section 1.7.6, "Median Cable Barrier System on I-65."

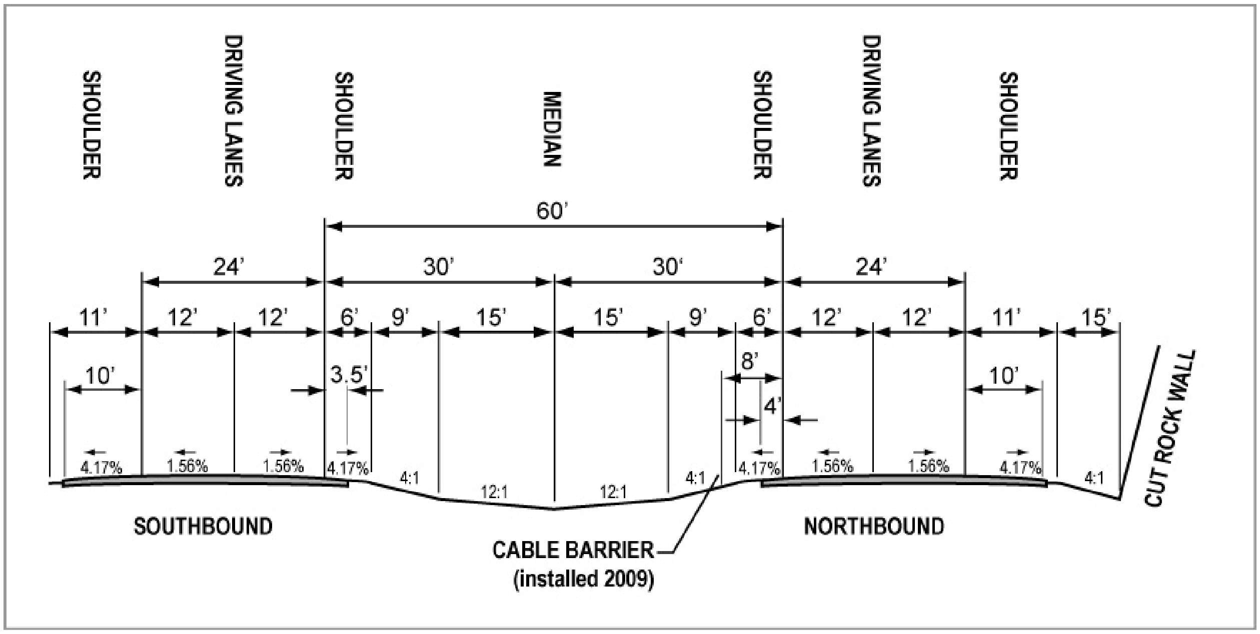


Figure 8. Topography of the I-65 roadway and median.

1.7.2 Traffic Metrics

The average daily traffic (ADT) count for I-65 in 2008 was 36,800 vehicles per day. The Kentucky Transportation Cabinet (KYTC) indicated that large truck traffic accounted for about 35 percent of the total traffic along I-65 in the vicinity of the accident.[52]

1.7.3 Highway Speed

The design speed and the speed limit designation for I-65 is 70 mph. A speed survey conducted by the KYTC in July 2007 indicated that the 85th percentile speed for cars was 76.0 mph; the 50th percentile speed was 71.9 mph. The 85th percentile speed for trucks was 70.0 mph, and the 50th percentile speed was 66.7 mph.

1.7.4 Accident History

Kentucky's overall fatal accident rate for 2008, considering both urban and rural travel routes, was 1.74 fatalities per 100 million vehicle miles traveled; this compares to a national average of 1.25 fatalities per 100 million vehicle miles traveled.

[52] "Large truck" is defined as a truck with a GVWR of greater than 10,000 pounds.

From 2003–2010,[53] along I-65 between mileposts 0.0 and 123.9, a total of 50 median crossover crashes occurred, resulting in 37 fatalities and 108 injuries. Accident records for the 10.5-mile segment of I-65 that includes the accident location[54] for a similar time frame showed 19 cross-median crashes, including 4 fatal cross-median crashes.[55] In the same 10.5-mile section, the crash rates averaged 0.49 cross-median crashes per mile per year and 0.37 fatal cross-median crashes per mile per year. The median cable barrier was installed in May 2009. This accident was the first cross-median crash to occur in the 10-month period since the installation of the cable barrier on this highway segment.

About 2 years before this accident, on March 19, 2008, at about mile marker 61 on I-65 (a location 0.06 mile from this accident site), a pickup truck crossed the median and had a head-on collision with a van and a secondary impact with a truck-tractor semitrailer, which resulted in five fatalities.

1.7.5 Physical Evidence

The physical evidence at the accident scene indicated that the southbound truck departed the left shoulder at approximately a 5° angle,[56] traveled 269 feet across the median, and entered the northbound traffic lanes at approximately a 15° angle. As shown in figure 9 below, investigators found evidence of braking 96 feet from the point of departure from the roadway[57] but no evidence of steering input.[58] The roadway prior to the point of departure was inspected for evidence of tire failure or mechanical disablement; none was found. No witnesses mentioned any maneuvering by the truck that would have resulted in a loss of lateral stability, and investigators found no evidence of evasive maneuver on the part of the driver.

Road markings indicated the location where the truck left the median and entered the northbound travel lanes. (Damage to the median barrier system is discussed in the next section.) Deep gouging appeared on the roadway at the accident location. Investigators found evidence of paint transfer between the vehicles and from the vehicles to the cut rock wall.

[53] The period measured was from March 4, 2003, to March 26, 2010.

[54] The segment measured was between mileposts 52.4 and 62.9.

[55] Accident counts reflect both north- and southbound travel.

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

[57] Braking is indicated by the deeper and more distinct tire tracks through the soft earth and by the pieces of mud and turf thrown up from the tracks.

[58] The sides of the tire tracks in the earthen median were sharp and vertical, with clear raised areas between the tracks from the dual tires; this indicates that no steering was taking place when the tracks were made.

Figure 9. View looking north of truck tracks across the median, showing furrows from brake application.

1.7.6 Median Cable Barrier System on I-65

A longitudinal high-tension cable barrier system was installed 8 feet to the left of the northbound travel lanes in the median of I-65; there was no barrier system adjacent to the southbound lanes. The cross-slope break[59] began 6 feet from the roadway edge; the cable barrier was 2 feet into the 1:4 slope. The proprietary cable barrier system, from Gibraltar Cable Barrier Systems, L.P. (Gibraltar), was a four-cable design mounted on 42-inch posts spaced 10 feet apart. The posts, which had metal sleeves installed in concrete foundations,[60] were placed on alternating sides of the four high-tension cables, which were attached using cable link attachments and locking plates.[61] (See figures 10 and 11 for diagrams showing the general design of the four-cable barrier system and a cross-section view of a standard post.)

[59] "Cross-slope break" is the location of a change in the relative steepness of the terrain, usually found at the edge of the paved roadway or where the roadway meets the shoulder.

[60] The posts were specified to be socketed versions, with caps fabricated from material meeting ASTM A30 or higher quality steel and galvanized to ASTM A123 after fabrication.

[61] The 3/4-inch cables were constructed of 3x7 wire rope (3 wires of 7 strands each) with a specified breaking strength minimum of 39,000 pounds and meeting American Association of State Highway and Transportation Officials (AASHTO) M30 type 1 class A coating standards.

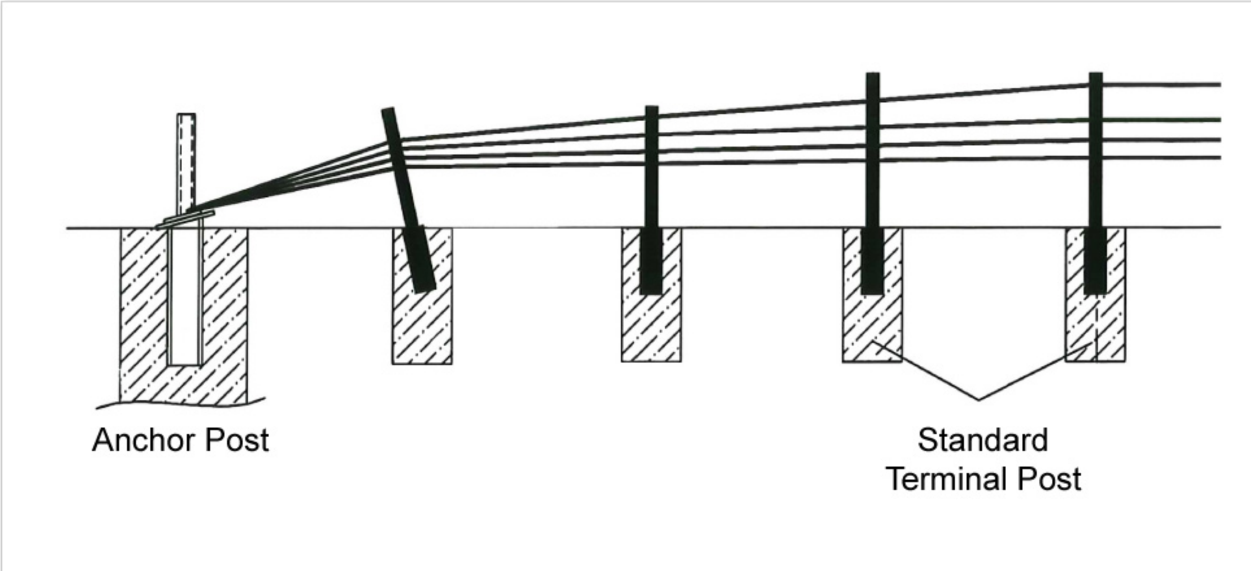


Figure 10. Type of four-cable barrier system used near the accident site.

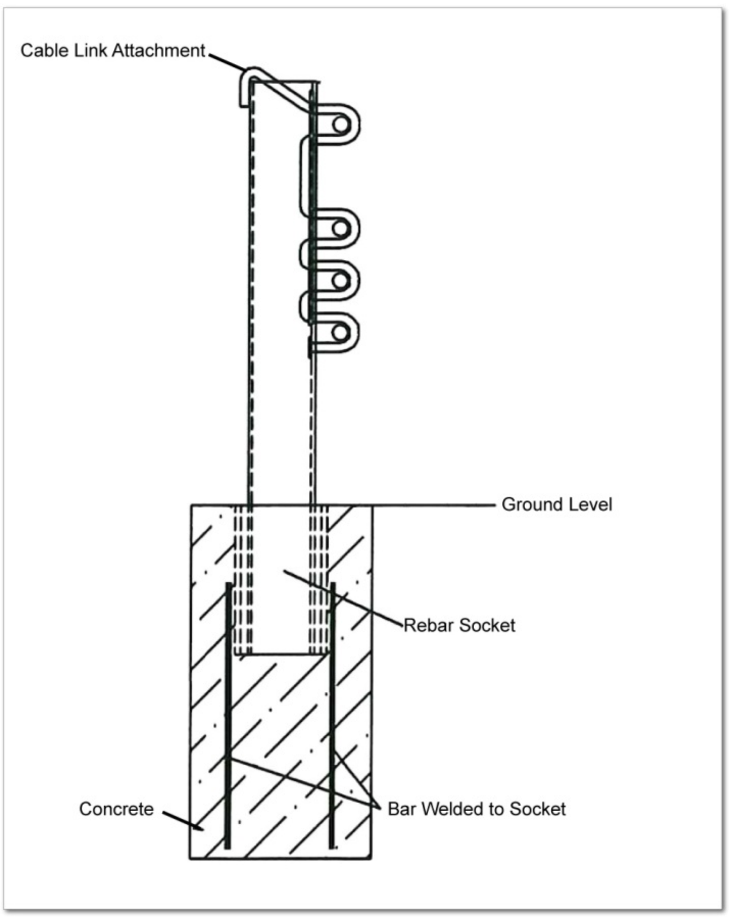


Figure 11. Cross-section of a standard post for a four-cable barrier system.

Design drawings indicated that posts placed on alternating sides of the cable were to be used in bidirectional traffic flows. If installed for traffic in one direction, the cables were to be placed on the traffic side of the posts. The I-65 installation used alternating sides of the posts, which could accommodate bidirectional traffic. Cables were mounted at heights of 20, 25, 30, and 39 inches. The cables were fastened to concrete end anchor posts approximately 1.4 miles north and 0.4 mile south of the accident site, for a total length between anchor posts of 1.8 miles (9,504 feet). The concrete end anchor posts measured 2 feet by 6 feet. The barriers had a design deflection distance of 6.8 feet during crash testing, which used 350-foot anchor spacing and 10-foot post spacing.

As the truck exited the median, it struck and overrode the four-strand, high-tension cable barrier, as shown in figure 12, below. The initial impact by the truck was at a post located on the median side of the cables, and six posts in the impact area were bent over. The barrier system had a downward vertical loading from the truck’s overriding it; the truck did not become entangled in the steel cable ropes.

Figure 12. Overridden and damaged cable barrier.

Gibraltar provided investigators with information and photographs of other barrier accidents involving large trucks. In general, the information showed that when the cable engages or captures a large CMV, the cable is heavily loaded, and it stretches or snaps; many more posts are damaged by cable deflection.

High-tension cable systems are designed to deflect when struck by a vehicle.[62] The degree of deflection depends on the type of system, the spacing of the anchorages, and the spacing of the posts. Deflection provided by cable systems allows an errant vehicle to come to a stop over the distance of the deflection, which is a key difference between a flexible and a rigid barrier. This characteristic of cable barrier systems has the advantage of causing less harm to vehicle occupants. Because cable systems are designed to capture or safely redirect the vehicle rather than deflecting it back into traffic, they can also prevent successive accidents. Because cable barrier systems deflect in the direction of impact, their placement with respect to other traffic lanes must accommodate their deflection distance.

1.8 Roadside Safety

1.8.1 Cross-Median Crash Risk

Fatality Analysis Reporting System (FARS)[63] data show that for the recent 5-year period from 2005–2009, there were 6,011 vehicles involved in fatal cross-median crashes on divided interstate highways.[64] A total of 1,030 truck-tractor semitrailers were involved in fatal cross-median accidents on interstates during this period; they accounted for 17.1 percent of all such involved vehicles, as compared to 0.4 percent (23) large buses, 2.7 percent (162) single-unit trucks, and 79.8 percent (4,796) passenger vehicles.

Although truck-tractor semitrailers are less likely to be the crossing vehicle in a cross-median crash, their level of involvement in fatal cross-median crashes is higher than their percentage of registered vehicles or vehicle miles traveled would indicate. According to 2008 FARS data, among all vehicles involved in fatal cross-median crashes on interstates, truck-tractor semitrailers accounted for 19.2 percent; by comparison, they accounted for 0.9 percent of registered vehicles and 9.9 percent of vehicle miles traveled on interstates.

Cross-median crashes are far deadlier than non-cross-median crashes. The NTSB examined 135,198 police-reported crashes that occurred on divided highways in California in 2008. There were 3.3 fatalities per 100 accidents for cross-median crashes, compared to 0.6 fatalities for non-cross-median crashes. Similarly, when crashes involve tractor semitrailers, the accident is more likely to include a fatality. Cross-median crashes involving passenger

[62] System design capability can accommodate vehicles of up to 22,000 pounds traveling at speeds as high as 56 mph.

[63] FARS is a census of fatal accidents on U.S. public roads in which at least one person died within 30 days following the crash. NHTSA, an agency of the U.S. Department of Transportation (DOT), maintains the FARS. FARS data are obtained from police reports, driver records, vehicle records, and death certificates.

[64] From the NTSB public docket for Munfordville, Kentucky, accident file 75586, *Supplemental Report: U.S. Fatal Cross-Median Interstate Accidents* (Washington, DC: National Transportation Safety Board, March 30, 2011). The cross-median crashes were identified based on sequence-of-event coding for each vehicle.

vehicles average 3.2 fatalities per 100 accidents, compared to 4.7 fatalities per 100 such accidents when a tractor semitrailer is involved.

The Federal Highway Administration (FHWA) estimates that, as of 2008, about 2.2 million truck-tractor combination units were registered, and the average miles traveled per combination unit for that year were about 64,800 miles.[65] (See figure 13 for the sites of fatal cross-median truck crashes on interstates in 2006–2009. Location identification information [latitude/longitude data] is not available for 2005 accidents.)

