Collision Between a Ford Dump Truck and Four Passenger Cars Glen Rock, Pennsylvania April 11, 2003

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NTSB/HAR-06/01

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Notation 7743A

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Washington, D.C.

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Adopted February 7, 2006

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

National Transportation Safety Board. 2006. *Collision Between a Ford Dump Truck and Four Passenger Cars, Glen Rock, Pennsylvania, April 11, 2003*. Highway Accident Report NTSB/HAR-06/01. Washington, DC.

Abstract: About 3:36 p.m. on April 11, 2003, in the Borough of Glen Rock, Pennsylvania, a 1995 Ford dump truck owned and operated by Blossom Valley Farms, Inc., was traveling southbound on Church Street, a two-lane, two-way residential street with a steep downgrade, when the driver found that he was unable to stop the truck. The truck struck four passenger cars, which were stopped at the intersection of Church and Main Streets, and pushed them into the intersection. One of the vehicles struck three pedestrians (a 9-year-old boy, a 7-year-old boy, and a 7-year-old girl), who were on the sidewalk on the west side of Church Street. The truck continued across the intersection, through a gas station parking lot, and over a set of railroad tracks before coming to rest about 300 feet south of the intersection. As a result of the collision, the driver and an 11-year-old occupant of one of the passenger cars received fatal injuries, and the three pedestrians who were struck received minor-to-serious injuries. The six remaining passenger car occupants and the truck driver were not injured.

Major safety issues identified in this report include maintaining air brakes equipped with automatic slack adjusters, the knowledge and skills needed to drive air brake-equipped vehicles, and motor carrier oversight.

As a result of its investigation of this accident, the Safety Board makes safety recommendations to the Federal Motor Carrier Safety Administration, the 50 States and the District of Columbia, the Commercial Vehicle Safety Alliance, manufacturers and marketers of automatic slack adjusters, manufacturers of vehicles equipped with air brakes, the National Institute for Automotive Service Excellence (ASE), and publishers of ASE certification test study guides.

Contents

Acronyms and Abbreviations

AAMVA	American Association of Motor Vehicle Administrators
ABS	antilock brake system
ADT	average daily traffic
ASA	automatic slack adjuster
ASE	National Institute for Automotive Service Excellence
ATA	American Trucking Associations, Inc.
Blossom Valley	Blossom Valley Farms, Inc.
CCMTA	Canadian Council of Motor Transport Administrators
CDL	commercial driver's license
CFR	*Code of Federal Regulations*
CVSA	Commercial Vehicle Safety Alliance
EDSMAC4	Engineering Dynamics Simulation Model of Automobile Collisions, 4th revision
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSRs	*Federal Motor Carrier Safety Regulations*
GVWR	gross vehicle weight rating
HVE	Human, Vehicle, Environment
ISS-2	Inspection Selection System
MCMIS	Federal Motor Carrier Management Information System
NHTSA	National Highway Traffic Safety Administration
NPRM	notice of proposed rulemaking
OOIDA	Owner-Operator Independent Drivers Association
PennDOT	Pennsylvania Department of Transportation
psi	pounds per square inch
SafeStat	Safety Status Measurement System
SIMON	Simulation Model Non-linear
SRPD	Southern Regional Police Department
THC	tetrahydrocannabinol
UMTRI	University of Michigan Transportation Research Institute
USDOT	U.S. Department of Transportation

Executive Summary

About 3:36 p.m., eastern daylight time, on April 11, 2003, in the Borough of Glen Rock, Pennsylvania, a 1995 Ford dump truck owned and operated by Blossom Valley Farms, Inc., was traveling southbound on Church Street, a two-lane, two-way residential street with a steep downgrade, when the driver found that he was unable to stop the truck. The truck struck four passenger cars, which were stopped at the intersection of Church and Main Streets, and pushed them into the intersection. One of the vehicles struck three pedestrians (a 9-year-old boy, a 7-year-old boy, and a 7-year-old girl), who were on the sidewalk on the west side of Church Street. The truck continued across the intersection, through a gas station parking lot, and over a set of railroad tracks before coming to rest about 300 feet south of the intersection. As a result of the collision, the driver and an 11-year-old occupant of one of the passenger cars received fatal injuries, and the three pedestrians who were struck received minor-to-serious injuries. The six remaining passenger car occupants and the truck driver were not injured.

The National Transportation Safety Board determines that the probable cause of this accident was the lack of oversight by Blossom Valley Farms, Inc., which resulted in an untrained driver improperly operating an overloaded, air brake-equipped vehicle with inadequately maintained brakes. Contributing to the accident was the misdiagnosis of the truck's underlying brake problems by mechanics involved with the truck's maintenance; also contributing was a lack of readily available and accurate information about automatic slack adjusters and inadequate warnings about the safety problems caused by manually adjusting them.

During the investigation, the Safety Board identified the following major safety issues:

- Maintaining air brakes equipped with automatic slack adjusters,
- Knowledge and skills needed to drive air brake-equipped vehicles, and
- Motor carrier oversight.

As a result of this accident investigation, the Safety Board makes recommendations to the Federal Motor Carrier Safety Administration, the 50 States and the District of Columbia, the Commercial Vehicle Safety Alliance, manufacturers and marketers of automatic slack adjusters, manufacturers of vehicles equipped with air brakes, the National Institute for Automotive Service Excellence (ASE), and publishers of ASE certification test study guides.

Factual Information

The Accident

Synopsis

About 3:36 p.m., eastern daylight time, on April 11, 2003, in the Borough of Glen Rock, Pennsylvania, a 1995 Ford dump truck owned and operated by Blossom Valley Farms, Inc., (see figure 1) was traveling southbound on Church Street, a two-lane, two-way residential street with a steep downgrade, when the driver found that he was unable to stop the truck. The truck struck four passenger cars, which were stopped at the intersection of Church and Main Streets, and pushed them into the intersection. One of the vehicles struck three pedestrians (a 9-year-old boy, a 7-year-old boy, and a 7-year-old girl), who were on the sidewalk on the west side of Church Street. The truck continued across the intersection, through a gas station parking lot, and over a set of railroad tracks before coming to rest about 300 feet south of the intersection. As a result of the collision, the driver and an 11-year-old occupant of one of the passenger cars received fatal injuries, and the three pedestrians who were struck received minor-to-serious injuries. The six remaining passenger car occupants and the truck driver were not injured.

Figure 1. Accident truck. (Source: Southern Regional Police Department)

Narrative

The 21-year-old accident truck driver worked for Blossom Valley Farms, Inc., (Blossom Valley) an agricultural nursery, making deliveries of landscaping materials, including mulch, dirt, and stone. He had been working for Blossom Valley for 10 days

when the accident occurred. According to the accident driver,[1] on the day of the accident, he started work about 8:00 a.m., and his first delivery in the 1995 Ford dump truck consisted of 8 yards of mulch to an address in Parkton, Maryland. (See figure 2.) He also made his second and third deliveries, of 4 yards of mulch and 2 yards of Red Mountain Stone, respectively, to Parkton. On the way back from the third delivery, he stopped at a fast food restaurant in Shrewsbury, Pennsylvania, where he picked up food and then returned to Blossom Valley. He ate lunch in the truck while topsoil was loaded into the truck.[2] The fourth delivery of the day was a load of 14 yards of unscreened topsoil, which was being delivered a day late. The driver indicated that he knew it should take three trips to complete the topsoil delivery because the truck's capacity was limited to 5 scoops of wet topsoil[3] (it was raining at the time). The employee who loaded the truck told the driver he had loaded 7 scoops[4] and that the driver should go on with the delivery.

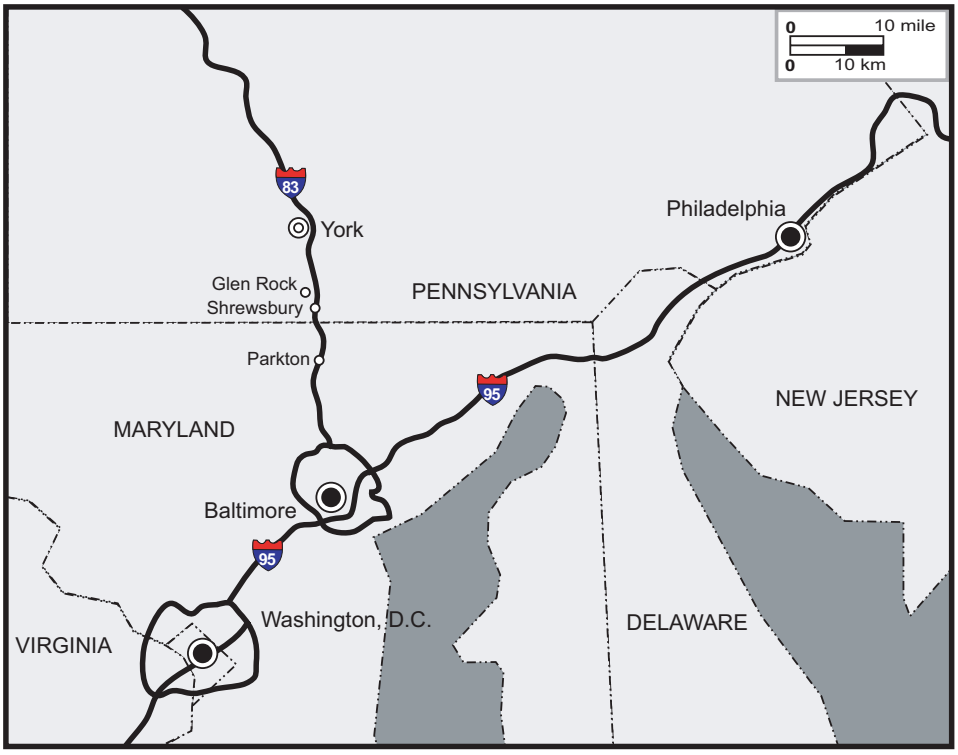

Figure 2. Map of the general region of the accident site.

[1] Southern Regional Police Department (SRPD) officers interviewed the accident driver on the day of the accident. A Safety Board investigator interviewed the accident driver on April 17, 2003.

[2] The truck was loaded using a front-end loader that had a bucket or scoop that held about 1 yard of material by volume. Blossom Valley charged its customers by the yard; the company loaded by the scoop; and the weight of the scoop varied depending on the material.

[3] A few days before the Glen Rock accident, the driver had a minor accident. At the time, the truck had been loaded with 7 scoops of unscreened topsoil. The driver said that when he told the owner about the minor accident, the owner told him that the truck should never be loaded with more than 5 scoops of topsoil.

[4] The postaccident weight of the 7 scoops was about 11,060 pounds (5.53 tons), or about 1,580 pounds (0.79 ton) per scoop. Five scoops would have weighed about 7,900 pounds (3.95 tons).

The driver indicated that he followed the directions printed on the delivery invoice given to him by his employer. He traveled north on the Susquehanna Trail and turned left on Church Street toward Glen Rock. He said he saw the "3/4 ton limit, Except Local Deliveries" signs at the beginning of Church Street but continued anyway because the directions given him by Blossom Valley told him to use that street and he thought he was making a local delivery. (See figures 3 and 4.) He said that he was traveling 25 to 35 mph on Church Street and stopped at the top of the hill near a water tower and electrical substation. (A witness following the truck indicated in a police interview that the accident truck did not stop.)

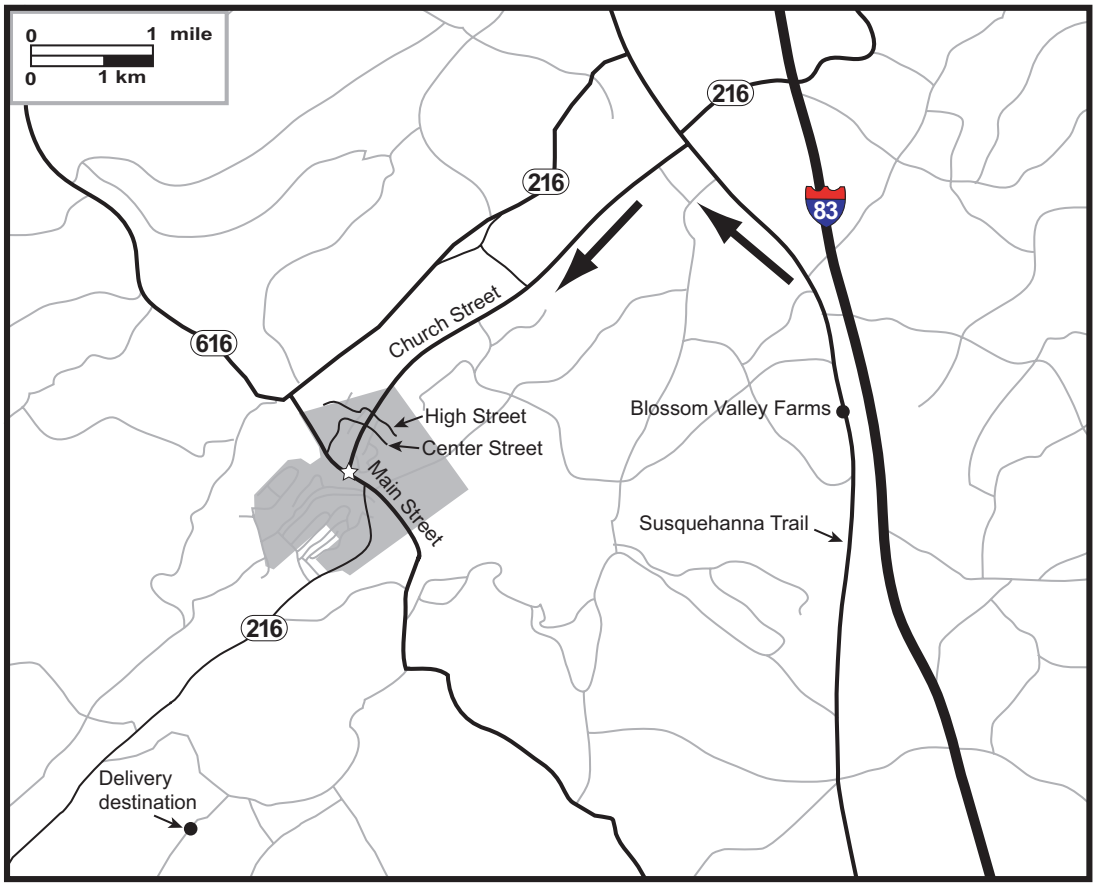

Figure 3. Map of the accident area, showing the Borough of Glen Rock (shaded area), the location of Blossom Valley Farms, and the intended delivery destination. The large arrows show the direction of the accident truck's travel.

Figure 4. Weight prohibition signs at the beginning of Church Street.
(Source: Pennsylvania Department of Transportation)

The accident driver stated that as he started down the hill (see figure 5), he did not select a lower gear. He said that at some point during the descent, he pumped his brakes and the truck began to speed up. He also stated that about a quarter of the way down the hill, he lost his brakes and the brake warning light in the truck began to flash. He said he knew then that he had brake problems because his boss and a coworker had told him that if the brake light flashed, he did not have enough pressure [air pressure].[5] He said he could not stop the truck, and he saw children and cars at the bottom of the hill. He indicated that he leaned out the window and yelled, "No brakes, get out of the way" as the truck neared Center Street (about 3 blocks from the accident site). He said he struck the back of a black car and thought he "went airborne." He said that he did not sound the horn and that he was not wearing a seat belt. He stated that his recollection of the events after the initial impact was "vague."

[5] The truck was equipped with air brakes, which convert compressed air into a linear force that acts upon a number of components to apply the brake shoes against the brake drum, creating friction, which stops the vehicle.