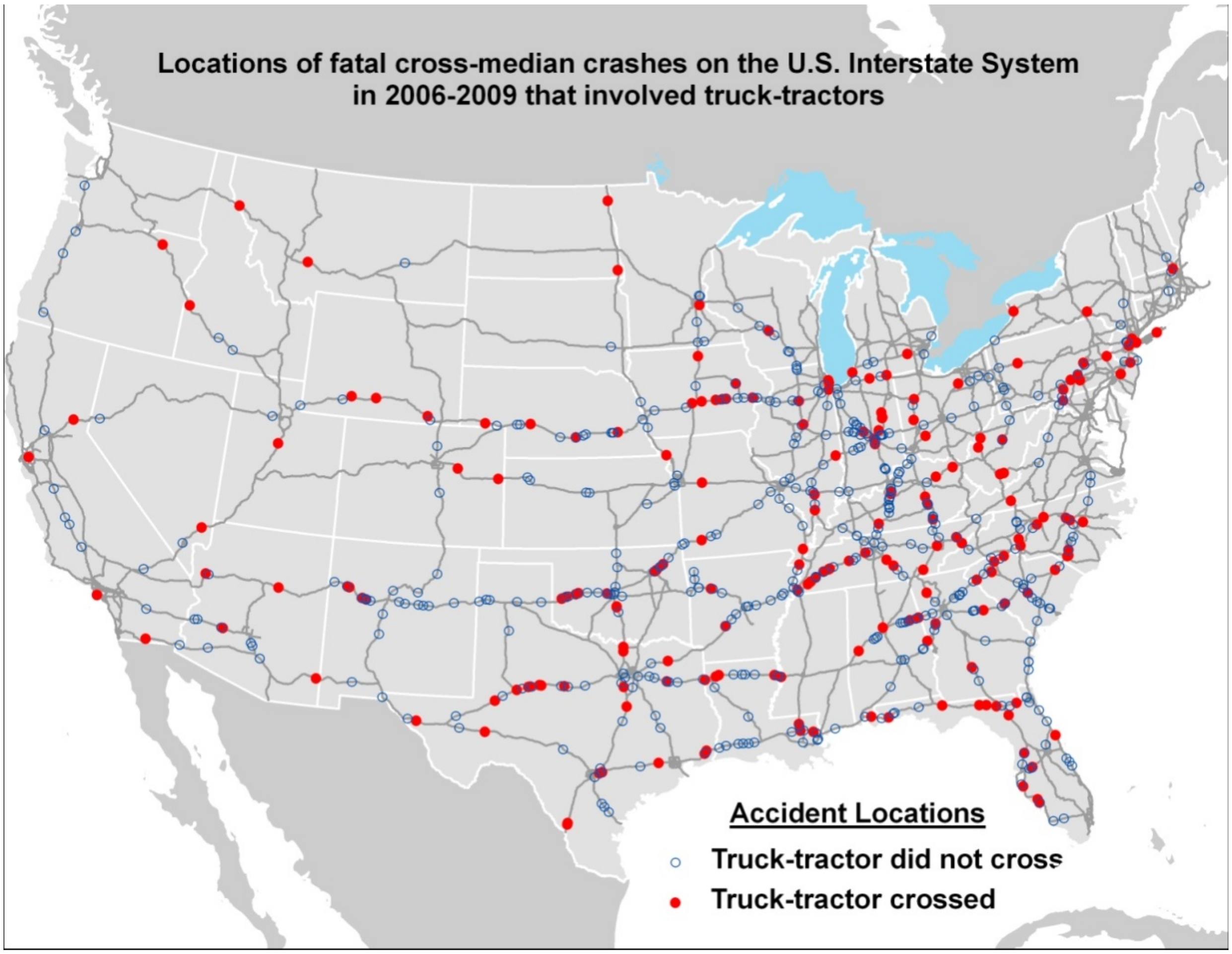


Figure 13. Fatal cross-median truck crashes on interstates from 2006–2009.

[65] See <http://www.fhwa.dot.gov/policyinformation/statistics/2008/vm1.cfm>, accessed April 6, 2011. Combination units traveled an estimated 70.465 billion vehicle miles on U.S. interstates, both rural and urban, in 2008. By comparison, aggregated state vehicle miles traveled on both rural and urban interstates totaled 725.078 billion vehicle miles.

Research on cross-median crash rates collected by Texas and published in 2006,[66] as well as other work,[67] confirms that cross-median crashes are one of the more severe crash events. For example, North Carolina reported that interstate cross-median crashes represented 3 percent of all interstate crashes but 32 percent of interstate fatalities during the study period. Texas found that most median-related crashes (85 percent) occur on freeways and interstate highways.[68]

1.8.2 Median Barrier Systems

The AASHTO *Roadside Design Guide* states that the "primary purpose of roadside barriers is to prevent a vehicle from leaving the traveled way and striking a fixed object or terrain feature that is less forgiving than the barrier itself."[69] In general, roadside design follows the "clear zone" philosophy, which is an important concept with regard to barriers.[70] Barriers are an obstruction; they represent a hazard to motorists, and it is preferable to have an unencumbered roadside recovery area whenever possible.

Median barriers are longitudinal roadside obstructions designed to redirect vehicles that may strike either side of the barrier. Their purpose is to prevent vehicles departing the travel lanes from crossing the median and entering traffic traveling in the opposite direction. Because cross-median accidents are generally high-speed, opposing-direction events, they are particularly hazardous and are more likely than most types of accidents to involve incapacitating or fatal injury. Installation of median barriers should be considered when the hazard of entering or traversing the median outweighs the hazard of striking the barrier.

1.8.3 Barrier Types

The *Roadside Design Guide* categorizes roadside barriers as "rigid," "semi-rigid," or "flexible," depending on the barrier's deflection characteristics when struck. For example, vertical concrete Jersey barriers are a rigid design, blocked-out W-beam rails[71] are semi-rigid, and cable barriers are flexible systems. Flexible barriers are generally more forgiving than semi-rigid or rigid systems, because most of the impact energy is dissipated by the deflection of

[66] R. Bligh and others, *Median Barrier Guidelines for Texas*, FHWA/TX-06/0-4254-1 (College Station, Texas: Texas Transportation Institute, January 2006). In addition to containing information concerning Texas, the report summarized cross-median crash risk and state guidelines for California, North Carolina, Pennsylvania, Arizona, and Missouri.

[67] W. Hughes and others, *Improved Guidelines for Median Safety*, Interim Report NCHRP Project 17-14, October 1997.

[68] *Median Barrier Guidelines for Texas*, p. 22.

[69] *Roadside Design Guide*, 3rd ed. (Washington, DC: American Association of State Highway and Transportation Officials, 2006), p. 5-1.

[70] The *Roadside Design Guide* defines a "clear zone" as the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear run-out area. The desired minimum width is dependent upon traffic volumes, traffic speeds, and roadside geometry. Simply stated, a clear zone is an unobstructed, relatively flat area beyond the edge of the traveled way that allows a driver to stop safely or regain control of a vehicle that leaves the traveled way.

[71] The standard strong post W-beam guardrail consists of a W-beam rail element and strong posts (of wood or steel) spaced at 6 feet 3 inches, with the rail blocked out from the posts.

the barrier, which decreases the severity of impact forces imposed on the vehicle and its occupants.

Low-tension cable barrier systems, which are constructed of cable mounted to posts with just enough tension to remove the sag between mounting points, have been in use for decades and are generally not proprietary designs. High-tension cable barrier systems are a later development and have become popular median barrier choices for states in recent years.[72] High-tension cable barrier systems consist of three or four strands of prestretched braided wire rope mounted under tensions that range from 2,000–9,000 pounds. Gibraltar began manufacturing high-tension cable barrier in June 2005. The firm has provided approximately 1,500 miles of barrier to highway agencies in the United States and Canada.

1.8.4 Engineering Design Guides

***Manual for Assessing Safety Hardware*.** The AASHTO *Manual for Assessing Safety Hardware* (MASH) was developed under National Cooperative Highway Research Program (NCHRP) Project 22-14(2), *Improvement of Procedures for the Safety-Performance Evaluation of Roadside Features*.[73] The MASH represents the latest evolution in barrier testing and, since January 1, 2011, it is used to evaluate the structural adequacy of barrier systems. It contains revised criteria for evaluation of highway safety features based on changes in vehicle fleets. The MASH uses the same test level designations as its predecessor, NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, which was issued in 1993. However, with the adoption of the MASH, some aspects of the test criteria were updated and changed.[74] As with NCHRP Report 350, the MASH utilizes full-scale crash testing but does not provide site-specific guidance regarding barrier implementation. The performance of safety barriers, distinguished by standard vehicle type, impact angles, and travel speeds, is categorized according to test level, as follows:

[72] In the 5-year period beginning in 2003, Texas installed 800 miles of median cable barrier at a cost of $200 million. It has been reported that 5,094 miles of cable barrier were installed by the five companies that manufacture such systems in the 20-month period from May 2006–January 2008; this mileage represents more than 10 percent of the 46,600 miles of U.S. interstate.

[73] The MASH was reviewed and approved by the AASHTO Standing Committee on Highways by June 1, 2009. As of January 1, 2011, the FHWA ceased accepting any new designs under the test criteria of NCHRP Report 350.

[74] In particular, test vehicles were updated to increase their masses to better reflect current fleet characteristics; for instance, the small car mass was increased from 1,800 to 2,420 pounds, and the pickup truck mass was increased from 4,400 to 5,000 pounds. Both tests are conducted at 25° impact angles. In addition, Test Level Four criteria for single-unit trucks were significantly changed; the test vehicle weight was increased from 18,000 to 22,000 pounds, and the impact speed was increased from 50 to 56 mph. The intent of these changes was to create a more rigorous test that would distinguish Test Level Four from Test Level Three criteria. Test Level Five criteria for tractor-trailer trucks and Test Level Six criteria for tankers did not change from those established in NCHRP Report 350. The design force values for Test Level Three and Test Level Four barriers under NCHRP Report 350 was 54 kips in the transverse or lateral direction. (A kip represents 1,000 pounds-force.) Under the MASH, the Test Level Four transverse design value is 76 kips.

Test Level One (TL-1) is generally acceptable for work zones with low posted speeds and very low volume, low-speed local streets;

Test Level Two (TL-2) is generally acceptable for work zones and most local and collector roads with favorable site conditions, as well as where a small number of heavy vehicles is expected and posted speeds are reduced;

Test Level Three (TL-3) is generally acceptable for a wide range of high-speed arterial highways with very low mixtures of heavy vehicles and favorable site conditions;

Test Level Four (TL-4) is generally acceptable for the majority of applications on high-speed highways, freeways, expressways, and interstate highways with a mixture of trucks and heavy vehicles;

Test Level Five (TL-5) is generally acceptable for the same applications as TL-4 and where large trucks make up a significant portion of the ADT or when unfavorable site conditions justify a higher level of railing resistance; and,

Test Level Six (TL-6) is generally acceptable for applications where cargo tank trucks or similar high-center-of-gravity vehicles are anticipated, particularly with unfavorable site conditions.

The FHWA requires that when median barriers are used on the National Highway System (NHS), they must, at a minimum, comply with TL-3 standards for crash testing. Engineering judgment, *Roadside Design Guide* guidance, and states' department of transportation policies serve as the bases for determining when and where a median barrier should be installed. However, although such subjective guidance is available, no national standard defines when a median barrier must be installed on the NHS.

***Roadside Design Guide*.** The AASHTO *Roadside Design Guide* is a synthesis of current information and operating practices related to roadside safety. It focuses on safety treatments that can minimize the likelihood of serious injuries and provides guidance to highway agencies about the use of roadside barriers.[75]

Section 6.2 of the *Roadside Design Guide* provides the national guidance for median barriers established by AASHTO. A combination of factors, such as traffic volume and median width, is typically used to indicate the need for median barriers. The basic premise in such guidance is that 80 percent of errant motorists are able to recover within 30 feet of the traveled way.

The *Roadside Design Guide* recommends installing barriers at locations where the median is 30 feet wide or less. For locations with median widths between 30 and 50 feet, or where the ADT is less than 20,000, the guidelines provide for flexibility when a study indicates

[75] *Roadside Design Guide,* table 5.2, pp. 5–10.

that a barrier is not cost-effective.[76] To apply this flexibility, states are encouraged to conduct a study, such as a cost/benefit analysis, for medians on their system to determine whether a barrier is appropriate in these locations. For locations with median widths greater than 50 feet, the *Roadside Design Guide* indicates that a barrier is not typically necessary except in special circumstances, such as at a location with a significant history of cross-median crashes. (See figure 14 for the guidelines from the *Roadside Design Guide* for determining when to install a median barrier.)

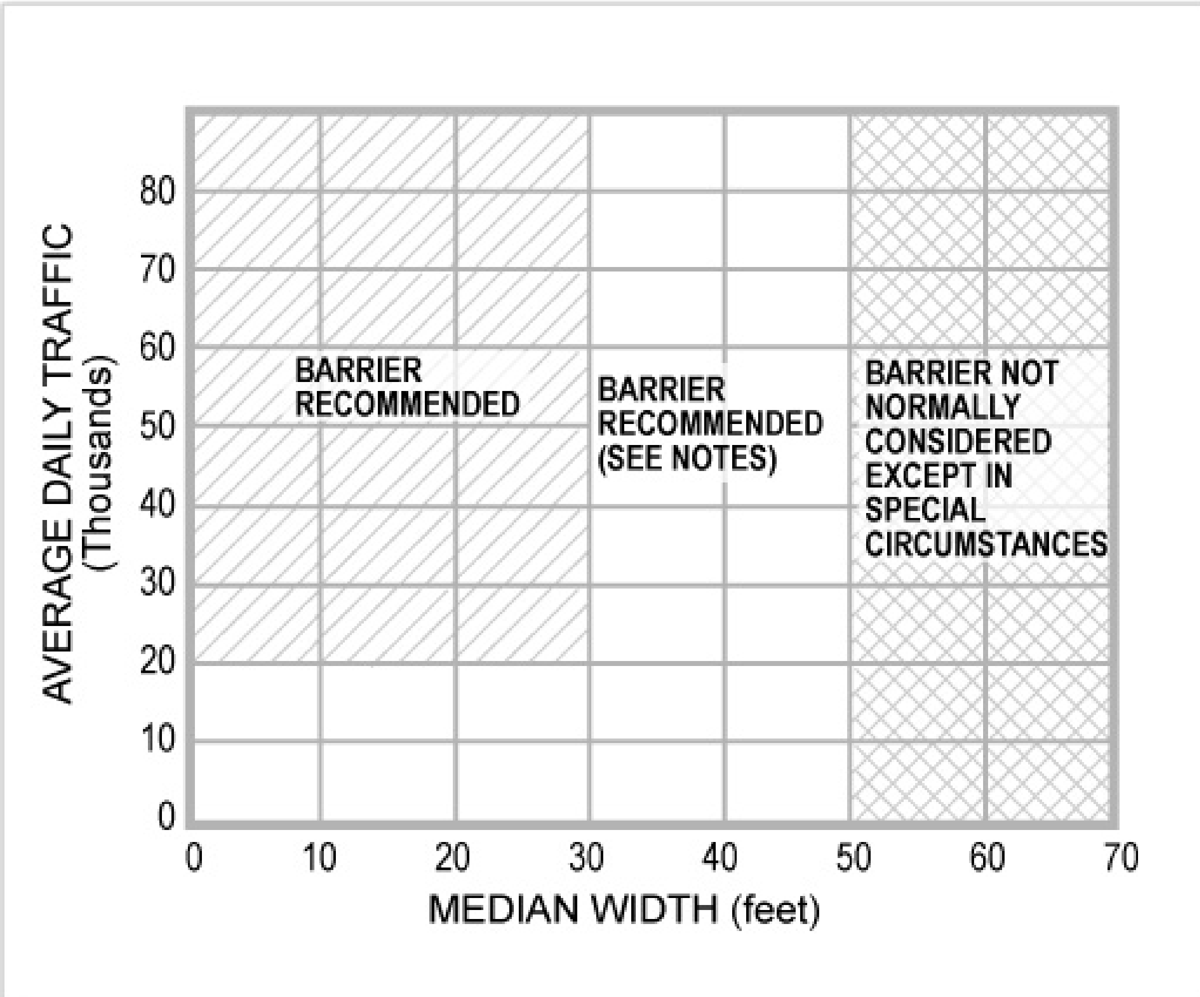


Figure 14. *Roadside Design Guide* guidelines for determining whether to install median barriers on high-speed, fully controlled-access roadways. Notes to the guidelines encourage states to conduct a study on whether a barrier is appropriate for locations with medians 30–50 feet wide, as well as for locations with medians less than 30 feet wide with ADT less than 20,000. (Adapted from the *Roadside Design Guide*, figure 6.1.)

[76] See D. Sickling, K. Lechtenberg, and S. Peterson, *Guidelines for Guardrail Implementation*, NCHRP Report 638 (Lincoln, Nebraska: Midwest Roadside Safety Facility, 2009). Although this report is not specific to median barriers, it provides a detailed cost/benefit methodology for the more general category of guardrails.

The *Roadside Design Guide* does not define "significant crash history" or what percentage of heavy vehicles constitutes a "heavy traffic" mix. The guide also does not provide a formal definition of what constitutes a cross-median crash.

State Policies. In the 1990s, several states noticed an increase in the number of cross-median crashes and developed new guidelines for their highways that expanded the use of median barriers. Some states have adopted policies for installing median barriers in medians up to 50 feet wide and some have gone as high as 75 feet wide. In 2004, the FHWA conducted a nationwide survey of cross-median crashes, and based on responses received from 25 states, it found that significant percentages of fatal cross-median crashes were occurring in locations where median widths exceeded 30 feet.[77] Although the survey found that some cross-median crashes occurred in medians with widths that exceeded 200 feet, approximately two-thirds of crashes occurred in medians with widths of 50 feet or less.

The increased use of median barriers has some disadvantages. The initial cost of installing a barrier can be significant. In addition, the barrier installation will generally increase the number of accidents because it reduces the recovery area available to drivers. Another concern associated with median barrier installation is that it limits the ability of maintenance and emergency service vehicles to cross the median as needed. In snowy climates, a median barrier may also affect the ability to store snow in the median during snow removal efforts. Other environmental impacts may also develop, depending on the grading required to install the barrier. For these reasons, a one-size-fits-all policy for median barrier use has not been considered appropriate. However, median barriers can significantly reduce the occurrence and severity of cross-median crashes and the overall severity of median-related crashes. Given their potential to reduce high-severity crashes, states are increasingly considering use of median barriers on high-speed, fully controlled-access roadways that have traversable medians.[78]

1.8.5 Median Barrier Research

AASHTO's NCHRP contains numerous references relevant to median barriers in general[79] and median cable barriers in particular. NCHRP Project 20-7(210) developed preliminary guidelines for the selection and use of cable barrier systems, based on a state-of-the-practice review of cable barrier installations.[80] That work included a comprehensive survey to identify practices and construction standards for the use of cable barrier systems.[81]

[77] *Roadside Design Guide*, p. 6-1.

[78] Roadside slopes of 1:4 and less steep are considered traversable. Slopes between 1:3–1:4 are considered traversable but nonrecoverable.

[79] See, for example, pending NCHRP Project 22-22, *Placement of Traffic Barriers on Roadside and Median Slopes*.

[80] D. Alberson, N. Sheikh, and L. Chatham, *Guidelines for the Selection of Cable Barrier Systems–Generic Design vs. High-Tension Design*, NCHRP Project 20-7(210) Final Report (College Station, Texas: Texas A&M Research Foundation [for the NCHRP], July 2007).