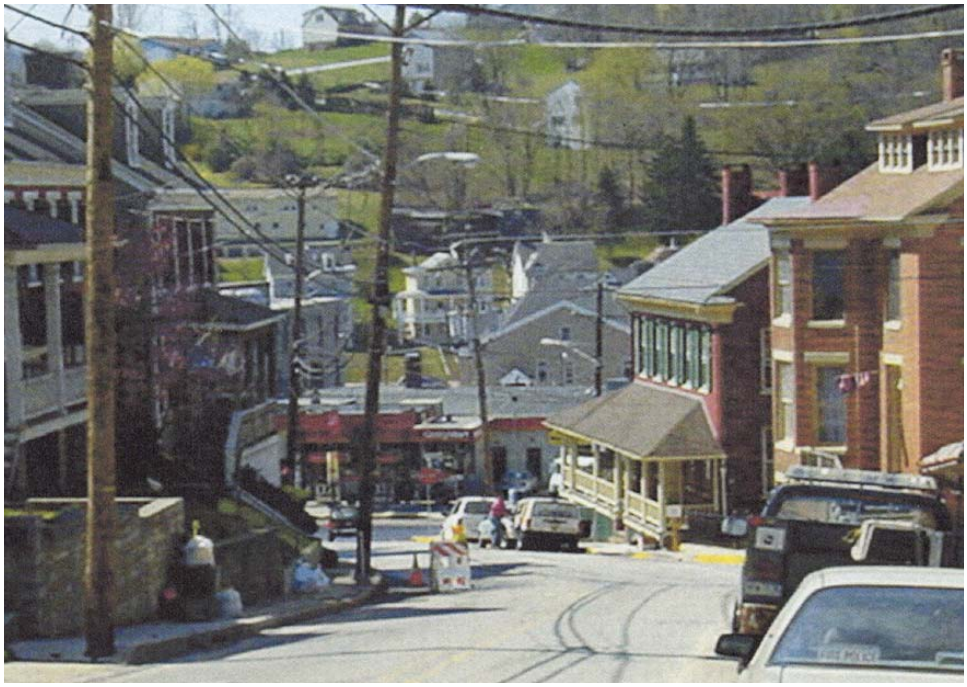

Figure 5. Descending grade on southbound Church Street.
(Source: Pennsylvania Department of Transportation)

Witnesses reported that just before the accident, a school bus had unloaded students on Main Street. After exiting the bus, the students crossed Church Street and, as the bus began to leave, they walked up the sidewalk on the west side of Church Street. Witnesses also reported that four passenger cars were stopped at the "STOP" sign for southbound traffic on Church Street, where it intersects with Main Street. The first car in the queue was a 1997 Pontiac Grand Prix, occupied by a driver and three passengers; the second was a 1996 Mazda Protégé, occupied by a driver; the third was a 1987 Chevrolet Nova, occupied by a driver and a front seat passenger; and the fourth was a 1993 Chevrolet Camaro, occupied by a driver.

About 107 feet north of the intersection, the accident truck struck the rear of the Camaro, causing it to rotate clockwise and pushing it into the Nova. The Nova rotated counterclockwise; the rear of the vehicle climbed the 6-inch-high curb and struck three children on the sidewalk and a metal post on a fence on the west side of the sidewalk. The Nova continued to rotate counterclockwise and struck the Mazda, pushing it forward into the rear of the Pontiac. The truck pushed the passenger cars into the intersection.

The Camaro came to rest near the northwest corner of the intersection of Church and Main Streets, facing south. The Nova came to rest with its front wheels on the southern sidewalk in front of the gas station, facing south. The Mazda and Pontiac came to rest in the parking area of the gas station, west of the Nova by about 25 feet and facing southeast. The accident truck proceeded across Main Street, through the western portion of the gas station parking lot, onto Water Street, across the railroad tracks, and then west

into an alley, coming to rest about 130 feet west of the intersection of the alley and Water Street. The truck traveled about 407 feet from its initial point of impact with the Camaro to its point of rest. (See figures 6 and 7.)

Figure 6. Intersection of Church Street and Main Street looking southbound on Church Street. (Source: Southern Regional Police Department)

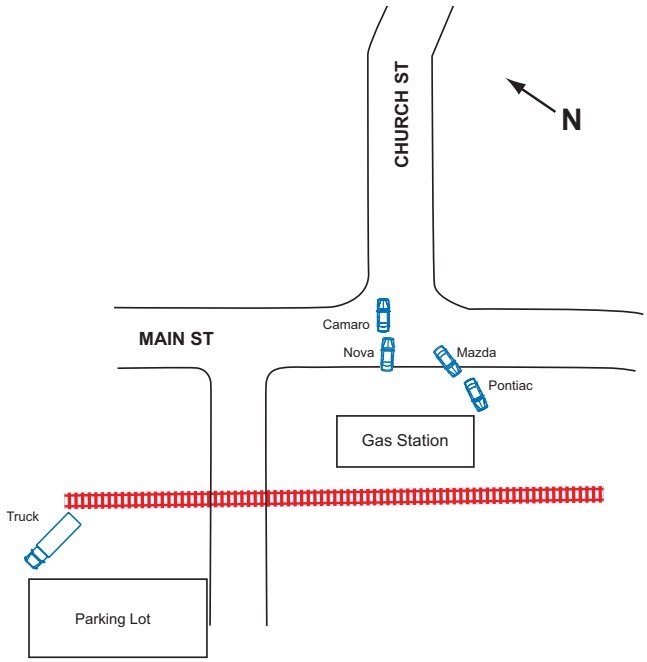

Figure 7. At-rest positions of the vehicles at the accident scene.

Emergency Response

SRPD, Glen Rock Fire and Ambulance, and Loganville Fire Company responders were dispatched at 3:36 p.m. Glen Rock Ambulance responders were on scene within a minute, Glen Rock Fire Department personnel were on scene by 3:39 p.m., and SRPD officers arrived on scene about 3:44 p.m. In addition, the Shrewsbury and New Freedom, Pennsylvania, fire companies responded to the accident. Glen Rock, Rose Fire Company, and Jacobus ambulance services transported patients to Penn State Hershey Medical Center and York Hospital.

Injuries

The following table is based on the International Civil Aviation Organization's injury criteria, which the Safety Board uses in accident reports for all transportation modes.

Table 1. Injuries.

Injury type[A]	Drivers	Passengers	Pedestrians	Total
Fatal	1	1	0	2
Serious	0	0	1	1
Minor	0	0	2	2
None	4	2	0	6
Total	5	3	3	11

[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, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface."

Driver Information

The 21-year-old truck driver lived in White Hall, Maryland, and had been working for Blossom Valley as a truck driver since April 1, 2003. He possessed a Maryland Class "C" noncommercial driver's license. This license permitted the driver to operate an automobile, station wagon, light truck, or any motor vehicle, except a motorcycle, with a gross vehicle weight of 26,000 pounds or less.[6] A commercial driver's license (CDL) is required to drive a single vehicle weighing 26,001 pounds or more.[7]

[6] Maryland Department of Transportation, Motor Vehicle Administration, *Maryland Driver's Handbook* (Glen Burnie, MD: Maryland Department of Transportation, September 1993).

[7] Title 49 CFR 383.23 and 383.91.

On the day of the accident, the driver was operating a commercial truck with a gross vehicle weight rating (GVWR)[8] of 26,000 pounds that was equipped with an air brake system, which does not operate in the same way that hydraulic brake systems for automobiles do. (This report will discuss operation of air brake systems in a subsequent section.) According to the accident driver, he had no experience driving an air-braked truck before Blossom Valley hired him, and the largest vehicle he had previously driven was a pickup truck. According to the driver and his employer, he received no air brake training. He said that he had been shown how to operate the lift on the accident truck. At the time of the accident, he had been driving the accident truck for less than a week. Postaccident, he told investigators that he did not know that pumping an air brake-equipped truck's brakes depleted the brakes' air pressure.

Three days before the accident, on April 8, 2003, the driver had a minor accident in the same truck, which he stated was due to loss of braking. (The driver's truck rolled into the back of a stopped passenger car. Neither vehicle suffered substantial damage.)

Truck Information

The accident truck was a 1995 Ford Motor Company, F-800 Series, 2-axle truck with a dump body. It was equipped with a Ford FD-1060 6-cylinder diesel engine that produced 175 horsepower at 2,500 rpm, an Allison model AT-545 4-speed automatic transmission, air brakes, and a hydraulic dump bed. It did not have an antilock brake system (ABS). The truck had an odometer reading of 145,095 miles. According to the manufacturer, the truck's GVWR was 26,000 pounds. The SRPD weighed the truck during the postaccident investigation and found the total weight to be 26,600 pounds. In July 2003, the Pennsylvania Department of Transportation (PennDOT) weighed the truck on portable scales with the load removed, and the empty weight was 15,540 pounds. The wheelbase was 207 inches, and the overall truck length was 25 feet, 5.5 inches.

The truck was equipped on the front and rear axles with standard S-cam drum foundation air brakes[9] with automatic slack adjusters (ASAs). A Bendix model 2150 single-cylinder, gear-driven compressor supplied air to the system. The air governor was a Bendix model D-2, permanently set at 110 pounds per square inch (psi).

As part of the Safety Board's normal protocol, investigators tested the brakes postaccident. The diesel engine was operable, and all air testing was done with air supplied by the engine-mounted Bendix compressor, using the vehicle foot valve (brake pedal) for brake testing. The diesel engine was started and full brake applications were made at about 90 psi of air pressure. No air leaks were discovered in the air brake system.

[8] The GVWR is the value (based on axle ratings) specified by the manufacturer as the loaded weight of a single vehicle.

[9] For the purposes of this report, the term "foundation brake system" (for cam-actuated brakes) means all mechanical components involved in providing braking force, including the brake chambers, S-cam and camshaft, brake drums, brake linings, slack adjusters, and all associated hardware, including washers, clevises, clevis pins, cotter pins, bushings, springs, and rollers.

The brake testing results, summarized in table 2, indicated that the pushrod stroke for both rear brakes exceeded the adjustment limit by 1/2 inch, resulting in little or no brake force for the rear wheels.

Table 2. Accident truck brake test results summary.

Axle	Air chamber size	Slack arm length[A]	Pushrod stroke	Adjustment limit[B]	Rated stroke[C]
Left front	T-16	5 1/2 in.	1 1/2 in.	1 3/4 in.	2 1/4 in.
Right front	T-16	5 1/2 in.	1 1/2 in.	1 3/4 in.	2 1/4 in.
Left rear	T-30	5 1/2 in.	2 1/2 in.	2 in.	2 1/2 in.
Right rear	T-30	5 1/2 in.	2 1/2 in.	2 in.	2 1/2 in.

[A] The distance from the center of the splined camshaft to the center of the clevis pin, which secures the pushrod to the slack adjuster; also known as the "lever arm length."

[B] The maximum pushrod stroke permitted. The values utilized for the "brake adjustment limit" are those stated in the *Commercial Vehicle Safety Alliance (CVSA) North American Standard Out-of-Service Criteria*. (Revised edition, April 2003.)

[C] The total length the pushrod can travel inside the air chamber. (When the "pushrod stroke" is equivalent to the "rated stroke," generally no braking forces are obtained when the brakes are applied.)

The truck was equipped with Gunite[10] ASAs on all four brakes. After the accident, Safety Board investigators removed the automatic adjusters from the rear brakes, along with the quick-connect clevises and clevis pins,[11] and took them to the Gunite facility for testing. The quick-connect clevises had wear in the clevis holes, where they attached to the slack adjusters, and some flexing was observed where the two parts met. The combination of wear in the clevis pin holes and flexing of the joints rendered the automatic feature of the ASAs inoperative. When tested with the clevises and clevis pins from the accident truck, the pushrod stroke would not go below 2 1/2 inches, at which point it produced little or no brake force. When the two rear adjusters were tested at the Gunite facility with new clevises and clevis pins, the adjusters worked correctly and kept the adjustment well under 2 inches.

All four brake drums were removed, examined, photographed, and measured. The front axle had 15-inch drums and the rear axle had 16.5-inch drums. Heat cracks were present in all the drums, and some discoloration (bluing) was found on the front drums, which were smooth. The drum diameters were measured with a calibrated Central Tool digital brake drum gauge, and all were within manufacturer's tolerances. The brake shoe widths were 4 inches for the front wheels and 7 inches for the rear wheels. The brake shoes had no observable cracks and exhibited no anomalies. All the shoes were measured and found to be within CVSA-established[12] tolerances.[13]

[10] Gunite Corporation of Rockford, Illinois, is a major manufacturer of wheel-end assemblies and components for the heavy-duty truck industry.

[11] The clevis and clevis pins connect the slack adjuster to the pushrod and are considered part of the foundation brake system. A quick-connect clevis is a two-part clevis that can wear and flex.

[12] The CVSA is a nonprofit organization dedicated to improving commercial vehicle safety that comprises Federal, State, and Provincial government agencies and representatives from private industry in the United States, Canada, and Mexico. The CVSA establishes and maintains commercial vehicle safety operational standards and practices, inspection procedures, out-of-service criteria, and enforcement practices and penalties that provide for uniformity, compatibility, and reciprocity among CVSA member jurisdictions and industry partners.

[13] According to the *CVSA North American Standard Out-of-Service Criteria*, it is a violation for a lining to be 1/4 inch (8/32 inch) below the wear indicator. (Revised edition, April 2003.)

The truck was equipped with a dash-mounted red brake warning light, which illuminated when the air pressure went below 70 psi. An audible alarm accompanied this illumination. The spring brakes (parking brakes) were automatically fully applied on the rear axle when the system air reached about 40 psi. Investigators installed air gauges in all the air chambers, or in the service air line just outside the chamber, to check the amount of air going into the chamber during a service brake (foot pedal) application. When a forceful application was made at 90 psi, the chamber gauge pressure read about 75 psi on all four wheel positions (about 15 pounds less than the applied pressure).

The parking brake test was conducted by pulling the parking brake valve that applied the spring brakes. The engine was started and the transmission was moved into "DRIVE" in an attempt to move the vehicle forward on a concrete floor. The truck moved forward with only a slight increase in engine rpm. The truck was then placed in "REVERSE" and, with minimal engine acceleration, it went backward, even with the parking brake applied.

Highway Information

Church Street (State Route 3008) is a two-lane, two-way rural road 2.7 miles long between the Susquehanna Trail (State Route 3001) to the north and Main Street (State Route 216) to the south. The Susquehanna Trail is a two-lane, north/south roadway, which parallels Interstate Highway 83 on the west between Harrisburg and the Pennsylvania/Maryland State Line. The topography of the surrounding area is rolling hills.

As Church Street enters the Borough of Glen Rock, the downgrade becomes increasingly steep,[14] from 3.4 percent near the top of the hill to 13 percent at the base of the hill (intersection with Main Street). According to PennDOT, the roadway width varies from 20 feet before entering the borough to 26 feet inside the borough. There is an 8-foot-wide parking lane on the west side of Church Street in the borough, next to housing, and the travel lanes are 9 feet wide. Solid, double, yellow lines separate the north/south lanes.

Main Street is a two-lane, two-way, east/west roadway traversing the Borough of Glen Rock. Immediately to the east of the intersection between Main Street and Church Street, a painted pedestrian crosswalk traverses Main Street. A gas station is located on the south side of the T-intersection of Church Street and Main Street.

The speed limit on Church Street traveling south from the Susquehanna Trail is 55 mph. The speed limit changes 1.2 miles south of the intersection to 40 mph and again 1.8 miles south of the intersection, as Church Street enters the Borough of Glen Rock, to 25 mph. The speed limit at the accident site (intersection of Church Street and Main Street) is 25 mph.

[14] On June 10, 2003, Safety Board investigators measured the descending grade on Church Street using a surveyor's transit at 32 points (every 50 feet) over a 3,300-foot distance to determine the grades on the roadway.

According to PennDOT, the average daily traffic (ADT) on Church Street in 1998 was 3,213, of which 8 percent was trucks and buses. In 2001, the ADT was 3,915, of which 9 percent was trucks and buses.

PennDOT data indicated that from January 1999 to December 2002, 11 traffic accidents occurred on Church Street within the Borough of Glen Rock. Of the 11 accidents, 1 involved a fatality, 1 a major injury, 4 moderate injuries, and 5 minor injuries. Two of the 11 accidents involved trucks.

According to PennDOT, in 1965, after a fatal accident involving a truck at or near the April 11, 2003, accident intersection, the Borough of Glen Rock requested and obtained a weight restriction of 1,500 pounds (load capacity) on Church Street, and the street was so posted. At the intersection of the Susquehanna Trail and Church Street are R5-2 signs conforming to the *Manual on Uniform Traffic Control Devices* indicating that Church Street is a weight-restricted street. The signs indicate that the load weights are limited to 3/4 ton (1,500 pounds), except for local deliveries. The weight restriction applies only in the Borough of Glen Rock. (Refer to figures 3 and 4.) For traffic traveling northbound on the Susquehanna Trail, an additional sign reads, "Trucks over 1 ton use [Pennsylvania State Route] 216 to Glen Rock." (See figure 8.)