[81] Twenty-nine states responded to the survey.

Individual states have also initiated their own evaluations of cable barrier systems.[82] A recent report from the Texas Transportation Institute, *The Development of Guidelines for Median Cable Barrier Systems in Texas*, includes a comprehensive discussion of the development of high-tension cable barrier designs for medians and a state-of-the-practice literature review.[83] One early element of that project was a state scanning tour report.[84]

Recent Transportation Research Board work has focused on efforts to develop guidelines for the selection and placement of median cable barriers. NCHRP Project 17-14, *Improved Guidelines for Median Safety*, conducted by the University of North Carolina, produced a draft final report in July 2004, but the report was not finalized due to data limitations and the expense of improving the data. The more recent effort (started in 2006), NCHRP Project 22-21, *A Median Cross-Section Design for Rural Divided Highways*, was designed to avoid some of the expense and data problems encountered in ongoing NCHRP Project 17-14 by focusing on "typical" rather than exact cross-section designs. That project, as well as a related effort, NCHRP Project 22-22, *Placement of Traffic Barriers on Roadside and Median Slopes*, has the stated goal of developing improved guidelines for designing median cross-sections for inclusion in the *Roadside Design Guide*. An additional effort, NCHRP Project 17-43, *Long-Term Roadside Crash Data Collection Program*, has been planned.

NCHRP Project 22-25, *Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, began in April 2008 and is due for completion in 2011. The objectives of the project listed more than a dozen areas for which guidance is needed. These include the following: cross-section slope shape and width, lateral placement, three- versus four-cable considerations, high-versus low-tension systems, cable rope type, maintenance factors, post design considerations, cable anchor designs and placement, and soil and climate influences. As this project illustrates, state departments of transportation must consider many design decisions and lifecycle costs when selecting median barrier systems.

Because of the absence of detail in the *Roadside Design Guide*, many states have developed their own guidelines for median barriers.[85] As part of the Munfordville accident investigation, investigators examined Kentucky's draft *Guidelines for Median Barrier Application on Depressed Medians of Fully Controlled-Access Highways*. The Kentucky draft guidelines state the following with respect to the AASHTO 2006 *Roadside Design Guide*:

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[82] See, for example, D. Noyce, *Reducing Median Crossover Crashes in Wisconsin* (Madison, Wisconsin: Wisconsin Traffic Operations and Safety Laboratory, 2006).

[83] The work was completed as part of NCHRP Project 20-7(210) and was published in the following report: S. Cooner and others, *The Development of Guidelines for Cable Median Barrier Systems in Texas*, Report FHWA/TX-10/0-5609-2 (College Station, Texas: Texas Transportation Institute and the Federal Highway Administration, February 2009).

[84] *High Tension Cable Scanning Tour Report* (Urbana-Champaign, Illinois: Traffic Operations Laboratory, University of Illinois at Urbana-Champaign, December 2005). AASHTO, FHWA, and NCHRP projects use a project-scanning approach to survey or audit operational components and identify best practices.

[85] For example, California completed a detailed study in 1997 that suggested medians as wide as 75 feet with traffic volumes in excess of 60,000 ADT would be candidates for a median barrier study. California uses a crash study warrant to identify sections of freeways that may require installation of a median barrier. This warrant requires a minimum of 0.50 cross-median crashes per mile per year or 0.12 fatal cross-median crashes per mile per year. The rate calculation requires a minimum of three crashes occurring within a 5-year period. Kentucky uses these same criteria.

> Suggests guidelines for median barriers on high-speed, controlled-access roadways that have traversable, depressed medians. However, in the 1990's several States noted an increase in the number of cross-median crashes and developed guidelines for their highways that expanded the use of median barriers. Their studies are not complete. Without further guidance from AASHTO, it has become necessary to modify and expand previous guidance for installing median barriers.[86]

The Kentucky document also says that its purpose is to "provide direction to designers…on the use of crossover protection on depressed medians where installation of median barriers has not been previously warranted by AASHTO guidance."

Specifically, the Kentucky guidance calls for median barriers on fully controlled-access highways with traversable, depressed medians up to 30 feet wide and those with medians 30-72 feet wide when the ADT count exceeds 40,000 or if any of the following criteria apply:

- Three (or more) cross-median crashes per 5-year period;
- Cross-median crash rate exceeding 0.50 cross-median crashes per mile per year; or
- Fatal cross-median crash rate exceeding 0.12 cross-median crashes per mile per year.

1.8.6 Crash Testing and FHWA Acceptance

Accident dynamics are complex, and the most effective way of determining barrier performance is through full-scale, standardized crash tests that allow for comparison of different designs. As has been stated, there is no Federal requirement for the use or placement of barriers, but if a barrier is used on the NHS, it must meet the crash performance criteria stipulated by the FHWA. The FHWA reviews test results and issues acceptance letters for roadside safety hardware. The FHWA maintains a website that contains all the official acceptance letters for federally approved roadside safety devices.[87] States generally select hardware from the list of approved devices.

Gibraltar, the manufacturer of the barrier system used along I-65 in the vicinity of the accident, developed a high-tension cable system that was initially tested and accepted as meeting NCHRP Report 350 TL-3 criteria. In September 2005, the FHWA accepted a Gibraltar cable barrier system tested to NCHRP Report 350 TL-4 criteria that was based on a modified TL-3 cable barrier design.[88] The TL-4 design, as initially accepted, used three cables mounted at heights of 20, 30, and 39 inches on posts spaced 14 feet apart. The barrier successfully passed NCHRP Report 350 test 4-12, exhibiting a dynamic deflection of 7 feet in a configuration that used cable installation lengths of 350 feet. In October 2006, the FHWA accepted a modified

[86] From the KYTC draft document *Guidelines for Median Barrier Application on Depressed Medians of Fully Controlled-Access Highways.*

[87] See <http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/listing.cfm?code=long>, accessed February 24, 2011.

[88] FHWA acceptance letter B-137B was for a three-cable TL-4 barrier and a closely related TL-3 design. Both designs use three cables, but they differ in mounting height and post length. The post length for TL-3 designs is 6.25 feet; the post length for TL-4 designs is 7.00 feet.

design that added a fourth cable between the lower two cables, at a height of 25 inches. FHWA acceptance letters include the cable barrier test article deflection distances and a caution concerning the dynamic deflection for installations longer than test article distances (350 feet for NCHRP 350 tests and 600 feet for MASH tests).

In March 2006, Gibraltar provided the FHWA with information on additional TL-4 test results. For one test, posts were set 10 feet apart, and dynamic deflection was 6.8 feet. For the second test, posts were set 30 feet apart, resulting in 9.3 feet of deflection. In April 2006, the FHWA concurred that both tests met the evaluation criteria of NCHRP Report 350 test 3-11 and that either post spacing configuration could be used on the NHS. In October 2006, Gibraltar requested FHWA acceptance of post spacing between 10 and 30 feet. Both designs used three cables, and the FHWA accepted 12-foot post spacing on center with deflections of 7 feet, 20-foot post spacing with deflections of 8 feet, and 30-foot post spacing with deflections of 9 feet. A 2008 letter from the FHWA to Gibraltar noted that some transportation agencies had limited post spacing to approximately 20 feet. The Gibraltar posts installed on I-65 were spaced 10 feet apart.

The Gibraltar median cable barrier that Kentucky installed in the area of the accident in May 2009 was a TL-4 design; however, to perform at that level, its placement may not be on a grade steeper than 1:6 vertical slope.[89] The I-65 installation was on a 1:4 vertical slope, which the FHWA accepted as meeting the lesser criteria of a TL-3 barrier system.[90]

1.9 FMCSA Motor Carrier Oversight

1.9.1 Compliance, Safety, Accountability Program

In 1997, the FMCSA created the Safety Status Measurement System (SafeStat), which was a performance-based program that rated carriers in the following four safety evaluation areas (SEA)—accident, driver, vehicle, and safety management. Data for these four areas were collected from roadside inspections, compliance reviews, and the Motor Carrier Management Information System (MCMIS). Once data were collected and analyzed, a numerical score was assigned, and carriers were ranked based on their overall safety score. Scores ranged from 0 to 100, with higher numbers representing poorer safety scores. Based on those scores, carriers were ranked in terms of safety in categories "A" through "H," with an "A" ranking being poorest and an "H" being best. The FMCSA then prioritized motor carriers for compliance review based on their safety rankings, with those carriers with "A" and "B" safety rankings being first to receive compliance reviews. SafeStat data were not always accurate, and the FMCSA attempted to correct problems with the system over the years. In 1999, the NTSB issued a special investigative report that included a recommendation to the DOT to change the safety fitness methodology.[91] In 2003, following an investigation of the Loraine, Texas, motorcoach accident,

[89] At this grade, for every 6 feet of horizontal distance, the vertical distance changes 1 foot.

[90] Under NCHRP Report 350, the defining performance standard for the Gibraltar design used by Kentucky at this location, a TL-4 barrier could safely redirect a 17,600-pound single-unit truck traveling at a 15° angle into the barrier at 50 mph. A TL-3 barrier could safely redirect a 4,500-pound pickup truck traveling at a 25° angle into the barrier at 62 mph.

[91] *Selective Motorcoach Issues, February 11, 1999,* Highway Special Investigation Report NTSB/SIR-99/01 (Washington, DC: National Transportation Safety Board, 1999).

the NTSB recommended that the FMCSA revise the SafeStat system.[92] Following a Congressional mandate, the FMCSA began an overhaul of its entire carrier oversight program and spent more than a decade developing a new comprehensive safety analysis program.

In December 2010, the FMCSA launched a new enforcement system, the Compliance, Safety, Accountability (CSA) program, for commercial trucks and buses. The FMCSA is continuing its implementation of the CSA program.[93] The CSA program uses a Safety Measurement System methodology to rank a carrier's safety performance relative to its peers.[94] This methodology is intended to provide several improvements over SafeStat. The new system is organized by specific behaviors rather than by SafeStat's four general SEAs; as such, the system is intended to identify individual safety problems that can be targeted for correction. The Safety Measurement System uses a risk-based weighting that applies to all safety-based inspection violations; by comparison, SafeStat used only out-of-service violations and some selected moving violations.

The Safety Measurement System is organized by six Behavior Analysis and Safety Improvement Categories (BASICs) as well as crash involvement (Crash Indicator). The BASICs are Unsafe Driving, Fatigued Driving, Driver Fitness, Controlled Substances and Alcohol, Vehicle Maintenance, and Improper Loading/Cargo Securement.

According to the FMCSA, these categories are based on information from a number of sources, including the *Large Truck Crash Causation Study*, the *CSA 2010 Driver History Study*, the existing FMCSA regulatory structure, analysis conducted under the FMCSA's Compliance Review Workgroup, and SafeStat experience. The CSA team developed the BASICs under the premise that CMV crashes can be traced to the behavior of motor carriers and/or drivers. Consequently, two measurement systems are being developed for the CSA program—the Carrier Safety Measurement System and the Driver Safety Measurement System.[95]

The FMCSA now uses roadside inspection data taken from MCMIS, violation data weighted by crash risk,[96] state accident data, and compliance investigation results to develop safety performance measures. This information is available to FMCSA investigators, inspectors, and state and local law enforcement; to a limited extent, the public also has access to the information.

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

[93] On June 23, 2010, the FMCSA Administrator testified before the U.S. House of Representatives Committee on Transportation and Infrastructure Subcommittee on Highways and Transit concerning the CSA program and its planned implementation schedule. She testified that the agency would publish a notice of proposed rulemaking (NPRM) to revise the current safety fitness process within fiscal year 2011.

[94] The new program was initially named the Comprehensive Safety Analysis program. Its development took several years, and, anticipating implementation in 2010, the FMCSA called the program "CSA 2010." It subsequently became clear that the program would not be implemented in 2010; consequently, the FMCSA now refers to the endeavor as the CSA program.

[95] Per the *Comprehensive Safety Analysis 2010—Safety Measurement System (SMS) Methodology, Version 1.2, April 2009*, prepared by the John A. Volpe Transportation System Center for the FMCSA, April 17, 2009, pp. 2–1 and –2.

[96] There is an emphasis on out-of-service violations.

As a means of intervening in unsafe operations before they lead to accidents, the FMCSA has adopted a practice of issuing warning letters directly to carriers with known safety problems. The CSA program also includes an array of compliance review approaches intended to target risk better. The FMCSA has stated that, in 2011, it will propose rulemaking on safety fitness determinations (SFD) that will keep a carrier's safety rating separate from its on-site compliance review, which the FMCSA believes should have the effect of increasing the number of carriers receiving reviews.

1.9.2 Compliance Review Program

A compliance review is an on-site examination by the FMCSA (or a surrogate) of a motor carrier's operation, which includes examination of the carrier's hours-of-service practices, vehicle maintenance and inspection, driver qualifications, CDL requirements, financial responsibility, accidents, hazardous materials compliance, and other safety and transportation-related records. The purposes of the compliance review are to determine a motor carrier's compliance with the FMCSRs and to evaluate its safety culture. The FMCSA selects motor carriers for review based on the following six factors or events:

- Complaint investigation
- Enforcement followup
- Carrier request
- Fatal accident
- Major hazardous materials incident
- High SafeStat score (historically) or (currently) a high Safety Measurement System ranking

To develop a safety rating in a compliance review, an FMCSA representative[97] goes to a carrier's terminal to examine the appropriate records and interview company officials. The representative reviews the carrier's compliance with the safety fitness standard based on its compliance with a selected number of FMCSRs from appendix B of 49 CFR 385.717. The regulations are considered either "critical" or "acute" based on their relative safety implication. A critical regulation is one that relates to management and operational controls. An acute regulation is one for which the consequences of noncompliance are so severe that immediate corrective action is required.

The compliance review is organized in the following factors:

[97] This person is a specially trained FMCSA employee or a state officer funded through the Motor Carrier Safety Assistance Program (MCSAP). MCSAP is a grant program that provides funding for state personnel and equipment for the purpose of enforcing the FMCSRs.

- Factor 1: General – Parts 387 and 399
- Factor 2: Driver – Parts 382, 383, and 391
- Factor 3: Operational – Parts 392 and 395
- Factor 4: Vehicle – Parts 393 and 396
- Factor 5: Hazardous materials – Parts 397, 171, 177, and 180
- Factor 6: Accident – Recordable Rate[98]

Each factor is assessed a point value based on the number and weight of the violation, and the rating is based on the point accumulation, as follows: satisfactory = 0 points, conditional = 1 point, and unsatisfactory = 2 or more points. The factors are then summarized into a rating table to arrive at the overall rating determination of "satisfactory," "conditional," or "unsatisfactory."[99] After conducting the on-site review, the examining agent proposes a safety rating based on the FMCSA algorithm and submits the documentation to the FMCSA. FMCSA management makes the final determination of rating. Carriers determined to have an "unsatisfactory" rating may develop corrections to their safety management plan within 60 days for cargo carriers and 45 days for passenger carriers. Carriers submitting a plan to correct the deficiencies found during the compliance review may have their rating upgraded to "conditional" if FMCSA management approves the plan submitted. If corrections are not submitted or approved, the FMCSA will issue the carrier an "out-of-service" order, and it must cease operations. In addition to assigning the ratings, the FMCSA can assess civil fines on carriers for FMCSR violations.

1.9.3 New Entrant Program

Prior to the FMCSA's implementation of the new entrant program in 2003, a person interested in starting an interstate motor carrier operation would first assemble the assets necessary (vehicles, physical facility, financing, etc.) and then apply to the FMCSA for operating authority. The application would have been required to include the following forms: (1) MCS-150 for nonhazardous materials carriers or MCS-150B for hazardous materials carriers and (2) OP-1 for cargo carriers or OP-1(P) for passenger carriers or OP-1(FF) for freight forwarders. In addition, the prospective carrier would have to provide proof of having the

[98] Title 49 CFR 385.717 appendix B defines a "recordable accident" as "an accident that is consistent with the definition of 'accident' found in 49 CFR 390.5 and means an occurrence involving a commercial motor vehicle on a highway in motor carrier operations…that results in a fatality; in bodily injury to a person who, as a result of the injury, immediately receives medical treatment away from the scene of the accident; or in one or more motor vehicles incurring disabling damage that requires the motor vehicle to be transported away from the scene by a tow truck or other motor vehicle."

[99] The FMCSA safety ratings are identified as follows: "satisfactory," indicating that a compliance review of the carrier's records revealed no evidence of substantial noncompliance with safety requirements; "conditional," indicating that the carrier was out of compliance with one or more safety requirements; "unsatisfactory," indicating that the carrier's records show evidence of substantial noncompliance with safety requirements; and "unrated carrier," indicating that the carrier has not been assigned a safety rating by the FMCSA. A limited compliance review or an inquiry concerning a specific category may also result in the absence of a safety rating.

required insurance coverage. By filling out the application for authority to operate, the applicant was verifying that it had access to and was familiar with the FMCSRs.

On January 1, 2003, the FMCSA began its "new entrant safety assurance program." All new motor carriers operating in interstate commerce are required to apply to the FMCSA for registration as a new entrant. A new entrant carrier is subject to an 18-month safety-monitoring period.[100] Sometime after the new entrant's first 3 months of operation but before it completes 18 months of operation, the FMCSA conducts a safety audit of the carrier and evaluates its accident and roadside inspection data. At a minimum, the safety audit covers driver qualifications, driver duty status, vehicle maintenance, accident register, and controlled substances and alcohol use testing requirements. If the FMCSA identifies deficiencies, the carrier must provide the FMCSA evidence that it is correcting the faults found during the audit. The FMCSA has stated that it will grant permanent motor carrier registration only if the new entrant successfully completes the 18-month monitoring period. The numbers of new entrant applicants for 2008, 2009, and 2010 were 37,400; 41,280; and 33,845; respectively. These numbers also represent the new entrant safety audits the FMCSA conducted.