Figure 8. Intersection of Susquehanna Trail and Church Street. Note the weight restriction sign directing trucks over 1 ton to use Pennsylvania State Route 216. (Source: Pennsylvania Department of Transportation)

Additional signs and updated signs have periodically been erected in an effort to keep vehicles with weights in excess of the restriction from using Church Street. The borough ordinance[15] reads (in part)

> It shall be unlawful for any person to operate a motor vehicle, trailer, or semi-trailer, as defined in The Vehicle Code, having a load capacity in excess of fifteen hundred (1,500) pounds, on Church Street ….[except] (a) Delivering goods or supplying services to any location on said street or accessible only by the use of said street; and (b) Moving any such vehicle to the residence of the owner of such vehicle or to the customary place of parking such vehicle at any location on said Street or accessible only by the use of said Street.

PennDOT officials indicated that the restriction applies to vehicles "having a load capacity" in excess of 1,500 pounds; many of today's vehicles, including many pickup trucks, have a load-carrying capacity in excess of 1,500 pounds. According to PennDOT and the SRPD, enforcement of the weight restriction on Church Street is sporadic and complicated due to the wording of the ordinance and a local magistrate's interpretation of the ordinance to allow use of this street for local deliveries to addresses that are not on or intersecting the street.

Motor Carrier Information

General

At the time of the accident, Blossom Valley was a private interstate carrier located in New Freedom, Pennsylvania.[16] It was registered as a motor carrier with the U.S. Department of Transportation (USDOT). The carrier began operations in 1987; it transported building and construction materials, agricultural and farm supplies, and nursery stock. Blossom Valley trucks covered about 16,000 miles a year, including about 2,500 interstate miles. The majority of the interstate miles involved delivery of mulch, topsoil, stone, and nursery items. According to Blossom Valley's owner, before the accident, he was unaware of many of the Federal regulations and requirements concerning motor carrier operations.

The Blossom Valley fleet consisted of five trucks—two straight trucks,[17] a 1994 Chevrolet dump truck, a 1995 Ford utility dump truck (the accident truck), and a 1990 International[18] truck tractor with a 1997 Reit flatbed semitrailer. The tractor-semitrailer combination truck was the only vehicle in the fleet that required a driver with a CDL. It had a combined GVWR of 80,000 pounds and, like the accident truck, was air brake-equipped. The Chevrolet dump truck was equipped with hydraulic brakes. The carrier

[15] Ordinance 150 of the Council of the Borough of Glen Rock, York County, Pennsylvania, August 4, 1965.

[16] According to the *York Daily Record*, "News Section," for Tuesday, May 31, 2005, the business was sold in May 2005, and the new nursery does not make deliveries.

[17] A straight truck is a single-unit truck with two or more axles.

[18] International Truck and Engine Corporation of Warrenville, Illinois.

employed two drivers, one with a CDL and one without (the accident driver). The driver with a CDL drove the two straight trucks and the tractor-semitrailer.

According to statements made during Safety Board interviews with the accident driver, the motor carrier owner, and the other driver, Blossom Valley did not give the accident driver a road test. Title 49 CFR 391.31–33, "Road test," specifies that "a person shall not drive a commercial motor vehicle unless he/she has first successfully completed a road test and has been issued a certificate of driver's road test…." Title 49 CFR 390.5 defines a commercial motor vehicle as "any self-propelled motor vehicle… used on a highway in interstate commerce…[with] a gross vehicle weight rating of… 10,001 pounds or more…." The road test certificate or a copy of a valid CDL is to be retained in the driver's qualification files.

The accident driver operated within a 100-mile radius of the home terminal and returned to that location every night, so, according to 49 CFR 395.1(e), he was not required to keep a record of duty status. However, as a motor carrier, Blossom Valley was required to maintain driver time records. After the accident, Blossom Valley was unable to provide investigators with the required time records. The accident driver's actual hours of service are unknown.

On March 10, 2004, another Blossom Valley truck, driven by a different driver, was ticketed for traveling down Church Street, because the vehicle was in violation of the weight restriction.

Accident Truck Maintenance History

At the time of the accident, Blossom Valley did not have a regular, scheduled vehicle maintenance program in place as required by 49 CFR 396.3. Safety Board investigators obtained maintenance records from four facilities that serviced Blossom Valley's vehicles: RG Group and Beasley Ford, both in York, Pennsylvania; Truck Specialties, Inc., in Shrewsbury, Pennsylvania; and C & T Transport in Parkton, Maryland. The service facilities did not have preventative maintenance agreements with Blossom Valley. Rather, they serviced the carrier's vehicles when Blossom Valley brought them in for repairs.

Truck Specialties completed Pennsylvania State inspections of the accident truck in 2001 and 2002. The facility had last serviced the truck in May 2002 for non-brake-related repairs.

On April 10, 2002, about 1 year before the accident, the accident truck was stopped in Maryland and subjected to a CVSA level 1 inspection,[19] which included

[19] A CVSA level 1 inspection (North American Standard Inspection) includes examination of the driver's license and medical examiner's certificate and waiver, if applicable; the driver for alcohol and drug use; and the driver's record of duty status, as required, and hours of service. With respect to the vehicle, it includes inspection of the seat belt, vehicle inspection report, brake system, coupling devices, exhaust system, frame, fuel system, turn signals, brake lamps, tail lamps, head lamps, lamps on projecting loads, loading procedures, steering mechanism, suspension, tires, van and open-top trailer bodies, wheels and rims, windshield wipers, and emergency exits (on buses). In addition, during a level 1 inspection, adherence to hazardous materials regulations is checked.

checking the brakes for adjustment. At that time, the pushrod stroke for the left rear brake was 2 1/4 inches and the pushrod stroke for the right rear brake was 2 1/2 inches. The adjustment limit is 2 inches, so the brake condition resulted in the truck being placed out of service. Safety Board investigators interviewed the driver who was operating the truck at the time of this inspection. (Blossom Valley no longer employs this driver.) He stated that he [manually] adjusted the brakes before departing the inspection site. He also indicated he had adjusted the accident truck's brakes three or four times during his seasonal employment with Blossom Valley during 2002. He further stated that he had worked full-time as a mechanic for a construction company, was a Pennsylvania State-certified truck inspection mechanic, and had been a truck mechanic for more than 20 years.

On January 20, 2003, the accident truck underwent a Pennsylvania State annual inspection performed by the Beasley Ford dealership in York, Pennsylvania. According to the service manager, the truck mechanics at Beasley are certified by the National Institute for Automotive Service Excellence (ASE). (For more information, see the section in this report on "Inspector and Mechanic Certification Requirements" under "Other Information.") The dealership pays the expenses of acquiring and maintaining certification. The mechanic who performed the annual inspection was a Pennsylvania State-certified truck inspector. He told Safety Board investigators that the rear brakes were out of adjustment and that he had [manually] adjusted them.

According to the dealer's service manager, ASAs, which work "pretty well," still require inspection and manual adjustment, particularly if the vehicle operates in hilly or mountainous areas, or in dirt, gravel, or mud. The Ford owner's manual for a year 2003 model F650/750 (a vehicle similar to the accident truck) states

> Inspect standard air brakes equipped with automatic slack adjusters for proper brake adjustment every 4 months or 20,000 miles, and more frequently if operated in hilly or mountainous regions or in mud.

At the time of the January 2003 inspection, the recorded mileage on the truck was 142,810. The accident occurred less than 3 months later, at which time the odometer read 145,095 miles. No manual adjustments are known to have been made to the brakes between the January 20 inspection and the April 11 accident. The truck had traveled a total of 2,285 miles during that period. Table 3 summarizes the inspection history of the accident truck, indicating the date of each inspection, the type of inspection performed, and whether the brakes were adjusted.

Table 3. Glen Rock accident vehicle inspection history.

Date	Type of inspection	Comments
August 2, 2001	Pennsylvania State annual	Inspection and subsequent repairs performed by Truck Specialties mechanics; no brake problems noted
March 27, 2002	Pennsylvania State annual	Inspection and subsequent repairs performed by Truck Specialties mechanics; no brake problems noted
April 10, 2002	Roadside, CVSA level 1	Placed out of service for out-of-adjustment brakes; driver adjusted brakes and left inspection site
January 20, 2003	Pennsylvania State annual	Inspection and subsequent repairs performed by Beasley Ford; rear brakes out of adjustment
April 15–18, 2003	Postaccident inspection (CVSA level 1)	Placed out of service for out-of-adjustment brakes, a loose brake component, and an inoperative turn signal

Motor Carrier Oversight

General

At the time of the accident, Blossom Valley had not undergone a Federal Motor Carrier Safety Administration (FMCSA) compliance review or been assigned a safety rating, so it was considered an unrated carrier. Because the carrier had been involved in this multiple-fatality accident, the FMCSA conducted a compliance review of Blossom Valley's safety management controls on May 2, 2003. The compliance review revealed discrepancies in the areas of drug/alcohol testing, driver qualification files, records of duty status, vehicle inspection record-keeping, and driver/vehicle inspection reports. The compliance review resulted in a safety rating of "Conditional"[20] for Blossom Valley. As of October 13, 2005, the FMCSA safety rating had not changed.