Beginning in 2006, the FMCSA developed an Evasion Detection Algorithm to identify those household goods carriers with histories of poor safety performance and to screen household goods applicants.

In August 2008, the FMCSA developed the New Applicant Screening (NAS) Program and began applying it to newly registered passenger carriers before granting them operating authority. The NAS Program seeks matches on corporate-identifying data contained in the MCMIS, the Licensing and Insurance System, and the Enforcement Management Information System to identify new applicants that may be enforcement evaders. The FMCSA has estimated[101] that approximately 68,700 carriers apply for operating authority each year and about 40,000 carriers remain in the process after screening.[102] In some instances, the FMCSA has identified existing carriers that were reapplying for operating authority under different company names and/or management names but were essentially the same carrier that the FMCSA had put "out of service" or that owed civil penalties to the FMCSA due to violations discovered during a compliance review. These "reincarnated carriers" are also sometimes described as "chameleon carriers"[103] because they try to camouflage their past poor safety records by changing names, although they still lack adequate safety measures. In addition to reviewing applicant information to identify reincarnated or chameleon carriers, FMCSA investigators ask applicants questions intended to clarify their business relationships with other regulated entities. The FMCSA uses the

[100] All motor carrier new entrants must obtain a DOT number; if the operation is "for-hire," then it also must obtain a motor carrier (MC) number—both numbers must be obtained prior to any operation. An initial MC number provides provisional authority; authority becomes permanent following a successful 18-month safety-monitoring period.

[101] *Federal Register*, vol. 73, no. 242 (December 16, 2008), p. 76481.

[102] *The Trucker*, an online magazine of the trucking industry, estimates that there are approximately 3,900 motorcoach companies and over 500,000 cargo carriers.

[103] According to the FMCSA, as stated in docket 2001-11061, *Federal Register*, vol. 73, no. 242 (December 16, 2008), a chameleon carrier is "A carrier that attempts to register as a new entrant and operate as a different entity under a new DOT number in an effort to evade enforcement action and/or out-of-service orders issued against it by the Agency."

new entrant program and vetting criteria to help ensure that a "new" motor carrier is not a continuation of a previous motor carrier that reorganized to avoid enforcement action.

The FMCSA must consider the legal issue of "motor carrier successor liability" to determine if the old company and the new entrant are essentially the same. In a 2010 "Order Denying Petition for Reconsideration," the FMCSA decided that it was not necessary to determine whether the standard for successor liability of motor carrier civil penalty enforcement cases should be the traditional common law, the particular state law, or the Federal doctrine of substantial continuity. The FMCSA considers the retention of the same employees, supervisory personnel, and production facilities; production of the same products, with a continuity of assets and business operations; use of the same name; and presentation to the public as a basis to determine continuation of the same previous corporation.[104]

On December 16, 2008, the FMCSA published a final rule addressing the new entrant safety assurance process.[105] The intent of the rule was to improve the FMCSA's "ability to identify at-risk new entrant motor carriers and ensure that deficiencies are corrected before granting them permanent registration…." The rule specifically addresses reincarnated cargo carriers. The regulations state that any carrier that provides false or misleading information or conceals information is subject to revocation of its new entrant registration and civil penalties.[106] The final rule identifies 16 regulatory violations classified as automatic failures, meaning that violation of the rule would be cause for failure of an FMCSA safety audit.[107]

Following publication of the December 2008 final rule, a petition for reconsideration challenged that the FMCSA had failed to address section 210(a) of the Motor Carrier Safety Improvement Act of 1999 (Public Law 106-159, 113 Stat. 1764, December 9, 1999) requiring new entrant carriers to demonstrate a minimum knowledge of the safety standards. On August 25, 2009, the FMCSA published an advance notice of proposed rulemaking[108] to address the knowledge requirements in 49 CFR Part 385.

By way of background, Federal motor carrier law is organized under two distinct statutory frameworks: one governs economic/commercial regulation of the industry; the other addresses safety regulation of the industry. The statutory provision that provides the DOT the authority to grant operating authority is found within the economic statutory framework, not the safety framework. This results in limiting the DOT's ability to use the provision for safety purposes, that is, to raise the standards for those seeking operating authority. Legislative change is required to link the granting of operating authority to safety oversight.

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[104] FMCSA Docket Number: FMCSA-2004-17247, *Final Order in the Matter of Williamson Transport Co., Inc.*, July 20, 2010.

[105] *Federal Register*, vol. 73, no. 242 (December 16, 2008).

[106] Title 49 *United States Code* 521(b)(2)(A) sets civil penalties not to exceed $2,500.

[107] The violations calling for automatic failure of a safety audit concern the following regulations: 49 CFR 382.115(a) and (b), 382.201, 382.211, 382.215, 382.305, 383.3(a) and 383.23(a), 383.37(a), 383.51(a), 387.7(a), 387.31(a), 391.15(a), 391.11(b)(4), 395.8(a), 396.9(c)(2), 396.11(c), and 396.17(a).

[108] *Federal Register*, vol. 74, no. 163 (August 25, 2009).

1.10 Motor Carrier

1.10.1 Hester, Inc.

General. Hester, a family-owned company that began business in March 2004, operated the accident truck. The company, headquartered in Fayette, Alabama, operated a fleet of 26 conventional cab tractor units (24 owned and 2 leased) and 86 semitrailers at the time of the accident. The company employed 27 drivers, of whom 2 were owner-operators of the leased trucks.

Hester began operation under the FMCSA's new entrant program on March 15, 2004, and was granted DOT permanent authority[109] as an interstate motor carrier of general freight on November 16, 2005, after passing a safety audit.[110] The company did not undergo a compliance review between its 2005 safety audit and the March 2010 accident. MCMIS records indicate that the carrier's vehicles traveled 2.3 million miles in 2008. Federal regulation requires a property-carrying motor carrier to acquire $750,000 in insurance liability coverage to operate in interstate commerce; Hester had such insurance.

The corporate structure of the company consisted of a president; managers of sales and safety, operations and dispatch, and maintenance; and three mechanics. The majority of maintenance work was conducted through an in-house scheduled maintenance program. The company did not have a fatigue management program. The company did not provide health insurance to drivers. The company contracted for drug and alcohol testing services and provided a compliance statement for 2009 and an enrollment certificate for 2010. Company vehicles were not equipped with satellite or datalink capabilities; the company communicated with its drivers by means of their personal cellular telephones.

According to SafeStat, in February 2009, Hester had only one deficient SEA score, the driver SEA, and was rated a category "E" carrier overall. Roadside inspection data for the 12 months prior to March 28, 2010, indicated that Hester had 55 vehicle inspections with 11 vehicles placed out of service, resulting in a 20.0-percent out-of-service rate. Also, the data reported 91 driver inspections with 10 drivers placed out of service, for an 11.0-percent out-of-service rate. The national 2010 out-of-service rates for large trucks were 22.2 percent for vehicles and 5.3 percent for drivers. Prior to the accident, Hester had an FMCSA Inspection Selection System (ISS) rating[111] value above 75 and was listed as "inspect." Hester's accident rate calculated during the postaccident compliance review was 1.43 reportable accidents per

[109] Hester was given the identifying DOT number 1222388 and the MC number 483907.

[110] The safety audit was conducted on November 10, 2005.

[111] The ISS rating is a decision aid for safety inspectors conducting roadside driver/vehicle safety inspections of commercial vehicles; the ISS number guides them in selecting vehicles for inspection. The ISS inspection value is based on the motor carrier's safety performance data. When sufficient safety performance data for a carrier are available, the value is assigned from information derived from SafeStat, which reviews safety performance in the areas of crash history, inspection history, driver history, and safety management experience. When a motor carrier has little information on file, the ISS inspection value is based on an "insufficient data algorithm," which determines the inspection value by weighting the carrier's size and number of past inspections. The inspection value forms the basis for the ISS recommendation. The recommendation ranges from "inspect" (ISS value 75–100) for motor carriers with poor safety performance in one or more SEA, to "optional" (ISS value 50–74) for carriers with little or no safety data, to "pass" (ISS value 1–49) for carriers with good safety performance data.

million miles traveled.[112] When performing a compliance review of a motor carrier, the FMCSA considers an accident rate of 1.50 (or more) accidents per million miles traveled a deficient rate.

Postaccident. Following the March 26, 2010, accident, the FMCSA conducted a compliance review of Hester on April 1, 2010, which resulted in an "unsatisfactory" rating on April 20, 2010. The FMCSA found nine driver violations (detailed below) during that review, including an acute violation for allowing a driver with a suspended, revoked, or canceled CDL to operate a CMV.

The following are the driver violations found during the postaccident compliance review of Hester:

- Using a driver before the motor carrier has received a negative preemployment controlled substance test result. (Critical violation)
- Knowingly allowing, requiring, permitting, or authorizing to drive a driver with a CDL that is suspended, revoked, or cancelled by a state; or who is disqualified to operate a CMV. (Acute violation)
- Failing to maintain driver qualification file in accordance with 49 CFR 391.51.
- Failing to maintain inquiries into driver's driving record in driver's qualification file. (Critical violation)
- Requiring or permitting a property-carrying CMV driver to drive more than 11 hours.
- Requiring or permitting a property-carrying CMV driver to drive after the end of the 14th hour after coming on duty.
- Making false reports of records of duty status. (Drivers' records found inaccurate when compared to independent documents. Drivers are understating miles driven and/or times required to make trips.) (Critical violation)
- Making false reports of records of duty status. (Company's records of drivers' records of duty status prove inadequate for verification when compared to independent documents.)
- Failing to require a driver to prepare driver vehicle inspection reports.

In April 2010, the FMCSA fined the company $13,950 for violations found during the compliance review. In the notice of "unsatisfactory" rating, the FMCSA told the company it had 60 days to provide a corrective safety plan or a "cease operations" order would be issued.

On May 27, 2010, the FMCSA issued to Hester an *Order to Cease All Transportation in Interstate and Intrastate Commerce and Revocation of Registration*, to be effective June 5, 2010. In response to the order, the president of Hester submitted to the FMCSA Regional Service Center in Atlanta, Georgia, an outline of the corrective action he had taken since April 1, 2010.

[112] The accident rate is determined by multiplying the number of recordable accidents in the previous 12 months by 1 million and dividing by the carrier's mileage for the previous 12 months. Hester's 12-month mileage was 2.8 million miles, and it had four reportable accidents.

The FMCSA rejected his action plan and referred him to the Alabama state FMCSA office. The Alabama office also rejected his plan, stating the following:

> Hester, Inc. has failed to provide sufficient evidence that the violations cited in the compliance review have been corrected and that Hester, Inc.'s current operation meets the safety fitness standard specified in 49 CFR section 385.5.

Hester again submitted a request to upgrade the "unsatisfactory" rating. On June 9, 2010, the FMCSA again rejected the application, stating, "No evidence and/or documentation was provided that supported such corrective actions"; the FMCSA left the June 5, 2010, out-of-service order in effect.

1.10.2 Hester and FTS Fleet Services

FTS Fleet Services LLC is an authorized for-hire interstate common carrier of general freight, fresh produce, meat, garbage/refuse, refrigerated food, beverages, and paper products. The firm is located in Little Rock, Arkansas.[113] The company began operations as a contract carrier in 1986 and obtained broker authority in 1989.[114] As a broker, FTS Fleet Services had business dealings with Hester. FTS Fleet Services' broker authority was temporarily revoked and reinstated in 2002, and its contract authority was revoked in 2008 and restored in May 2010.

According to the FMCSA, following the March 2010 accident, the president of Hester approached the owner of FTS Fleet Services about the possibility of FTS Fleet Services buying Hester. Both principals subsequently made verbal statements to the FMCSA indicating that a purchase transaction had taken place, resulting in FTS Fleet Services becoming the new owner of Hester.

On May 14, 2010, the principal of Hester filed form MCS-150—*Application for USDOT Number* and form OP-1—*Application for Motor Property Carrier and Broker Authority* with the FMCSA under the company name FTS Fleet Services, on behalf of the owner of FTS Fleet Services. The physical address and telephone numbers on the forms were those of Hester, which, at the time, was going through the cease operations order process as a result of the "unsatisfactory" rating the FMCSA issued to it in April 2010. The OP-1 form indicated that the company FTS Fleet Services already had a DOT number, 2030556, and an MC number, 189686. These were the authority numbers of FTS Fleet Services, not of Hester. The person signing the forms, the principal of Hester, indicated that he was the president of the applying company (FTS Fleet Services).

On June 7, 2010, the FMCSA approved the application for operating authority and placed the company in the new entrant program. By June 10, 2010, FTS Fleet Services was operating with many of the same drivers and vehicles that Hester had used.

[113] FTS Fleet Services operates under the FMCSA-authorized DOT number 2030556 and MC number 189686.

[114] As a broker, FTS Fleet Services would serve as an agent between carriers and companies needing freight shipping and would negotiate and schedule such jobs.

In September 2010, *The Trucker* online magazine learned of the FTS Fleet Services operations[115] and contacted the FMCSA for information. The FMCSA initiated an investigation into the business relationship between FTS Fleet Services and Hester. In late October 2010, the FMCSA conducted a compliance review of FTS Fleet Services at the former Hester location in Fayette, Alabama. At that time, the FMCSA was told that the owner of FTS Fleet Services was the owner of the operation conducting business in Fayette, that the past owner of Hester was the president of the operation, and that another past principal of Hester was an employee in the carrier's garage. According to the FMCSA, its investigators were at the Fayette facility for 4 days conducting the compliance review. FMCSA management determined that the similarity of personnel and assets between the previous company, Hester, and the existing company, FTS Fleet Services, warranted additional investigation. On November 1, a week after the compliance review concluded, the FMCSA investigators returned to the Fayette location and conducted an additional investigation. The compliance review ultimately resulted in a "non-rated" status determination for the carrier.

The FMCSA MCS-150 form provides the basic operating details of a company, including, if approved, its operating authority. Every 2 years, or whenever a significant change occurs in its operations, a company must submit a revised MCS-150 form to the FMCSA. On December 20, 2010, the NTSB requested and received from the FMCSA the following 2010 MCS-150 forms for FTS Fleet Services:

- Dated May 6, 2010—signed by the owner of Hester, who was identified as the president and sole proprietor of FTS Fleet Services; indicated a fleet of 52 trucks and 126 trailers, with a company address in Fayette, Alabama;
- Date May 11, 2010—signed by the owner of Hester, who was identified as the president and sole proprietor of FTS Fleet Services; indicated a fleet of 52 trucks and 116 trailers, with a company address in Fayette, Alabama;
- Dated June 9, 2010—signed by the owner of Hester, who was identified as the president of FTS Fleet Services; indicated the owner of FTS Fleet Services as the managing director of FTS Fleet Services; indicated a fleet of 36 trucks and 116 trailers, with a company address in Little Rock, Arkansas;
- Dated August 18, 2010—signed by the owner of Hester, who was identified as the president of FTS Fleet Services; indicated the owner of FTS Fleet Services as the managing director of FTS Fleet Services; indicated a fleet of 26 trucks and 116 trailers, with a company address in Little Rock, Arkansas; and
- Dated October 18, 2010—signed by the owner of Hester, who was identified as operations director of FTS Fleet Services; indicated the owner of FTS Fleet Services as the managing director of FTS Fleet Services; indicated a fleet of 28 trucks and 60 trailers, with a company address in Fayette, Alabama.

Representatives of the FMCSA's Alabama state office continued to investigate FTS Fleet Services concerning the MCS-150 information. Ultimately, FMCSA headquarters officials

[115] The matter was noted in the magazine's November 18, 2010, article on FTS Fleet Services and Hester.

determined that the FTS Fleet Services business arrangement to purchase Hester was a "gentleman's agreement" to operate the company and that no purchase transaction had occurred. A settlement was reached between Hester, FTS Fleet Services, and the FMCSA on January 7, 2011. That settlement agreement stated the following:

> FMCSA shall link the HESTER, INC. (USDOT No. 1222388) and FTS FLEET SERVICES L.L.C. (USDOT No. 2030556) commercial motor carrier performance, compliance, and enforcement histories, and FMCSA shall review RESPONDENT'S safety rating on or before FEBRUARY 4, 2011.

Because of the continuing operation of Hester and FTS Fleet Services, the FMCSA issued a pending claim for $35,080 against the linked "respondent" for violations, including evading regulations, operating after an unsatisfactory rating, operating when prohibited, and violating a final order.[116] The FMSCA and the respondent agreed to a settlement of $13,950 and the FMSCA agreed to review the respondent's safety rating on or before February 4, 2011. On February 3, 2011, the FMCSA conducted a compliance review that resulted in a "satisfactory" rating for the carrier. Many of Hester's vehicles and drivers, as well as the Hester facility in Fayette, Alabama, currently operate as components of the motor carrier FTS Fleet Services.

1.11 Regulation of Commercial Drivers' Cellular Telephone Use

The FMCSA issued an NPRM titled "49 CFR Parts 383, 384, 390, 391, and 392—Drivers of CMVs: Restricting the Use of Cellular Telephones; Notice of Proposed Rulemaking; request for comments," which was published at 75 *Federal Register* 80014 on December 21, 2010. The NPRM proposed to prohibit commercial motor vehicle drivers from using handheld mobile[117] devices, including handheld cellular telephones, when driving.

The NPRM also proposed new disqualification sanctions for interstate drivers of CMVs who fail to comply with this Federal prohibition and new disqualification sanctions for CDL holders who have multiple convictions for violating a state or local law or ordinance on motor vehicle traffic control that prohibits the use of handheld mobile telephones. Additionally, the NPRM proposed to prohibit interstate motor carriers from requiring or allowing drivers of CMVs to use handheld mobile telephones while operating in interstate commerce.

[116] FMCSA case number AL-2011-0182-US1225, January 7, 2011.