FMCSA standards require a motor carrier to have adequate management controls in place to comply with applicable safety requirements. The FMCSA uses a rating formula to determine a motor carrier's safety fitness. The safety fitness rating methodology begins with an FMCSA-conducted compliance review,[21] applying the six factors shown in table 4 that rate the carrier's compliance with the *Federal Motor Carrier Safety Regulations* (FMCSRs).

[20] A "Conditional" rating means a carrier does not have adequate safety management controls in place to ensure compliance with the Safety Fitness Standards defined in 49 CFR Part 385, but the carrier is still allowed to operate.

[21] Title 49 CFR Part 385, appendix A.

Table 4. Factors for FMCSA safety compliance and the results of Blossom Valley's compliance review.

Factors	Applicable FMCSRs and other criteria	Results of May 2, 2003, Blossom Valley compliance review
1–General	Parts 387 and 390	Satisfactory
2–Driver	Parts 382, 383, and 391	Satisfactory
3–Operational	Parts 392 and 395	Satisfactory
4–Vehicle	Parts 393 and 396 and out-of-service rate	Unsatisfactory
5–Hazardous materials	Parts 107, 171, 172, 173, 177, 180, and 397	Not applicable
6–Accident	Recordable accident rate	Satisfactory

Factors 1–General, 2–Driver, 3–Operational, 4–Vehicle, and 5–Hazardous Materials are rated "Satisfactory," "Conditional," or "Unsatisfactory." Factor 6–Accident is rated either "Satisfactory" or "Unsatisfactory"; a "Conditional" rating is not given. The ratings are defined as follows:

- "Satisfactory"—Carrier has not violated any acute regulations or shown a pattern of noncompliance with critical regulations for that factor.
- "Conditional"—Carrier has violated an acute regulation or had a pattern of noncompliance with critical regulations.
- "Unsatisfactory"—Carrier has violated two or more acute regulations or has patterns of noncompliance with two or more critical regulations.

After the FMCSA May 2003 compliance review, two other vehicles in Blossom Valley's fleet underwent roadside inspections and were placed out of service. (See table 5.)

Table 5. Other Blossom Valley vehicle inspections.

Date	Type of inspection	Comments
June 3, 2003	Roadside	Chevrolet pickup with a trailer: trailer brakes inoperative (no actuator switch); breakaway brake device not connected; vehicle placed out of service
June 27, 2003	Roadside	International tractor with Reit trailer: 4 of 10 brakes out of adjustment; vehicle placed out of service

Inspection Selection System

The Inspection Selection System (ISS-2) is an FMCSA computer program designed to assist the inspector in the field in selecting vehicles for inspection. The intent of the program is to identify vehicles and carriers that have a history of unsafe practices and poor safety performance. An ISS-2 inquiry provides three types of guidance

(recommendations) to the inspector: "Inspect," "Optional," and "Pass." (See table 6.) The ISS-2 criteria are based on data analysis from the Federal Motor Carrier Management Information System (MCMIS) and the Safety Status Measurement System (SafeStat)[22] ratings in crash, vehicle, driver, and safety management history. If there is insufficient information about the carrier in the SafeStat system, the ISS-2 inspection values are based on the carrier's size and number of past inspections.

Table 6. ISS-2 inspection values and recommendations.

ISS-2 inspection value	Recommendation
75–100	Inspect (inspection warranted)
50–74	Optional (may be worth a look)
1–49	Pass (no inspection required)

When an inspector accesses the ISS-2 for a carrier, the system displays an inspection value, as well as the source of the value. If the ISS-2 indicates insufficient data to provide an inspection value, this means there is a lack of SafeStat or PRISM[23] data on that carrier. The ISS-2 also displays the carrier's "Violation Details," which provide information about the carrier's violation history compared to the national violation-warning threshold[24] in specific categories. Carriers with a violation history greater than the warning threshold are highlighted in that category, alerting the inspector to concentrate on or pay particular attention to items in that category during the inspection process. An ISS-2 inquiry also yields the latest MCMIS data (results of roadside inspections, compliance reviews, and accident information) and carrier information, based on the most recent updated carrier registration information.

As of March 24, 2003,[25] Blossom Valley had an ISS-2 inspection value of 65, based on insufficient data in the system regarding the carrier. As of September 19, 2003, 5 months after the accident, its inspection value was 82, based on the result of the FMCSA compliance review safety rating of "Conditional." As of September 23, 2005, the carrier's inspection value was 73. (The ISS-2 system automatically reduces the severity of an infraction over time.)

[22] The FMCSA's SafeStat analysis program uses data from Federal and State sources, including roadside inspections, accident data, and enforcement actions for all carriers, to develop a safety fitness assessment for a motor carrier.

[23] PRISM is a Federal and State program that correlates motor carrier safety fitness to State commercial vehicle registrations. See <www.fmcsa.dot.gov/factfigs/Prism.htm>.

[24] This is an FMCSA algorithm that uses national inspection histories and carrier census information to develop thresholds.

[25] On May 24, 2003, investigators accessed the ISS-2 system to query the status of Blossom Valley. At that time, the ISS-2 system stated that, as of March 24, 2003 (about 3 weeks before the accident), Blossom Valley's inspection value was 65.

Meteorological Information

The nearest National Oceanic and Atmospheric Administration weather-reporting station to the accident site was the Automated Surface Observing System in York, Pennsylvania. At the time of the accident, the temperature was 45° F, the skies were overcast, and the winds were 7 knots from the west. There was a mist and light rain. According to SRPD investigators, the roadway was wet at the time of the accident.

Toxicological Information

The accident truck driver told police that he began using illicit drugs in October 2002 (about 6 months before the accident). He acknowledged use of cocaine, marijuana, heroin, rock cocaine, and hydrocodone. (The driver did not have a prescription for the prescription medication hydrocodone.) He admitted using marijuana 2 days before the accident and estimated that he had last used cocaine about 2 weeks before the accident. He denied use of any controlled substance on the day of the accident.

Blood and urine specimens were collected from the driver at 6:33 p.m. and 6:55 p.m., respectively (about 3 and 3 1/4 hours postaccident). At the request of the York County, Pennsylvania, District Attorney, National Medical Services of Willow Grove, Pennsylvania, conducted postaccident toxicological testing of the truck driver's blood and urine. Postaccident urinalysis showed the presence of methylecgonine and benzoylecgonine[26] (both metabolites of cocaine), morphine,[27] and Δ^9-carboxy-tetrahydrocannabinol,[28] an inactive metabolite of Δ^9-tetrahydrocannabinol (THC, the active hallucinogenic compound in marijuana). Blood was tested only for THC and metabolites; test results were negative.[29] Urinalysis testing results for ethyl alcohol and cocaethylene[30] were also negative.

Tests and Research

To evaluate the effectiveness of the truck's brakes, the Safety Board conducted computer simulations of the truck's descent on Church Street to the accident site and its impact with the four passenger cars. Investigators used a Human, Vehicle, Environment (HVE)[31] system that employed two physics modules, the Simulation Model Non-linear

[26] Benzoylecgonine, 4,900 nanog/mL.

[27] Testing was positive for both total morphine (conjugated and unconjugated, 970 nanog/mL) and free morphine (unconjugated, 150 nanog/mL). Free morphine is the active biologic agent.

[28] 91 nanog/mL.

[29] Laboratory reporting limits of $\geq$1.0 nanog/mL (Δ^9-THC) and $\geq$5.0 nanog/mL (11-hydroxy-Δ^9-THC and Δ^9-carboxy-THC).

[30] Cocaethylene is a compound formed when cocaine and alcohol are present simultaneously.

[31] The Engineering Dynamics Corporation, Beaverton, Oregon, developed the HVE system for engineers and scientists to use as a simulation tool to study vehicle and occupant kinematics.

(SIMON)[32] for the truck descent and EDSMAC4[33] for the impact. The driver estimated his speed at the time of impact at 40 to 45 mph but stated that when he last looked at the speedometer, the truck was going 25 mph. The speed at impact was needed to determine a target speed for the truck at the bottom of the hill.

SIMON uses Brake Designer to assess the effects of temperature on the brake drums and linings. The HVE system has a Ford F-800 truck in its vehicle library. The size and adjustment of the brakes, the engine power curve, the transmission ratios, the differential ratio, and the load of the vehicle were set to replicate the accident truck in the simulation. Using the simulation tools, the brakes could be applied and released at different intervals as the vehicle descended the hill. SIMON does not model the compressor output and determine the available air pressure, but the force applied to the brake pedal can be varied. SIMON does model aerodynamic drag and rolling resistance. For the simulation, the downgrade was modeled as one grade that was 3,350 feet long at an average grade of 7.7 percent. This is equivalent to the grade at the accident site hill, which varied continuously. Based on the physical evidence (including tire marks and final vehicle positions) and HVE default vehicles for the 1993 Chevrolet Camaro, 1996 Mazda Protégé, 1987 Chevrolet Nova, and 1997 Pontiac Grand Prix, the EDSMAC4 simulations of the vehicle collisions near the intersection indicated that the speed of the truck at impact with the Camaro was about 35 mph.

The impact speed of 35 mph was used as a target for the SIMON downhill final speed. Witness statements concerning the speed of the truck on the hill varied. The driver stated that he stopped near the water tower and electrical substation at the top of the hill. He indicated that he pumped the brakes and that a quarter of the way down the hill, he lost the brakes. He said that as he was traveling about 25 mph, the brake warning light on the dashboard began to flash.[34] A witness following the truck, however, stated that the truck did not stop and was traveling 25 to 30 mph at the top of the hill and then increased speed as it went down the hill. Numerous scenarios were simulated, including having the accident truck stop at the top of the hill and having it crest the hill at 25, 35, 45, and 55 mph. Simulations were made with and without sufficient brake pressure, for a total of 35 simulation runs. The simulations showed that the front brake drums could have heated from 615° F to 1,441° F. (At temperatures in excess of 900° F, brakes fade[35] rapidly.) See appendix B for information on the simulations.

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[32] SIMON allows users to simulate the response of one or more vehicles to driver inputs and environmentally related factors. It is designed to fully utilize HVE Brake Designer, which models user-defined system components to estimate their behavior.

[33] EDSMAC4, or the Engineering Dynamics Simulation Model of Automobile Collisions, 4th revision, permits simulation of single- or multiple-vehicle crashes and is based on the Simulation Model of Automobile Collisions, which Calspan developed for the National Highway Traffic Safety Administration (NHTSA).

[34] Testing showed that the red brake warning light came on when the brake air pressure dropped below 70 psi, and the rear parking brakes applied when the pressure dropped below 40 psi, but because the rear brakes were so far out of adjustment, the parking brakes would have had little or no effect on slowing the truck.

[35] Brake fade is heating of the brake drums and linings, which causes an expansion of the drums, reducing a brake's ability to slow or stop a vehicle.

The simulations showed that if the driver had pumped the brakes rapidly and depleted the truck's air pressure to below 50 psi, the truck would not have been able to stop. If the driver had applied the brakes too late on the descent, the front brakes would have overheated, and the driver would not have been able to stop. If the driver had allowed the speed of the truck to exceed 38 mph on the descent, the front brakes would have overheated and faded. The simulations showed that the lowest brake drum temperatures occurred when the brakes were continually snubbed[36] on and off as the truck went down the hill. The simulations indicated that the front brakes would have slowed the truck somewhat, keeping the truck to about 35 mph at the time of impact.

Other Information

Commercial Driver's License

The majority of States (32) have a classified license system, which is one in which the State issues different licenses for specific classes of vehicles. Before the CDL program was instituted (see below), in States that did not have a classified license system, any person licensed to drive an automobile could drive a commercial motor vehicle.

The CDL requirement was established under the Commercial Vehicle Safety Act of 1986 and became effective nationwide in 1992. It established testing and license requirements for drivers of commercial motor vehicles. The main purpose of the act was to reduce or prevent truck and bus accidents and fatalities by disqualifying unsafe commercial motor vehicle drivers.[37] The classifications of CDL, by vehicle group descriptions, are

- Combination Vehicle (Group A)—Any combination of vehicles with a gross combination weight rating of 11,794 kilograms or more (26,001 pounds or more) provided the GVWR of the vehicle(s) being towed is in excess of 4,536 kilograms (10,000 pounds).
- Heavy Straight Vehicle (Group B)—Any single vehicle with a GVWR of 11,794 kilograms or more (26,001 pounds or more), or any such vehicle towing a vehicle not in excess of 4,536 kilograms (10,000 pounds) GVWR.

[36] A 1992 University of Michigan Transportation Research Institute (UMTRI) study, conducted to determine what information should be included in the CDL program on braking a truck while descending mountain roads, found that it was better to apply more pressure (about 20 pounds) for 3 seconds and then release for about 6 seconds (a procedure called a "snub") than to apply brakes at a low level of pressure (10 pounds) and hold them on while descending the mountain. Snubbing resulted in slightly lower brake temperatures, and the hottest brakes were cooler if the snubbing strategy was used, but the difference was not large. See P. Fancher, C. Winkler, and M. Campbell, *The Influence of Brake Strategy on Brake Temperatures in Mountain Descents*, UMTRI-92-11, March 1992.

[37] Title 49 CFR 383.91.

- Small Vehicle (Group C)—Any single vehicle, or combination of vehicles, that meets neither the definition of Group A nor that of Group B as contained in this section, but that either is designed to transport 16 or more passengers including the driver, or is used in the transportation of materials found to be hazardous for the purposes of the Hazardous Materials Transportation Act and which require the motor vehicle to be placarded under the Hazardous Materials Regulations.

Any CDL driver operating a commercial motor vehicle equipped with air brakes must pass an air brake test indicating that the driver has specific knowledge about air brake systems, inspection of the brakes, and "implications of low air pressure warning."[38] If a CDL driver has not passed the air brake test, the CDL will display an "L" restriction, meaning the driver is prohibited from driving air brake-equipped vehicles. A CDL driver may have this restriction removed by passing a State air brake test at a later date.

Canadian Air Brake Endorsement

Since 2001, Transport Canada has required all drivers to have an air brake endorsement to drive any vehicle equipped with air brakes. According to the Canadian National Safety Code #4, "Classified Driver's Licence Program," a driver must possess a valid driver's license of an appropriate class to operate the assigned vehicle, including an air brake endorsement when the vehicle is equipped with air brakes. Transport Canada reports that Canada has experienced a reduction in brake-related accidents since the adoption of this requirement.[39] Also, between September 1999 and September 2004, Canada experienced a 25-percent reduction in brakes found to be out of adjustment to the point of being out of service.[40]

Brake Systems

Passenger cars are usually equipped with hydraulic brake systems. Trucks are equipped with either hydraulic brakes or air brakes. The two brake systems operate differently. A hydraulic brake system is filled with hydraulic fluid. When the brake pedal is depressed, a proportional force is applied to the fluid, which in turn forces the brake shoes against the drums, creating friction, which stops the vehicle. When the brake is released, the pressure is released, and the brakes release. Hydraulic brake systems are closed systems, so there is no depletion of the brake fluid. Also, hydraulic systems have little discernible lag time between pedal depression and brake application.

An air brake system converts compressed air into a linear force that acts upon a number of components, including the pushrod, slack adjuster, and camshaft, to apply the brake shoes against the brake drum, creating friction, which stops the vehicle. The

[38] Title 49 CFR 383.111(g).

[39] This information was obtained through conversations between Transport Canada officials and Safety Board investigators during the April 2004 CVSA meeting in Little Rock, Arkansas.

[40] From Operation Air Brake data for 1999 through 2004. (Operation Air Brake will be discussed later in this report.)

compressor provides a supply of air to the holding tanks (also known as air supply reservoirs). When the brakes are applied, the stored air is distributed in the system through relay valves to the brake chambers, which convert the air pressure to a linear force. Using this force, the pushrod moves a slack adjuster that is attached to a camshaft, which rotates and causes the brake shoes to expand and contact the brake drum. When the brakes are released, the air used to activate the brakes is exhausted to the atmosphere. (See figure 9.)