[117] The NPRM stated that in popular usage, mobile telephones are often referred to as "cell phones" and, therefore, the NPRM's proposed rules would apply to the range of technologies used to provide wireless telephone communications. The rule uses the broader term "mobile telephones" as well as the more popular term "cellular telephone" (often abbreviated as "cell phone").

In its response to the NPRM, the NTSB urged the FMCSA to go beyond the prohibition on handheld mobile device use and to develop a final rule that would prohibit drivers from using a handheld or hands-free wireless device while operating a CMV.[118]

[118] The NTSB affirmed this general position to prohibit wireless device use by CMV drivers in its recent comments on a Pipeline and Hazardous Materials Safety Administration NPRM, "Hazardous Materials: Restricting the Use of Cellular Phones by Drivers of Commercial Motor Vehicles in Intrastate Commerce" (*Federal Register*, vol. 76, no. 83 [April 29, 2011], p. 23923). The rulemaking proposes to prohibit the use of handheld mobile telephones, including handheld cellular telephones, by drivers during the operation of a motor vehicle containing certain quantities and types of hazardous materials.

2. Analysis

2.1 Introduction

This analysis explains the probable cause of the accident and includes discussion of the following safety issues identified in this report:

- The need to prohibit the use of cellular telephones by drivers of CMVs;
- The need to provide objective warrants, rather than general guidelines, for the application of median barriers;
- The need to revise state seat belt laws to include occupants of 15-passenger vans;
- The need to detect unsafe motor carriers attempting to obtain operating authority by submitting inaccurate or deceptive information to the FMCSA; and,
- The need to evaluate the performance of the FMCSA new entrant program.

The remainder of this introductory section discusses those elements of the investigation that the NTSB was able to determine did not affect the cause of the accident or the extent of its outcome.

It had been raining in the area of the accident some hours earlier, and the road remained wet in the early morning hours; but the rain had ceased, and temperatures were above freezing when the accident occurred. The truck was descending a slight grade, and the road would not have held standing water. The NTSB concludes that weather and road surface conditions were not factors in the accident.

The truck departed the southbound roadway at a 5° angle. This shallow angle of departure was not caused by an abrupt, evasive steering maneuver. Such an angle is consistent with a driver's drifting off the road due to distraction or fatigue. The NTSB concludes that the truck driver did not depart the roadway to avoid another vehicle or a roadway obstruction.

There was braking evidence in the median after the truck departed the roadway, indicating that the truck driver was not affected by a medically incapacitating event that prevented him from controlling the vehicle. Furthermore, the review of his medical history was unremarkable. He had seen an internist in January 2010, just 2 months before the accident, for low back pain, and that exam noted no indication of acute medical problems. Postaccident toxicological tests and autopsy information did not reveal any medical issues. The NTSB concludes that the truck driver was not incapacitated by a medical event that prevented him from controlling his vehicle.

Both sides of the southbound lanes approaching the point of road departure were inspected for vehicle debris or any evidence of a road hazard; none was found. Postaccident testing of the trailer's braking system indicated that it was functional, and there was evidence of braking in the median. Investigators examined the truck's steering system and found no anomalies. Postaccident internal inspection of the steering gear revealed that the center tooth on the output shaft had an overload torsional shear fracture. The input shaft assembly had corresponding damage to the right-hand side of the helix. When the two damaged areas were aligned, they indicated that the wheels had been pointed straight ahead on the truck when it struck the cut rock wall on the right side of the northbound travel lane.

The day before the accident, the truck underwent repair work to replace the driveline between the differentials on axles 2 and 3. Postaccident examination found that the intermediate drive shaft between axles 2 and 3 remained connected. Investigators found no evidence in the vehicle's mechanical systems to indicate that a system failure caused the vehicle to depart the roadway. The NTSB concludes that no investigative evidence indicated that mechanical failure on the truck was a factor in the accident.

Following the accident, emergency responders were dispatched, and the Hart County Ambulance Service was on scene 9 minutes after being notified by dispatch. Air medical service was available and responded to the incident commander's request for assistance. More than a dozen emergency response organizations and two private wrecker companies responded to the accident. The NTSB concludes that the initial emergency response to the accident was timely and sufficient. Police and fire response was delayed because of traffic conditions that necessitated an alternate approach route to the accident scene. Had the first responding unit communicated its access problems to dispatch, subsequent responding units could have been informed that the northbound route to the scene was blocked, which would have led them to select alternate routes to reach the accident. This communication problem was addressed by the emergency response organizations in debriefing meetings that followed the accident.

Due to the complexity of the dynamics of this collision, it was not possible to determine the exact speeds of the involved vehicles at impact. The broad range for assumptions concerning postcollision deceleration of the van and interpretation of the accident data in characterizing the van's collision with the wall limited the precision of speed calculations. Based upon the preimpact path of travel of the vehicles through the collision sequence, the damage to the involved vehicles, the damage to the cable barrier, and the postimpact trajectory of the involved vehicles, it appears the combination unit and the van were traveling near the posted speed limit of 70 mph when the combination unit departed the roadway. No evidence indicated that the driver of the van initiated braking or changed speed just prior to impact with the truck.

2.2 Cellular Telephone Use by Commercial Drivers

2.2.1 Driver Distraction Due to Cellular Telephone Use

In evaluating the possible role of cellular telephone distraction, the NTSB examined the proximity of cellular telephone use to the time and location of the accident, the nature of the cellular telephone use and how that use would affect driving performance, details about the calls based on witness interviews, and the nature of the driver error committed.

As indicated by the records of his cellular service provider, the truck driver repeatedly used his cellular telephone while driving. By mapping cellular tower service for the truck driver's telephone, investigators determined that the driver used his telephone to make calls, receive calls, send text messages, and receive text messages a total of 69 times while driving in the 24-hour period prior to the accident.

The truck driver placed four calls while driving on the morning of the accident; the first of these occurred at 4:28 a.m. He then received an incoming call at 4:51 a.m. The driver made additional outgoing voice calls at 5:03 a.m., 5:07 a.m., and 5:14 a.m. A friend of the driver said he received a call from the driver at 5:14 a.m. and talked to the driver about social plans, but he stated that the connection was dropped. According to the truck driver's cellular provider, the network did connect the two telephones, but the call duration was less than 1 second.[119] Consequently, the friend's recollection that he had a conversation with the driver is inconsistent with the information in the cellular telephone records. The friend's cellular records also show that he placed calls to the truck driver at 5:15 a.m., 5:16 a.m., 5:17 a.m., 5:19 a.m., 5:26 a.m., and 5:31 a.m. The persistence on the part of the friend, who made six calls in 16 minutes in an attempt to reach the truck driver, suggests that the suddenly dropped call may have been a cause of concern to the friend.

Based on the timing of known cellular telephone calls, the dropped call at 5:14 a.m., the repeated callback behavior of the friend (beginning at 5:15 a.m.), and the shallow departure angle of the accident vehicle from the roadway, the NTSB concludes that because he was distracted from the driving task by the use of his cellular telephone at the time of the accident, the truck driver did not maintain control of his vehicle.

2.2.2 NTSB Recommendation History on Cellular Telephone Use

In 2004, the NTSB investigated an accident involving a motorcoach that crashed into a bridge overpass on the George Washington Memorial Parkway in Alexandria, Virginia.[120] As the bus approached the Alexandria Avenue Bridge, it passed warning signs indicating that the bridge had only a 10-foot 2-inch clearance in the right lane. Nevertheless, the driver remained in the right lane and drove the 12-foot-tall bus under the bridge, colliding with the underside of the overpass, destroying the bus roof, and injuring 11 passengers. The bus driver reported that he had been talking on a hands-free cellular telephone when the accident occurred. The NTSB determined that the probable cause of this accident was the bus driver's failure to notice and respond to posted low-clearance warning signs and to the bridge itself, due to cognitive distraction resulting from conversing on a hands-free cellular telephone while driving. The NTSB's investigation resulted in the following recommendation to the FMCSA:

> Publish regulations prohibiting cellular telephone use by commercial driver's license holders with a passenger-carrying or school bus endorsement, while driving under the authority of that endorsement, except in emergencies. (H-06-27)

[119] According to the cellular provider of the friend who received the call, the duration of the call was 3 seconds. The provider indicated that it is not uncommon for a slightly longer duration in this range, as a result of system disconnect processing.

[120] *Motorcoach Collision with Alexandria Avenue Bridge Overpass, George Washington Memorial Parkway, Alexandria, Virginia, November 14, 2004*, Highway Accident Report NTSB/HAR-06/04 (Washington, DC: National Transportation Safety Board, 2006).

Safety Recommendation H-06-27 is "Open—Acceptable Response." A companion recommendation was made to the 50 states and the District of Columbia, as follows:

> Enact legislation to prohibit cellular telephone use by commercial driver's license holders with a passenger-carrying or school bus endorsement, while driving under the authority of that endorsement, except in emergencies. (H-06-28)

Safety Recommendation H-06-28 is currently classified with an "Open—Acceptable Response" overall status.

On September 27, 2010, the FMCSA issued a final rule that prohibits texting by CMV drivers while operating in interstate commerce and imposes sanctions, including civil penalties and disqualification, for drivers who fail to comply with this rule. Additionally, motor carriers are prohibited from requiring or allowing their drivers to engage in texting while driving.[121] On December 21, 2010, the FMCSA published an NPRM proposing to restrict the use of handheld mobile devices, including handheld cellular telephones, by CMV drivers while operating in interstate commerce as a necessary component of an overall strategy to reduce the number of accidents caused by distracted driving.[122] The FMCSA has not yet issued a final rule from this rulemaking, but, according to the FMCSA, it will issue a final rule before the end of 2011.

Other transportation modes have addressed the restriction of cellular telephone use. For example, the Federal Railroad Administration issued Emergency Order 26, which restricts railroad operating employees from using distracting electronic and electrical devices while on duty; the order took effect in October 2008 and was subsequently codified in regulation.[123]

2.2.3 Research on Driving Distractions

Research has demonstrated that distractions while driving degrade several aspects of driving performance, resulting in slower reaction times, slower driving speeds, and more frequent lapses in attention.[124] Further, studies have shown that conversing on a hands-free

[121] *Federal Register*, vol. 75, no. 186 (September 27, 2010), p. 59118.

[122] *Federal Register*, vol. 75, no. 244 (December 21, 2010), p. 80014.

[123] Federal Railroad Administration docket FRA-2009-0118 and 49 CFR Part 220.

[124] (a) D.L. Strayer and F.A. Drews, "Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers," *Human Factors*, vol. 46, no. 4 (2004), pp. 640–649. (b) K.E. Beede and S.J. Kass, "Engrossed in Conversation: The Impact of Cell Phones on Simulated Driving Performance," *Accident Analysis and Prevention*, vol. 38, no. 2 (2006), pp. 415–421. (c) D.L. Strayer and W.A. Johnston, "Driven to Distraction: Dual-Task Studies of Simulated Driving and Conversing on a Cellular Phone," *Psychological Science*, vol. 12 (2001), pp. 462–466. (d) J.L. Harbluk, Y.I. Noy, and M. Eizenman, *The Impact of Cognitive Distraction on Driver Visual Behavior and Vehicle Control*, TP#13889E (Ottawa, Canada: Transport Canada, 2002). (e) D.L. Strayer, F.A. Drews, and W.A. Johnston, "Cell Phone-Induced Failures of Visual Attention During Simulated Driving," *Journal of Experimental Psychology-Applied*, vol. 9, no. 1 (2003), pp. 23–32.

cellular telephone while driving impairs performance.[125] This substantial body of research indicates that changes in driving behavior occur when the cognitive distraction of a cellular telephone conversation diverts attention from driving, and that the use of either a handheld or a hands-free cellular telephone while driving can impair performance. In the case of the Munfordville truck driver, investigators could not determine whether the driver was using a handheld or hands-free device when he placed the 5:14 a.m. call that precipitated the accident; however, either action would have resulted in cognitive distraction.

The NTSB firmly believes that commercial drivers must focus their attention on operating their large, heavy commercial vehicles rather than switching their attention between driving tasks and telephone use. The NTSB does not differentiate between handheld and hands-free devices because research shows that both types of cellular telephones produce performance degradation. The NTSB restated this position in its response to the December 2010 NPRM by the FMCSA that proposed prohibiting the use of handheld mobile devices, including handheld cellular telephones, by drivers of CMVs. In its response to the proposed rulemaking, the NTSB asked the FMCSA to go beyond the prohibition on handheld mobile device use proposed in the NPRM and to develop a final rule that would prohibit drivers' use of a handheld or hands-free wireless device while operating a CMV. The NTSB took the same position in its comments on a recent Pipeline and Hazardous Materials Safety Administration NPRM proposing to prohibit the use of handheld mobile telephones, including handheld cellular telephones, by drivers during the operation of motor vehicles containing certain quantities and types of hazardous materials.[126] Therefore, the NTSB concludes that because changes in driving behavior occur when the cognitive distraction of a cellular telephone conversation diverts attention from driving, use of either a handheld or a hands-free cellular telephone while driving can impair driver performance.

2.2.4 Safety Benefit of Prohibiting Cellular Telephone Use

Wireless device use is pervasive in our society.[127] Although the use of cellular devices by accident drivers can be documented through records from cellular service providers, the distracting effect of these devices as a contributing factor in highway accidents is difficult to determine. It is usually necessary to attempt to obtain driver or eyewitness testimony. Beyond that evidence, which is rare, police officers must subpoena the billing records of the cellular service provider and analyze the time sequences for cellular use in relation to the accident timelines. Consequently, it is certain that accidents in which distraction due to use of wireless

[125] (a) C.J.D. Patten and others, "Using Mobile Telephones: Cognitive Workload and Attention Resource Allocation," *Accident Analysis and Prevention*, vol. 36, no. 3 (2004), pp. 341–350. (b) J.E.B. Tömros and A.K. Bolling, "Mobile Phone Use–Effects of Handheld and Handsfree Phones on Driving Performance," *Accident Analysis and Prevention*, vol. 37, no. 5 (2005), pp. 902–909. (c) D.A. Redelmeier and R.J. Tibshirani, "Association Between Cellular-Telephone Calls and Motor Vehicle Collisions," *The New England Journal of Medicine*, vol. 336, no. 7 (1997). (d) S. McEvoy and others, "Role of Mobile Phones in Motor Vehicle Crashes Resulting in Hospital Attendance: A Case-Crossover Study," *British Medical Journal* (July 2005).

[126] "Hazardous Materials: Restricting the Use of Cellular Phones by Drivers of Commercial Motor Vehicles in Intrastate Commerce," *Federal Register*, vol. 76, no. 83 (April 29, 2011), p. 23923.

[127] As of June 2010, there were 292.8 million wireless subscribers, and the U.S. population had a wireless penetration of 93 percent, according to midyear estimates by CTIA–The Wireless Association. See <http://www.ctia.org/media/industry_info/index.cfm/AID10323>, accessed March 6, 2011.

devices played a role are under-reported. NTSB analysis of FARS data (2005–2009) of fatal cross-median accidents on interstates determined that among vehicles that crossed the median, police cited cellular telephone use or presence as a potential contributing factor for 3.1 percent of passenger vehicles and 6.1 percent of truck-tractors.

The NTSB considers that driver education and rulemaking prohibiting the use of mobile cellular devices by commercial drivers would improve safety on the nation's highways by reducing the likelihood of, or preventing, accidents, as well as reducing the injuries and fatalities associated with distracted driving. This opinion is shared by the MCSAC, which has recommended rulemaking to ban the use of handheld and hands-free cellular telephones and text messaging by CDL drivers.[128] Similarly, since January 2009, the National Safety Council has advocated a total ban on wireless device use while driving, saying that the practice is clearly dangerous and leads to fatalities.[129]

The research examining the expected efficacy of bans on cellular telephones has been mixed. The Insurance Institute for Highway Safety (IIHS) recently conducted a study assessing the safety outcomes, as measured by insurance collision loss rates, for both handheld telephone bans and texting bans.[130] The IIHS found that state bans on the use of handheld cellular telephones have not decreased insurance claim rates. In a similar IIHS study of four states (California, Louisiana, Minnesota, and Washington) where the effect of texting bans could be evaluated, three of the four states experienced a statistically significant increase in insurance collision rates. In July 2011, the Governors Highway Safety Association (GHSA) released a report reviewing distracted driver research.[131] In part, the report was based on a search of 8 major research databases that included over 350 scientific papers on distracted driving published in the past decade. The GHSA report concluded that there was no evidence that cellular telephone laws have reduced crashes. However, one limitation of understanding the effects of these laws is that none of the bans examined included hands-free cellular telephone use.

The NTSB examined research on the effectiveness of company policies in limiting cellular telephone use by commercial drivers. The FMCSA considered the prevalence of crashes and near-crashes related to telephone use in a naturalistic study of commercial truck and bus drivers.[132] Unlike previous naturalistic research on commercial drivers, company cellular telephone policy was included as a variable. The study found that a company's cellular telephone policy was effective in reducing cellular telephone use by drivers. Further, the FMCSA study found that drivers working for companies with a cellular telephone policy also had fewer cellular

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[128] This position was reflected in a March 27, 2009, letter from the MCSAC chairperson to the FMCSA concerning the MCSAC National Agenda for Motor Vehicle Safety.

[129] For more information on the National Safety Council position, see <http://www.nsc.org/Pages/NationalSafetyCouncilCallsforNationwideBanonCellPhoneUseWhileDriving.aspx>, accessed July 25, 2011.

[130] See <http://www.iihs.org/research/topics/pdf/HLDI_Bulletin_27_11.pdf>, accessed July 5, 2011.

[131] E. Williams-Bergen and others, *Distracted Driving, What the Research Shows and What the States Can Do* (Governors Highway Safety Association, July 2011). The full text of the report is available at <http://statehighwaysafety.org/html/publications/pdf/sfdist11.pdf>, accessed July 22, 2011.

[132] J.S. Hickman, R.J. 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 (September, 2010).

telephone-related safety-critical events than drivers working for a company with no cellular telephone policy. Additional research supporting the benefits of company cellular telephone policy was conducted by the Network of Employers for Traffic Safety, which considered the crash rates per million miles of 45 companies from diverse industries.[133] The study included approximately 400,000 vehicles that logged more than 8 billion miles during 2009. This study found that company vehicle fleet crash rates were lowest at companies that had policies prohibiting cellular telephone use (both handheld and hands-free) and that had established strong consequences, including termination, for employees who violated such policies.

The efficacy of company cellular telephone policies may be related to the safety culture the company projects by employing such a policy. Further, companies with cellular telephone policies can provide a strong deterrent to violating the policy, through negative performance evaluations or employment termination. A prohibition on cellular telephones for commercial drivers would require all carriers affected by the ban to develop effective cellular telephone policies.

The circumstances of the Munfordville accident illustrate that the prohibition against cellular telephone use—both handheld and hands-free—should apply to all operators of CMVs, not just passenger-carrying drivers, as was recommended in Safety Recommendation H-06-27. No professional CDL driver should be using a cellular telephone, even in a hands-free mode, while operating a CMV. Commercial drivers, as evidenced by their required training, medical certification, and Federal oversight, are held to a higher safety standard than are private drivers. These factors indicate that CMV drivers should be required to maintain a higher degree of safety with respect to cellular telephone use, as well. Therefore, the NTSB reclassifies Safety Recommendation H-06-27 to the FMCSA "Closed—Superseded." To supersede Safety Recommendation H-06-27 with a broader recommendation, the NTSB recommends that the FMCSA prohibit the use of both handheld and hands-free cellular telephones by all CDL holders while operating a commercial vehicle, except in emergencies. Similarly, the NTSB reclassifies Safety Recommendation H-06-28 to the 50 states and the District of Columbia "Closed—Superseded." The NTSB recommends that the 50 states and the District of Columbia prohibit the use of both handheld and hands-free cellular telephones by all CDL holders while operating a commercial vehicle, except in emergencies.

[133] *Fleet Safety Benchmark Report Data Year 2009*, Network of Employers for Traffic Safety and SMS/FleetRisk Advisors (October 2010).

2.3 Driver Fatigue

Although many factors affect driver fatigue, the primary ones are (1) the previous night's sleep length and cumulative sleep loss, (2) the time of day, with consideration of circadian rhythm[134] and normal work schedule, (3) the length of time awake and time on task, and (4) potential sleep disorders. These prime indicators, as well as numerous individual considerations, provide evidence of fatigue involvement in any accident.[135]

Investigators of the Munfordville accident found the following evidence with respect to each of these factors. (1) The driver had not received a full night's sleep on the evening of March 25–26, the night before the accident. Based on cellular telephone tower evidence, he was stopped at a truck stop from 11:15 p.m. to shortly before 4:00 a.m. Consequently, given the time necessary to carry out minimal post- and predriving tasks, he had an opportunity to obtain only a little over 4 hours sleep, not the 7–9 hours needed for a full, restorative rest cycle. A 3–4 hour acute sleep loss impairs performance and alertness. Such acute sleep deprivation has been found to increase the risk of an injury crash, with a 2-hour sleep loss resulting in noticeable decrements in divided attention and vigilance.[136] Performance decrements are seen the day following even low levels of sleep loss—as little as 1 or 2 hours[137]—and the odds of being in a crash are 2.58 times higher for a driver who only had 6.0–6.9 hours of sleep the night before.[138]

On the two nights spent near Lansing, Michigan, awaiting repair of the truck, March 23 and 24, the driver stayed in a motel room and had no work requirements, indicating that he most likely had the opportunity to obtain 7–9 hours of rest and that he was not starting the trip experiencing cumulative sleep loss. During the 6.5 hours on March 25 that the driver waited for his truck to be repaired, he remained at the garage. His lack of cellular telephone activity for some periods of that time indicates that he may have napped during this interval, but given the circumstances of the garage's business environment, any possible naps would have been short and conducted under poor sleep conditions. (2) With regard to time of day, the driver began driving a little before 4:00 a.m. on the morning of March 26; the accident occurred at 5:14 a.m. In the early morning hours, the body's internal clock tends toward a low level of alertness. Examinations of accident risk versus time of day have indicated that the highest risk of a

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

[135] Three of these four factors were identified in *Uncontrolled In-Flight Collision with Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station, Guantanamo Bay, Cuba, August 18, 1993,* Aircraft Accident Report NTSB/AAR-94/04 (Washington, DC: National Transportation Safety Board, 1994). Since the adoption of that aviation report, the NTSB has added consideration of sleep disorders, due to their pervasiveness in society.

[136] (a) T. Roehrs and others, "Ethanol and Sleep Loss: A 'Dose' Comparison of Impairing Effects," *Sleep*, vol. 26, no. 8 (December 15, 2003), pp. 981–985. (b) M. Carskadon and T. Roth, "Sleep Restriction," in *Sleep, Sleepiness, and Performance*, pp. 155–167.

[137] (a) R.T. Wilkinson, R.S. Edwards, and E. Haines, "Performance Following a Night of Reduced Sleep," *Psychonomic Science*, vol. 5 (1966), pp. 471–472. (b) G. Belenky and others, "Patterns of Performance Degradation and Restoration During Sleep Restriction and Subsequent Recovery: A Sleep Dose-Response Study," *Journal of Sleep Research*, vol. 12 (2003), pp. 1–12.

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

drowsy/dozing driver accident occurs between 4:00 a.m. and 6:00 a.m.[139] (3) At the time of the accident, the driver had been driving for less than 2 hours, indicating that length of driving time was not a factor. (4) The driver had a BMI of 31.7; a BMI of greater than 30 puts him at risk for sleep apnea; however, the driver's wife stated that he did not have trouble sleeping and did not snore, and no medical evidence indicated that he had a sleep disorder.

The NTSB's review of fatigue factors determined that at least two of the four main fatigue indicators most likely affected this driver. The driver was affected by insufficient sleep on the night before the accident (factor 1), and he could have been affected by the early morning hour in which the accident occurred (factor 2). However, the investigation did not reveal any evidence that the driver's fatigue from these two factors negatively influenced his driving performance. Tire mark evidence in the median shows that the driver executed braking action within 1–2 seconds after departing the roadway. Cellular telephone records place him on the telephone at the time of the accident. In previous accidents, the NTSB has identified the tendency of fatigue to interfere with operators' ability to redirect their attention as a cause of accidents. In this accident, the driver's distraction caused by his use of a cellular telephone might have been aggravated by a reduced ability to shift his attention as required back to the dynamic driving environment. The NTSB concludes that the truck driver was fatigued at the time of the accident, which may have contributed to the distraction effects caused by the use of his cellular telephone.

2.4 Highway Median Barriers

2.4.1 Barrier Systems

Roadside design guidance[140] indicates that median barrier applications on divided interstate roads are not normally considered for medians wider than 50 feet.[141] However, because of the severity of cross-median crashes, many states, including Kentucky, have begun installing median barriers in accident-prone locations with median widths up to 75 feet, and accident mitigation analysis and cost/benefit model assessments have supported these decisions.[142] Median barriers are not required on any highway in the NHS. However, if a state determines to install a longitudinal or median barrier along an NHS highway, the barrier must meet TL-3

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

[140] For the purposes of this discussion and with respect to median barrier information, it should be emphasized that "guidance" and "guidelines" are not synonymous with "warrants." Warrants identify specific metrics, such as accident rate, ADT, and percentage of heavy vehicle traffic that, if exceeded, indicate a barrier should be placed in that location. Guidance and guidelines, in the context of this report, refer to less specific and often subjective indications that a barrier should be considered or that additional study may be appropriate.

[141] *Roadside Design Guide*, 3rd ed. (Washington, DC: American Association of State Highway and Transportation Officials, 2006), p. 3–1.

[142] (a) NCHRP Report 633, *The Impact of Shoulder Width and Median Width on Safety* (Washington, DC: Transportation Research Board, 2009). (b) E.T. Donnell and J.M. Mason, "Methodology to Develop Median Barrier Crash Warrant Criteria," *Journal of Transportation Engineering,* American Society of Civil Engineers, vol. 132, no. 4, (April 2006), pp. 269–281.

standards (at a minimum). TL-3 barriers are designed to redirect passenger cars but are usually inadequate for redirecting CMVs.

The severity of cross-median accidents is a significant factor in a state's decision to install median barriers along divided highways. In 2009, some 2,987 large trucks were involved in fatal accidents; fatalities in accidents involving large trucks made up about 10 percent of all fatalities in motor vehicle accidents that year.[143] Although the overall percentage of fatal accidents involving large trucks appears relatively small, their level of involvement in fatal cross-median crashes is higher than their percentage of registered vehicles or vehicle miles traveled. These numbers are less than exact and almost certainly represent an undercount because cross-median accidents can be difficult to identify using FARS data. Also, there is no single accepted definition of "cross-median crash,"[144] which adds to the uncertainty of the accident data.

Different barrier systems—categorized as rigid, semi-rigid, and flexible—have different characteristics. Flexible median barrier systems have the beneficial quality of being less destructive to vehicles and their occupants than rigid barriers, such as those made of concrete, and they are designed to capture rather than deflect errant vehicles. Although they are less expensive to install than many barrier systems, high-tension cable barriers involve higher maintenance costs because cable hits must be repaired[145] and increased maintenance carries with it an increased exposure risk to maintenance crews. Installation and use of high-tension cable barrier systems have increased throughout the states in recent years.[146] Between 2008 and 2010, Kentucky installed approximately 150 miles of cable barrier on six interstates and two state highways.

Because of the lack of appropriate Federal warrants on barriers, some states have developed their own detailed guidance about when and where median barriers should be used. The recent *Development of Guidelines for Cable Median Barrier Systems in Texas*[147] is a good example of the kind of work being initiated by the states. FHWA research has shown that cable barrier effectiveness is related to barrier design (for example, cable numbers, heights, and tensioning); configuration of the median (shape, width, slopes, and depth); and lateral position of

[143] For information, see <http://www.fmcsa.dot.gov/documents/facts-research/CMV-Facts.pdf> and <http://www.ai.volpe.dot.gov/CarrierResearchResults/HTML/2009Crashfacts/2009LargeTruckandBusCrashFacts.htm>, both accessed June 16, 2011.

[144] This issue will be discussed later in this Analysis; see section 2.4.6, "Definition of a Cross-Median Crash."

[145] One state manual on cable barrier maintenance noted that maintenance departments can expect seven hits per mile per year.

[146] Several surveys of state use of cable barrier systems have been conducted, and they show that use of the systems has increased markedly in recent years. The following references contain state survey information: (a) S. Cooner and others, *The Development of Guidelines for Cable Median Barrier Systems in Texas*, Report FHWA/TX-10/0-5609-2 (College Station, Texas: Texas Transportation Institute and the Federal Highway Administration, February 2009). (b) X. Qin and M. Wang, *High-Tension Median Cable Barrier In-Service Performance Evaluation and Cost Effectiveness Analysis*, 89th Annual Transportation Research Board Meeting, January 2010. (c) M. Ray and R. McGinnis, *Guardrail and Median Barrier Crashworthiness*, NCHRP Synthesis 244 (Washington, DC: Transportation Research Board, June 1997).

[147] *The Development of Guidelines for Cable Median Barrier Systems in Texas*, FHWA/TX-10/0-5609-2.

the barrier within the median.[148] However, no detailed Federal warrants exist for median barrier systems. Only general guidance is provided for median barrier implementation in the 2006 AASHTO *Roadside Design Guide*.

A 2005 Transportation Research Board paper reporting on NCHRP Project 17-14, *Improved Guidelines for Median Safety*, found that 76 percent (28 of 37 responding state transportation departments) used the *Roadside Design Guide*.[149] However, it also reported that 9 of 37 states had design guidelines that differed from the principles established in the *Roadside Design Guide*.

2.4.2 NTSB Recommendation History on Median Barriers

The NTSB addressed the issue of median barrier warrants in its report on the 1997 Slinger, Wisconsin, accident.[150] On February 12, 1997, a tractor/double-semitrailer combination unit with empty trailers was traveling on a four-lane, limited access highway when it lost control. The truck crossed a 50-foot depressed median and struck a flatbed loaded with lumber; in turn, the flatbed lost control, crossed the median, and was struck by a passenger van and a refrigerator truck. Eight of the nine passenger van occupants were killed. The NTSB concluded that the traffic volumes, speed, and history of median encroachment accidents warranted the installation of an effective median barrier system at the accident location. The NTSB also concluded that the warrant guidance for median barriers provided in the AASHTO *Roadside Design Guide* was inadequate. As a result of the investigation, the NTSB issued Safety Recommendation H-98-12 to the FHWA and a companion Safety Recommendation H-98-24 to AASHTO, as follows:

> Review, with the Federal Highway Administration, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadways. (H-98-24)

On February 2, 1999, the NTSB classified these recommendations "Open—Acceptable Response." In the subsequent years, several NCHRP projects have focused on median barrier safety.[151] The NTSB reiterated Safety Recommendations H-98-12 and -24 in the report of its

[148] K.S. Opiela, D. Marzougui, and C.D. Kan, *Developing Functional Design and Evaluation Requirements for Cable Median Barriers*, paper prepared for the 2011 Transportation Research Board Annual Meeting Program, p. 2.

[149] E.T. Donnell and W.E. Hughes, *State Transportation Agency Median Design and Safety Practices: Results From a Survey* (2005). (Manuscript submitted for publication and presentation consideration to the 84th Annual Meeting of the Transportation Research Board, National Research Council, Washington, DC).

[150] *Multiple Vehicle Crossover Accident, Slinger, Wisconsin, February 12, 1997*, Highway Accident Report NTSB/HAR-98/01 (Washington, DC: National Transportation Safety Board, 1998).

[151] The projects included NCHRP 17-14, *Improved Guidelines for Median Safety*; NCHRP 22-12, *Guidelines for Selection, Installation, and Maintenance of Highway-Safety Features;* NCHRP 15-30, *Median Intersection Design for Rural High-Speed Divided Highways*; NCHRP 22-14(2), *Improved Procedures for Safety-Performance Evaluation of Roadside Features*; NCHRP 22-21, *Median Cross-Section Design for Rural Divided Highways*; and NCHRP 22-22, *Placement of Traffic Barriers on Roadside and Median Slopes*.

investigation of another cross-median accident, which took place near Largo, Maryland, in 2002.[152]

In 2007, the NTSB noted that in chapter 6 of the 2006 revision of the AASHTO *Roadside Design Guide*, the FHWA, in cooperation with AASHTO, had published updated median barrier guidelines. The revised text encourages the states to evaluate the need for a median barrier on freeways where traffic volumes exceed 20,000 vehicles per day for median widths of up to 50 feet, as well as for areas where an accident problem exists.[153] The 2006 *Roadside Design Guide* also notes that an evaluation may be made for high-speed, high-volume divided highways, operating like freeways, where an accident problem has been documented. For states that have not yet developed their own analyses of accident data, the revised *Roadside Design Guide* encourages the use of an accident-based warrant; examples would include the warrant review developed by the California Department of Transportation[154] or as documented in research supported by the Pennsylvania Department of Transportation.[155] Based on these revisions to the 2006 *Roadside Design Guide*, and on the revisions to the testing under MASH that addressed changes to the fleet, the NTSB classified Safety Recommendation H-98-12 to the FHWA "Closed—Acceptable Action" on September 17, 2007. Because of the ongoing NCHRP work by AASHTO and policy work by the states, Safety Recommendation H-98-24 to AASHTO remained "Open—Acceptable Response."

The NTSB also addressed high-performance barrier warrants in a recommendation made to AASHTO in 2005, as a result of its investigation of two consecutive cross-median accidents that took place in Fairfield, Connecticut.[156] The NTSB recommended that AASHTO take the following action:

> Establish warrants in the *Roadside Design Guide* regarding the selection and use of high-performance barriers, including 42- and 50-inch-high concrete barriers, that are capable of redirecting heavy trucks. (H-05-31)

Safety Recommendation H-05-31 is classified "Open—Acceptable Response." Although this recommendation is not specific to median barriers, it does recognize the need for warrants particular to the selection and use of high-performance barriers.

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[152] *Ford Explorer Sport Collision With Ford Windstar Minivan and Jeep Grand Cherokee on Interstate 95/495 Near Largo, Maryland, February 1, 2002*, Highway Accident Report NTSB/HAR-03/02 (Washington, DC: National Transportation Safety Board, 2003).

[153] In 2004, the FHWA determined that two-thirds of cross-median crashes occurred at locations where the median width was 50 feet or less.

[154] J.B. Borden, *Median Barrier Study Warrant Review*, California Department of Transportation, December 1997.

[155] E.T. Donnell and J.M. Mason (2006).

[156] *Multiple Vehicle Collision on Interstate 95, Fairfield, Connecticut, January 17, 2003*, Highway Accident Report NTSB/HAR-05/03 (Washington, DC: National Transportation Safety Board, 2005).

2.4.3 Median Barrier Warrants for Heavy Vehicles

The high-tension median cable barrier at the accident location was a TL-4 design, installed in accordance with TL-3 performance criteria because it was on a 1:4 slope. The implementation of the MASH revised the single-unit truck performance test for TL-4 barriers. The test vehicle weight was increased from 18,000 to 22,000 pounds, and the impact speed was increased from 50 to 56 mph. The changes created a more rigorous test that distinguished the TL-4 from the TL-3 criteria.[157] The design force value for TL-3 and TL-4 barriers under NCHRP Report 350 was 54 kips in the transverse or lateral direction. Under the MASH, the TL-4 transverse design value is 76 kips.[158] A 76,660-pound vehicle traveling at 60 mph[159] with an impact angle of 15° would have an estimated applied force approaching 200 kips. The NTSB concludes that the forces in this accident exceeded the capability of a cable barrier system that was not designed to safely contain or redirect a heavy vehicle such as the accident truck.

As noted above, some AASHTO member states have conducted research and established policies concerning median barrier systems that are more extensive and detailed than those provided in the median barrier implementation guidelines of the current edition of the *Roadside Design Guide*. A TL-5 median barrier, designed to contain and redirect heavy trucks, would have been needed in the I-65 median to prevent this cross-median crash; however, the rural nature of this area and the lack of *Roadside Design Guide* criteria for the use of high-performance barriers resulted in Kentucky's using a TL-3 barrier system. Consequently, the NTSB concludes that the *Roadside Design Guide* provides inadequate warrants and standards for the selection and installation of median barriers along roadways with high volumes of heavy vehicle traffic. Moreover, the warrants needed by the states to make informed cost/benefit decisions should include quantifiable variables such as median width, accident frequency, accident severity, traffic volume, percentage of heavy traffic, traffic speeds, degree of median cross slope, number of travel lanes, and degree of road curvature. The states also need warrants particularly to address median barrier performance characteristics appropriate to installation sites. Despite state action, AASHTO has not been sufficiently active in reviewing and revising guidance for the use of median barriers, particularly with regard to high-performance barriers. Therefore, the NTSB reclassifies Safety Recommendation H-98-24 to AASHTO "Closed—Superseded," and recommends that the FHWA and AASHTO work together to establish warrants and implementation criteria for the selection and installation of TL-4 and TL-5 median barriers on the NHS. Once they are available, AASHTO should publish these warrants and criteria in the *Roadside Design Guide*.

[157] The TL-5 criteria did not change from the parameters established in the previous standard, NCHRP Report 350.

[158] *Load and Resistance Factor Design Specification,* table A13.2-1.

[159] This force calculation uses a vehicle speed of 60 mph in recognition of the decrease in speed that would have occurred as the truck crossed the median prior to impact with the barrier.

2.4.4 Accident Rates and Heavy Vehicle Traffic Volume

The 2006 *Roadside Design Guide* recommends installing median barriers on high-speed, fully controlled-access highways where the median is 30 feet wide or less[160] and the ADT count is greater than 20,000 vehicles per day. These criteria were based on evaluations of crossover accidents carried out by California[161] and the Texas Transportation Institute,[162] as well as the judgment of an AASHTO task force. In the early 1990s, California revised its median barrier guidelines to include consideration of accident rates.[163] In 2008, Kentucky drafted *Guidelines for Median Barrier Applications on the Depressed Medians of Fully Controlled-Access Highways*, which incorporated the accident rates developed by California; that is, 0.50 cross-median crashes (of any severity) per mile per year or 0.12 fatal cross-median crashes per mile per year. The *Roadside Design Guide* states that for median widths greater than 50 feet, a barrier is usually only considered under special circumstances, such as at locations with a significant history of cross-median crashes. However, in 2004, the FHWA found that about one-third of cross-median crashes occurred at locations with median widths greater than 50 feet. Procedures to select an appropriate barrier performance level include "high percentage of heavy vehicle traffic" as a decision factor.[164] However, no metric defines what constitutes a "high percentage."[165] The NTSB concludes that the volume of heavy vehicle traffic should be a factor in median barrier selection. The NTSB recommends that the FHWA and AASHTO work together to identify cross-median crash rates that call for special consideration when selecting median barriers. Once they are available, AASHTO should publish the rates in the *Roadside Design Guide*. The NTSB also recommends that the FHWA and AASHTO work together to define the criteria for median barrier selection, including heavy vehicle traffic volume. Once they are available, AASHTO should publish the criteria in the *Roadside Design Guide*.

2.4.5 High-Tension Cable Barrier Deflection

High-tension cable barriers are being used along highways that have substantial proportions of heavy truck traffic,[166] and one aspect of their placement is consideration of cable deflection from a crash impact. In the Munfordville case, the FHWA acceptance letters to Gibraltar noted that one barrier test installation used posts on 14-foot centers with 350-foot cables, resulting in a deflection of 7.0 feet. An additional TL-4 test, using posts spaced on

[160] The *Roadside Design Guide* recommends installing barriers on medians with widths of 30 feet and less; for medians with widths between 30 and 50 feet, a median may be recommended, depending on the results of further study. (See figure 14 of this report for reference.)

[161] V.D. Graf and N.C. Wingerd, *Median Barrier Warrants* (Sacramento, California: Traffic Department of the State of California, 1968).

[162] H.E. Ross, *Warrants for Traffic Barriers in Texas*, Research Report 140-8 (College Station, Texas: Texas Transportation Institute, Texas A&M University, 1974).

[163] L.L. Seamons and R.N. Smith, *Past and Current Median Cable Barrier Practices in California*, (Sacramento, California: California Department of Transportation, 1991).

[164] *Roadside Design Guide*, p. 6-3.

[165] *Supplemental Guidance on Safe Accommodation of Heavy Vehicles on U.S. Highways* (Washington, DC: Federal Highway Administration, Office of Safety, Office of Safety Design, October 8, 2004).

[166] With respect to I-65, about 35 percent of the traffic consisted of commercial vehicles.

30-foot centers, resulted in 9.3 feet of deflection. The Commonwealth of Kentucky installed posts on 10-foot center spacing.

In-service field installations differ considerably from MASH barrier test articles. The FHWA issued an acceptance letter to Gibraltar for the cable barrier system based on a 350-foot test article length, as specified in NCHRP Report 350. With the adoption of the MASH, the test article length has been increased to 600 feet. The cable barrier near Munfordville had an installation length of 9,504 feet (distance between anchor terminal fittings). Such lengths are not uncommon; for instance, Texas policy calls for the maximum run of cable length to be approximately 10,000 feet.[167] The NTSB concludes that, to adequately address cable barrier deflection, the test article evaluations for high-tension cable barrier systems conducted according to the MASH should consider the test length applications used in the field. To ensure that states include dynamic deflection considerations in the selection and installation of cable barrier systems, the NTSB recommends that the FHWA provide to state transportation agencies information from current research, such as NCHRP Project 22-25, *Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, about the safety risks associated with the installation of cable barrier systems that differs from the configuration of the system as designed and tested; information should include the risks associated with the dynamic deflection that may occur when installation distances between cable barrier anchorages differ from the 600-foot test length prescribed in the MASH. Because state transportation agencies use FHWA acceptance letters to qualify their selection of median barriers, the NTSB further recommends that the FHWA include, in its product acceptance letters for cable barrier safety devices, cautionary language reflecting current research, such as NCHRP Project 22-25, *Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, to warn state transportation agencies of the safety risks associated with the installation of cable barrier systems that differs from the configuration of the system as designed and tested; language should include the risks associated with the dynamic deflection that may occur when installation distances between cable barrier anchorages differ from the 600-foot test length prescribed in the MASH.

2.4.6 Definition of a Cross-Median Crash

There is no official, broadly accepted definition of the term “cross-median crash,” and the absence of such a definition has implications for understanding the accident history of any particular segment of highway. In addition, existing definitions of this term are not always clear and comprehensive. The following definition, taken from a recent FHWA/Texas report,[168] may illustrate the point:

> For the purposes of this project, the research team developed the following definition of a cross median crash: ‘A crash where a vehicle departs from its traveled way to the left, traverses the median separation between the highway’s directional lanes, and collides with a vehicle traveling in the opposite direction.’

[167] FHWA/TX-10/0-5609-2, p. 2–22.

[168] FHWA/TX-10/0-5609-2, p. 2–1.

The absence of a standard definition leaves many accident situations in doubt with regard to characterizing them as cross-median crashes. Questionable examples include the following: vehicles departing the roadway, crossing the median, and colliding with a tree; vehicles crossing the median and, while not hitting another vehicle, causing another vehicle to lose control; and vehicles prevented from crossing because they were contained by a median barrier. Moreover, because of this lack of a clear and comprehensive definition, FARS data, which rely on sequence-of-event coding, have difficulty characterizing an accident as a cross-median crash. Currently, there is no specified code in FARS to identify cross-median crashes; instead, the terminology “Motor Vehicle In-Transport on Different Roadway” is used, and this code may also include a vehicle falling from a bridge overpass onto a different road.[169] FARS data are crucial to understanding the extent of the cross-median crash problem and to developing solutions to address it—and no alternative comprehensive data sources are available in this area. The NTSB concludes that NHTSA data concerning cross-median crashes would be improved by a standard definition describing what constitutes a “cross-median crash.”

Following its investigation of an accident that occurred in 1997 in Slinger, Wisconsin,[170] the NTSB issued Safety Recommendation H-98-13 to the FHWA, asking it to revise the coding in the guidelines for the *Model Minimum Uniform Crash Criteria* to facilitate identification of cross-median crash events. That recommendation was “Closed—Acceptable Action” in February 1999, based on the FHWA’s explanation of a combination of coding parameters (sequence-of-event coding and trafficway descriptions) that could be used to identify cross-median crashes.[171] The NTSB’s difficulty in distinguishing cross-median crashes in FARS data analyses for this report illustrates the analytical complexity associated with trying to identify one of the most serious accident types. State transportation agencies regularly conduct cross-median crash analyses in support of barrier application decisions and, depending on how they use the FARS data, their results vary.

In light of the need for better accident analysis in this area, the NTSB recommends that NHTSA and GHSA work together to add a standard definition for “cross-median crash” and a data element for cross-median crash accidents to the *Model Minimum Uniform Crash Criteria*. Adding “crossed median” to each of the three attributes of crash data element C6—*First Harmful Event* could be an appropriate approach because those attributes (noncollision; collision with person, motor vehicle, or nonfixed object; and collision with fixed object) add meaning to further characterize the outcome of the median crossing. Providing a more direct characterization of cross-median crashes in the vehicle data element V20–*Sequence of Events* offers another possible solution.

[169] The terminology “Motor Vehicle In-Transport on Different Roadway” differs from “Motor Vehicle In-Transport on Same Roadway” in that it applies when the motor vehicle in transport leaves one roadway, enters a different roadway, and then has a collision with a motor vehicle in transport on that roadway. For example, the coding “Motor Vehicle In-Transport on Different Roadway” is used when one motor vehicle in transport travels across the median of a divided highway, enters oncoming traffic, and is struck, or when a motor vehicle in transport traveling on an overpass falls from the overpass to the roadway below and strikes or is struck by a motor vehicle moving on that roadway. This code is only used for the motor vehicle crossing over onto the other traffic way.

[170] NTSB/HAR-98/01.

[171] No coding change to the *Model Minimum Uniform Crash Criteria* was associated with the FHWA explanation.

2.5 Seat Belt Laws Affecting 15-Passenger Vans

2.5.1 Munfordville Accident Van

All 15 seat positions in the van were equipped with either lap belts or lap/shoulder belts. Of the 12 van occupants, only 4 were using safety restraints: a 4-month-old infant in a rearward-facing convertible child restraint in the second bench row directly behind the driver, an adult female occupant in the second row center seat position next to the infant, and two children, ages 3 and 5, in forward-facing child restraints in the left and center seat positions in the third bench row. Because of the severity and location of the intrusion into the interior, the 4-month-old infant and the adult seated in the second row sustained fatal head injuries. The two surviving children were not in the intrusion area and were strapped into child restraints held by seat belts, which kept them secure. The seats remained attached to the vehicle, and the children were harnessed by the child restraints throughout the accident sequence. The NTSB concludes that the two children who survived the accident did so because of the protection provided by their child restraint systems.

The remaining eight van occupants were unrestrained. For the unrestrained driver and passenger seat occupants of the first row, intrusion into the occupant space was the primary cause of the fatal injuries. The six remaining unrestrained occupants were thrown from their seating compartments. When the van came to final rest, the unrestrained adult occupant who had been in the back (fifth) row and the two unrestrained adult occupants who had been in the fourth row seated in the left and center seat positions were all found located behind the right front bucket seat. The two unrestrained adult occupants who were seated in the right-side seat positions in the third and fourth rows were ejected. The unrestrained occupant of the right front passenger seat was also ejected. The NTSB cannot determine whether the use of occupant restraints would have prevented the fatalities of all the unrestrained occupants, especially those in the area of intrusion, but restraint use would have prevented ejections and occupants' motion out of their seating locations. In addition, restraint use might have allowed the occupants to "ride down" the collision as the vehicle decelerated throughout the accident sequence. The NTSB concludes that had all the occupants of the 15-passenger van been restrained, some injuries might have been mitigated and the likelihood of ejections would have been reduced.

Seat belt use rates among occupants of 15-passenger vans involved in fatal accidents are significantly lower than those associated with occupants of other passenger vehicles. During the 5-year period from 2003 to 2007, about 67 percent of all occupants of 15-passenger vans that rolled over, resulting in fatal accidents, were unrestrained.[172] Occupants who were killed were four times as likely to be unrestrained as restrained.[173]

[172] By comparison, for the same period, 55 percent of passenger vehicle occupants in fatal crashes were unrestrained. See *Traffic Safety Facts Research Note,* "Fatalities to Occupants of 15-Passenger Vans, 1997–2006," DOT HS 810 947 (Washington, DC: National Highway Traffic Safety Administration, May 2008).

[173] For the 5-year period 2003–2007, out of the 1,367 occupants involved in such accidents, 212 of those killed were unrestrained and 716 of those surviving were unrestrained (68 percent unrestrained). See *Traffic Safety Facts Research Note,* "Fatalities to Occupants of 15-Passenger Vans, 2003–2007," DOT HS 811 143 (Washington, DC: National Highway Traffic Safety Administration, May 2009).

2.5.2 Safety Standards

Kentucky's occupant protection restraint law, KRS 189.125—*Requirements of use of seat belts, child restraint systems, and child booster seats,* limits its definition of motor vehicles covered by the law to those vehicles designed to carry 10 or fewer passengers. Such a narrow definition does not cover 15-passenger vans and similar vehicles that need seat restraints at least as much as smaller vehicles do. The NTSB concludes that the Kentucky seat belt statute is too restrictive in its definition of "vehicle" and does not afford safety benefits to occupants of 15-passenger vans. The NTSB recommends that the Commonwealth of Kentucky revise its seat belt law so that it applies to all vehicles designed to carry 15 or fewer passengers.

Treating 15-passenger vans as buses for the purposes of safety standards has created a gap in the application of state primary seat belt laws to larger passenger vehicles. However, determining the extent of that gap from state to state is difficult. Many safety organizations track state seat belt laws according to age, seating location, and fines,[174] but determining each state's treatment of 15-passenger vans is far from straightforward. Some states qualify the definition of "passenger vehicle" based on number of passengers (Virginia); some states qualify applicable vehicles by weight (Connecticut); and some states exempt buses or school buses (Hawaii). Few states specifically identify a requirement for seat belt use in 15-passenger vans (Texas). NHTSA regularly publishes the *Summary of Vehicle Occupant Protection Laws*,[175] which provides some information on the applicability of state seat belt laws to 15-passenger vans and indicates that gaps in coverage can and do exist. The nature and composition of the summary make it difficult to identify which states' seat belt laws apply to 15-passenger vans on a case-by-case basis. The NTSB concludes that, based on NHTSA's 2011 *Summary of Vehicle Occupant Protection Laws*, states other than Kentucky also may not require restraint use in 15-passenger vans. Therefore, to make certain that all states are aware of the possible consequences of failing to ensure that their seat belt laws apply to 15-passenger vans, the NTSB recommends that GHSA inform its members of the circumstances of this accident, emphasizing that most of the van occupants who died in the accident were not restrained by seat belts and that, like Kentucky, other states may have seat belt laws that do not include 15-passenger vans and similar vehicles.

2.6 Motor Carrier Oversight

2.6.1 Safety Assessment

Between starting operation in March 2004 and the date of the accident, the motor carrier, Hester, had not undergone an FMCSA compliance review. The FMCSA conducted a safety audit of Hester in November 2005 before granting the carrier permanent operating authority. The SafeStat oversight program in effect for 2004–2010 identified some problems with Hester. As a result, the carrier was rated "inspect" for roadside driver/vehicle safety inspections. Hester's vehicle out-of-service rate was similar to industry averages, and its accident rate was below

[174] For example, see the following websites <www.ghsa.org/html/stateinfo/laws/seatbelt_laws.html>, <www.iihs.org/laws/safetybeltuse.aspx>, and <http://www-nrd.nhtsa.dot.gov/Pubs/811378.pdf>, all accessed July 20, 2011.

[175] For the current (9th) edition, see <http://www.nhtsa.gov/staticfiles/nti/pdf/811458.pdf>, accessed July 25, 2011 (DOT HS 811 458).

1.5 accidents per million miles traveled (the rate the FMCSA deems deficient for the purposes of compliance review ratings). However, Hester's driver out-of-service rate was 11.0 percent, more than twice the industry average (5.3 percent). Hester had a safety rating of "E" as a result of roadside inspections. This rating corresponded to a low priority for compliance review.

Following the accident, the FMCSA conducted a compliance review of Hester in April 2010 that resulted in an "unsatisfactory" rating based on three critical violations and one acute violation. Violations were associated with driver and operational areas. The FMCSA did not accept Hester's corrective action plan, and it issued a cease operations order, to be effective June 5, 2010, and fined the carrier $13,950 for violations.

The NTSB notes that the postaccident compliance review affirmed what was indicated by roadside inspections, that Hester had inadequate safety controls related to drivers. As a matter of resource allocation, the FMCSA prioritizes compliance reviews, and Hester's overall rating did not call for a compliance review. The NTSB remains concerned that a carrier can perform poorly in one safety area and not be required to address this poor performance.

The NTBS has two open recommendations related to the safety rating and the compliance system that the FMCSA is currently revising and implementing, Safety Recommendations H-99-6 and H-07-3:

> Change the safety fitness rating methodology so that adverse vehicle and driver performance-based data alone are sufficient to result in an overall unsatisfactory rating for the carrier. (H-99-6)
>
> To protect the traveling public until completion of the Comprehensive Safety Analysis 2010 Initiative, immediately issue an Interim Rule to include all *Federal Motor Carrier Safety Regulations* in the current compliance review process so that all violations of regulations are reflected in the calculation of a carrier's final rating. (H-07-3)

The current status of both recommendations is "Open—Unacceptable Response."

The NTSB understands that the FMCSA is currently revising its safety rating and compliance system as it implements the CSA program, and the Board anticipates that, when fully implemented, the program will address these two recommendations. The NTSB is concerned that the CSA program, which supersedes the oversight functions of the FMCSA's previous programs, has been in development for years and has only been partially realized. Based on the FMCSA Administrator's June 23, 2010, testimony before Congress, the NTSB anticipates a final rule on the CSA program's Carrier Safety Fitness Determination to be published for comment by the end of 2011.[176]

[176] As of July 22, 2011, the regulatory calendar on the FMCSA website identified the publication date for the CSA final rule as December 29, 2011.

2.6.2 Hester's Postaccident Relationship With FTS Fleet Services

Hester had a business relationship with the transportation broker FTS Fleet Services. Following the March 2010 accident, the president of Hester approached the owner of FTS Fleet Services about the possibility of its buying Hester. Both principals subsequently told the FMCSA that a purchase transaction had taken place, resulting in FTS Fleet Services becoming the new owner of Hester. The FMCSA put Hester out of operation on June 5, 2010; but on June 7, 2010, the FMCSA unknowingly granted the business operation that had been Hester authority to operate as a motor property common carrier under the name FTS Fleet Services. This firm was placed in the FMCSA new entrant program and continued its trucking operations throughout the summer. Between May and October 2010, five MCS-150 forms were filed indicating significant changes in the operations of FTS Fleet Services. All five submissions were signed by the principal owner of Hester; three indicated that the carrier's vehicles were addressed in Fayette, Alabama; two gave the address as Little Rock, Arkansas. The number of vehicles and trailers differed on each submission, ranging from 26–52 trucks and 60–126 trailers. Media attention in September 2010 prompted the FMCSA to initiate an investigation into the business relationship between FTS Fleet Services and Hester. In late October 2010, the FMCSA conducted a compliance review of FTS Fleet Services in Fayette, Alabama, at the physical location that had been the business premises of Hester.

FMCSA management in Washington, D.C., began investigating Hester's affiliation with FTS Fleet Services. The principals of the original FTS Fleet Services and of Hester told the FMCSA that a purchase transaction had taken place. However, FTS Fleet Services was unable to produce a purchase contract for Hester. The vehicles and the physical location of the carrier FTS Fleet Services were the same as those of Hester, and the names of company officials for both Hester and FTS Fleet Services appeared in the application documents of the "new" motor carrier. On November 1, 2010, a week after the October compliance review, the FMCSA investigators returned and conducted an additional investigation, which eventually resulted in a "non-rated" status determination for the carrier. The FMCSA ultimately determined that FTS Fleet Services had not purchased Hester.

A settlement agreement was reached in January 2011, which indicated that the FMCSA determined that the FTS Fleet Services operation was a continuation of Hester's operation. As a result of the continuing operation of Hester and FTS Fleet Services (referred to jointly in the settlement as the "respondent"), the FMCSA issued a pending claim for $35,080 against the respondent for violations.[177] However, the FMSCA and the respondent agreed to a settlement of $13,950, and the FMSCA agreed to review the respondent's safety rating on or before February 4, 2011.

Although the FMCSA eventually identified the Hester/FTS Fleet Services relationship, the identification was made only because of a special examination, not through the usual oversight methods. In effect, Hester operated as a motor carrier for months after receiving the FMCSA's cease operations order. FTS Fleet Services tried to assist in Hester's circumvention of the oversight system and eventually was operating from the Hester facility with many of the same trucks and drivers that Hester had used. Consequently, the NTSB concludes that the

[177] FMCSA case number AL-2011-0182-US1225, January 7, 2011.

postaccident continuation of Hester's operations, despite a cease operations order against the firm, shows that FMCSA oversight was inadequate to detect a deceptive and unsafe carrier in a timely manner.

2.6.3 NTSB Past Recommendations on Oversight of New Motor Carriers

The NTSB has issued many recommendations concerning FMCSA oversight of new motor carriers. Some are relevant to the discussion of Hester.

In its report on an accident that took place in Victoria, Texas,[178] the NTSB recommended that the FMCSA take action to deter falsification of applicant filings, as stated in Safety Recommendation H-09-34:

> Seek statutory authority to deny or revoke operating authority for commercial interstate motor carriers found to have applications for operating authority in which the applicant failed to disclose any prior operating relationship with another motor carrier, operating as another motor carrier, or being previously assigned a U.S. Department of Transportation number. (H-09-34)

The FMCSA has indicated that it is using its NAS tool, as well as manual research, to identify passenger carriers that may be trying to use the new entrant process to evade outstanding enforcement orders. On this basis, and while awaiting information whether the reauthorization legislation under consideration by Congress will allow the FMCSA to deny or revoke operating authority for commercial interstate motor carriers that have submitted fraudulent applications, the NTSB classified Safety Recommendation H-09-34 "Open—Acceptable Response" on September 9, 2011.

The FMCSA's NAS Program uses data to identify newly registered carriers that may have a history of enforcement problems. The screening process seeks matches between new registrants and information provided by previously registered motor carriers. In a series of MCS-150 filings during summer 2010, Hester and FTS Fleet Services provided the FMCSA with false and incomplete information. The result was that FTS Fleet Services was included in the $13,950 fine associated with Hester's April 2010 compliance review, but the FMCSA imposed no other penalty on either firm with respect to their efforts at falsification and deception. The NTSB concludes that if no significant consequences result when motor carriers intentionally provide false information to the FMCSA, noncompliant motor carriers will continue to try to evade the system and reregister as reincarnated carriers. In a June 13, 2011, oral statement regarding bus safety before the U.S. House of Representatives Committee on Transportation and Infrastructure, the FMCSA Administrator stated that the FMCSA had "provided technical assistance to Congress for authority" to deal with unsafe bus operators, including establishing a "successor liability" standard for reincarnated companies and substantially higher penalties for companies that attempt to operate illegally. The FMCSA must develop similar capabilities for all motor carriers, not just bus operations. Consequently, the NTSB reiterates Safety Recommendation H-09-34 to the FMCSA.

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

Further, this accident and the associated investigation illustrate that the FMCSA must develop additional means of identifying unsafe motor carriers trying deceptively to re-enter the industry. The FMCSA has been using the NAS Program to identify passenger carriers with histories of poor safety performance. The agency has been applying the NAS Program screening process to newly registered passenger carriers before granting them operating authority. Had the NAS Program screening process been applied to the "FTS Fleet Services" cargo carrier that sought operating authority in summer 2010, its system of inspecting, comparing, and matching corporate identification information might have detected the suspicious relationship between this "new" carrier and the "out-of-business" Hester, which had an outstanding fine for safety compliance violations. Thus, the NTSB concludes that expanding the NAS Program to include all new motor carrier entrants, rather than limiting it to passenger-carrying operations, could help the FMCSA detect reincarnated and unsafe cargo carriers. Therefore, the NTSB recommends that the FMCSA apply the vetting criteria of the NAS Program to the information submitted by all new entrant motor carriers.

As a result of its investigation of a 2008 motorcoach accident near Sherman, Texas,[179] the NTSB made a recommendation to the FMCSA to determine the efficacy of its NAS Program. Specifically, Safety Recommendation H-09-21 asked the FMCSA to take the following action:

> Develop an evaluation component to determine the effectiveness of your New Applicant Screening Program. (H-09-21)

Safety Recommendation H-09-21 is classified "Open—Acceptable Response," pending implementation of a system for state agencies to conduct background investigations on applicants and to effectively screen new applicants. The FMCSA has made a host of programmatic changes in the last year; however, the performance of the newly instituted changes has not yet been assessed. A program such as NAS, which seeks to identify unsafe motor carriers, cannot be adequately measured by how many unsafe carriers are identified—it is also important to know how many are not detected. The NTSB recognizes that the FMCSA does not have the resources to conduct periodic compliance reviews of all motor carriers. However, the compliance review process offers the FMCSA the opportunity to evaluate how well the NAS Program worked in characterizing any motor carrier that underwent the initial screening process. For example, the NTSB conducted a comparison between the elements of Hester's 2010 postaccident compliance review and the 16 automatic failure regulations established in the 2008 new entrant final rule and determined that the FMCSA would have failed the carrier in a safety audit under that rule.[180] By comparing the failed elements of a compliance review against the results of the NAS Program screening for that carrier, the effectiveness of the NAS Program can begin to be assessed. The NTSB concludes that failure to compare the data obtained from the NAS Program review of a motor carrier with subsequent compliance review data for that carrier represents a missed opportunity to assess the effectiveness of the NAS Program. Consequently, the NTSB reiterates Safety Recommendation H-09-21 to the FMCSA.

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[179] *Motorcoach Run-Off-the-Bridge and Rollover, Sherman, Texas, August 8, 2008,* Highway Accident Report NTSB/HAR-09/02 (Washington, DC: National Transportation Safety Board, 2009).

[180] Failure would have resulted for Hester's not being in compliance with 49 CFR 383.37(a), "Knowingly allowing, requiring, permitting or authorizing an employee with a CDL which is suspended, revoked, or cancelled by a State or who is disqualified to operate a commercial motor vehicle."

3. Conclusions

3.1 Findings

1. Weather and road surface conditions were not factors in the accident.

2. The truck driver did not depart the roadway to avoid another vehicle or a roadway obstruction.

3. The truck driver was not incapacitated by a medical event that prevented him from controlling his vehicle.

4. No investigative evidence indicated that mechanical failure on the truck was a factor in the accident.

5. The initial emergency response to the accident was timely and sufficient.

6. Because he was distracted from the driving task by the use of his cellular telephone at the time of the accident, the truck driver did not maintain control of his vehicle.

7. Because changes in driving behavior occur when the cognitive distraction of a cellular telephone conversation diverts attention from driving, use of either a handheld or a hands-free cellular telephone while driving can impair driver performance.

8. The truck driver was fatigued at the time of the accident, which may have contributed to the distraction effects caused by the use of his cellular telephone.

9. The forces in this accident exceeded the capability of a cable barrier system that was not designed to safely contain or redirect a heavy vehicle such as the accident truck.

10. The *Roadside Design Guide* provides inadequate warrants and standards for the selection and installation of median barriers along roadways with high volumes of heavy vehicle traffic.

11. The volume of heavy vehicle traffic should be a factor in median barrier selection.

12. To adequately address cable barrier deflection, the test article evaluations for high-tension cable barrier systems conducted according to the *Manual for Assessing Safety Hardware* should consider the test length applications used in the field.

13. National Highway Traffic Safety Administration data concerning cross-median crashes would be improved by a standard definition describing what constitutes a "cross-median crash."

14. The two children who survived the accident did so because of the protection provided by their child restraint systems.

15. Had all the occupants of the 15-passenger van been restrained, some injuries might have been mitigated and the likelihood of ejections would have been reduced.

16. The Kentucky seat belt statute is too restrictive in its definition of “vehicle” and does not afford safety benefits to occupants of 15-passenger vans.

17. Based on the National Highway Traffic Safety Administration’s 2011 *Summary of Vehicle Occupant Protection Laws*, states other than Kentucky also may not require restraint use in 15-passenger vans.

18. The postaccident continuation of Hester, Inc.’s, operations, despite a cease operations order against the firm, shows that Federal Motor Carrier Safety Administration oversight was inadequate to detect a deceptive and unsafe carrier in a timely manner.

19. If no significant consequences result when motor carriers intentionally provide false information to the Federal Motor Carrier Safety Administration, noncompliant motor carriers will continue to try to evade the system and reregister as reincarnated carriers.

20. Expanding the New Applicant Screening Program to include all new motor carrier entrants, rather than limiting it to passenger-carrying operations, could help the Federal Motor Carrier Safety Administration detect reincarnated and unsafe cargo carriers.

21. Failure to compare the data obtained from the New Applicant Screening Program review of a motor carrier with subsequent compliance review data for that carrier represents a missed opportunity to assess the effectiveness of the New Applicant Screening Program.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the truck driver’s failure to maintain control of the truck-tractor combination vehicle because he was distracted by use of his cellular telephone. Contributing to the severity of the accident were a median barrier that was not designed to safely contain or redirect the heavy vehicle and the lack of adequate guidance to the states in the form of high-performance median barrier warrants.

4. Recommendations

4.1 New Recommendations

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

To the Federal Highway Administration:

> Work with the American Association of State Highway and Transportation Officials to establish warrants and implementation criteria for the selection and installation of Test Level Four and Test Level Five median barriers on the National Highway System. (H-11-21)
>
> Work with the American Association of State Highway and Transportation Officials to identify cross-median crash rates that call for special consideration when selecting median barriers. (H-11-22)
>
> Work with the American Association of State Highway and Transportation Officials to define the criteria for median barrier selection, including heavy vehicle traffic volume. (H-11-23)
>
> Provide to state transportation agencies information from current research, such as National Cooperative Highway Research Program Project 22-25, *Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, about the safety risks associated with the installation of cable barrier systems that differs from the configuration of the system as designed and tested; information should include the risks associated with the dynamic deflection that may occur when installation distances between cable barrier anchorages differ from the 600-foot test length prescribed in the *Manual for Assessing Safety Hardware*. (H-11-24)
>
> Include, in your product acceptance letters for cable barrier safety devices, cautionary language reflecting current research, such as National Cooperative Highway Research Program Project 22-25, *Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, to warn state transportation agencies of the safety risks associated with the installation of cable barrier systems that differs from the configuration of the system as designed and tested; language should include the risks associated with the dynamic deflection that may occur when installation distances between cable barrier anchorages differ from the 600-foot test length prescribed in the *Manual for Assessing Safety Hardware*. (H-11-25)

To the Federal Motor Carrier Safety Administration:

Prohibit the use of both handheld and hands-free cellular telephones by all commercial driver's license holders while operating a commercial vehicle, except in emergencies. (H-11-26) [This recommendation supersedes Safety Recommendation H-06-27.]

Apply the vetting criteria of the New Applicant Screening Program to the information submitted by all new entrant motor carriers. (H-11-27)

To the National Highway Traffic Safety Administration:

Work with the Governors Highway Safety Association to add a standard definition for "cross-median crash" and a data element for cross-median crash accidents to the *Model Minimum Uniform Crash Criteria*. (H-11-28)

To the 50 states and the District of Columbia:

Prohibit the use of both handheld and hands-free cellular telephones by all commercial driver's license holders while operating a commercial vehicle, except in emergencies. (H-11-29) [This recommendation supersedes Safety Recommendation H-06-28.]

To the Commonwealth of Kentucky:

Revise your seat belt law so that it applies to all vehicles designed to carry 15 or fewer passengers. (H-11-30)

To the American Association of State Highway and Transportation Officials:

Work with the Federal Highway Administration to establish warrants and implementation criteria for the selection and installation of Test Level Four and Test Level Five median barriers on the National Highway System, and publish those warrants and criteria in the *Roadside Design Guide*. (H-11-31) [This recommendation supersedes Safety Recommendation H-98-24.]

Work with the Federal Highway Administration to identify cross-median crash rates that call for special consideration when selecting median barriers, and publish the rates in the *Roadside Design Guide*. (H-11-32)

Work with the Federal Highway Administration to define the criteria for median barrier selection, including heavy vehicle traffic volume, and publish the criteria in the *Roadside Design Guide*. (H-11-33)

To the Governors Highway Safety Association:

Work with the National Highway Traffic Safety Administration to add a standard definition for "cross-median crash" and a data element for cross-median crash accidents to the *Model Minimum Uniform Crash Criteria*. (H-11-34)

Inform your members of the circumstances of this accident, emphasizing that most of the van occupants who died in the accident were not restrained by seat belts and that, like Kentucky, other states may have seat belt laws that do not include 15-passenger vans and similar vehicles. (H-11-35)

4.2 Previously Issued Recommendations Reiterated in This Report

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

To the Federal Motor Carrier Safety Administration:

Seek statutory authority to deny or revoke operating authority for commercial interstate motor carriers found to have applications for operating authority in which the applicant failed to disclose any prior operating relationship with another motor carrier, operating as another motor carrier, or being previously assigned a U.S. Department of Transportation number. (H-09-34)

Develop an evaluation component to determine the effectiveness of your New Applicant Screening Program. (H-09-21)

4.3 Previously Issued Recommendations Reclassified in This Report

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

To the Federal Motor Carrier Safety Administration:

Publish regulations prohibiting cellular telephone use by commercial driver's license holders with a passenger-carrying or school bus endorsement, while driving under the authority of that endorsement, except in emergencies. (H-06-27)

Safety Recommendation H-06-27 is reclassified "Closed—Superseded" (superseded by Safety Recommendation H-11-26).

To the 50 states and the District of Columbia:

> Enact legislation to prohibit cellular telephone use by commercial driver's license holders with a passenger-carrying or school bus endorsement, while driving under the authority of that endorsement, except in emergencies. (H-06-28)

Safety Recommendation H-06-28 is reclassified "Closed—Superseded" (superseded by Safety Recommendation H-11-29).

To the American Association of State Highway and Transportation Officials:

> Review, with the Federal Highway Administration, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadways. (H-98-24)

Safety Recommendation H-98-24 is reclassified "Closed—Superseded" (superseded by Safety Recommendation H-11-31).

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Adopted: September 13, 2011

5. Appendix: Investigation

The National Transportation Safety Board (NTSB) received notification of this accident on March 26, 2010. The NTSB launched a team of investigators to address motor carrier, survival, human performance, vehicle, and highway factors. NTSB Vice Chairman Hart took part in the on-scene investigation.

Parties to the investigation were the Federal Highway Administration; the Federal Motor Carrier Safety Administration; the Kentucky Transportation Cabinet; the Kentucky State Police; the Hart County Office of Emergency Management; Gibraltar Cable Barrier Systems, L.P.; TRW Automotive; and Hester, Inc.

No investigative hearing was held in connection with this accident.