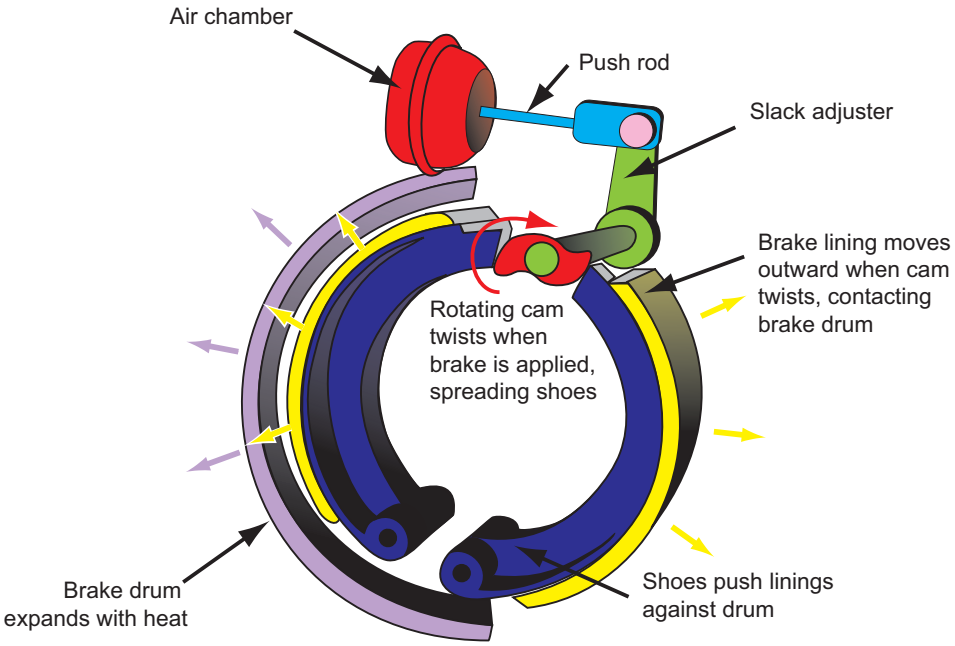

Figure 9. Brake schematic.

The air brake system is an open system, in that the air used to apply the brakes is lost, and the air supply must be replenished before the brakes can operate. Repeated brake applications in succession (pumping the brakes) may prevent an air brake system from re-supplying the air expended during braking quickly enough to maintain a supply of air sufficient to stop the vehicle.

Another distinct characteristic of an air brake system is the mechanical lag time, that is, the interval between the depression of the brake pedal and the application of the brakes. The lag time varies from about 0.20 to 0.55 second and may be longer in poorly maintained systems.[41] The mechanical lag time adds to the overall stopping distance. For instance, at 50 mph, a vehicle travels at 73.30 feet per second. In a typical air brake system

[41] Timing limitations are identified in 49 CFR 571.121, the course materials of the Institute of Police Technology and Management's Commercial Vehicle Inspection and Reconstruction course, and field testing conducted by Safety Board investigators from 1989 through 1998.

for which the lag time is 0.50 second, the vehicle will travel an additional 36 feet from the moment of brake pedal depression until the brakes are fully applied.

Vehicles that are typically equipped with air brakes include dump trucks, large transport trucks, and many types of buses. Some motor homes also have air brakes. Air brakes are optional on many trucks in the 19,501- to 33,000-pound weight classes. According to an article in *Heavy Duty Trucking*,[42] an air brake system's foundation brakes (drums and shoes) are large and can absorb a lot of heat. Hydraulic brakes typically wear out faster. In addition, air brake replacement parts are generally cheaper and more readily available than hydraulic brake system parts.

Automatic Slack Adjusters

ASAs, which are components of air brakes and are also known as automatic brake adjusters, have been offered as optional equipment on some commercial vehicles since the late 1960s. In 1992, the Safety Board noted, "The majority of truck tractors and about half the trailers currently being manufactured are equipped with automatic adjusters."[43] When the rule requiring automatic adjusters on all air brake-equipped vehicles built on or after October 20, 1994, was enacted,[44] most heavy vehicles were already in compliance. The primary purpose of ASAs is to maintain brake adjustment levels without a mechanic or driver having to adjust the brakes manually. (See figure 10.)

ASA Manufacturers' Guidance on Manually Adjusting ASAs. The Safety Board is aware of at least six companies that market ASAs.[45] The service manuals of all the ASA manufacturers reviewed suggest, implicitly or explicitly, that ASAs should not have to be manually adjusted, except at the time of initial installation or when brake components are replaced. Further, the manuals suggest that if an ASA is out of adjustment, it means that a problem exists with the installation, the slack adjuster itself, or other foundation brake components. None of the service literature reviewed suggests that routine manual adjustment of ASAs is a proper course of action for brakes found to be out of adjustment (excessive pushrod stroke).

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[42] "Getting the Right Truck," *Heavy Duty Trucking*, October 7, 2004. See <http://www.heavydutytrucking.com/200205/034a0205.asp>.

[43] National Transportation Safety Board, *Heavy Vehicle Airbrake Performance*, Safety Study NTSB/SS-92/01 (Washington, DC: NTSB, 1992) 48.

[44] Title 49 CFR 393.53(b).

[45] The six are Haldex Brake Products Corporation, headquartered in Kansas City, Missouri; Bendix Commercial Vehicle Systems LLC, headquartered in Elyria, Ohio; Bendix Spicer Foundation Brake LLC, headquartered in Elyria, Ohio; Gunite Corporation, headquartered in Rockford, Illinois; Rockwell Automotive, which in 1997 became Meritor Automotive, of ArvinMeritor, Inc., headquartered in Troy, Michigan; and Crewson Industries, Inc., headquartered in Buffalo, New York. (Note: Although Bendix Spicer markets an ASA, Haldex actually manufactures the Bendix Spicer adjuster.)

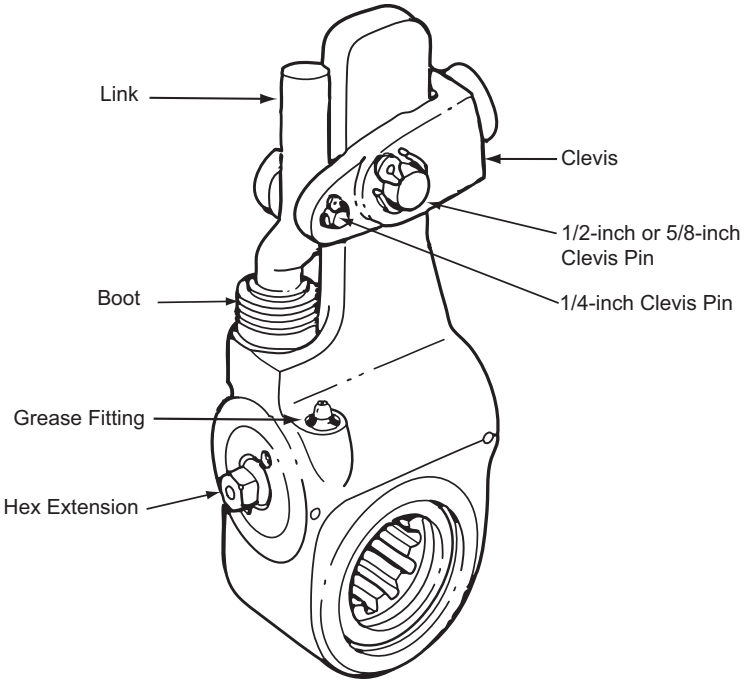

Figure 10. Schematic of a Gunite automatic slack adjuster. (Adapted from a figure that appears in the *Gunite Corporation Automatic Slack Adjuster Service Manual,* June 1994 edition.)

The accident truck was equipped with Gunite ASAs. The Gunite service manual states (bold print in original), **"An automatic slack adjuster should not have to be manually adjusted except for initial installation and at the time of brake reline."**[46] This manual also explains how to troubleshoot to find the cause of excessive pushrod stroke. It does not suggest that manual adjustment is a way to correct excessive pushrod stroke.

Further, according to ASA manufacturers, the adjuster will not hold adjustment as well when adjusted manually. Gunite, Haldex, and Bendix indicated to Safety Board investigators that they have not done any testing to show the relationship between manual adjustment of an ASA and the time (or number of brake applications) it may take for the adjuster to go back out of adjustment. The Haldex service manual states "Automatic adjusters should not be operated as manual adjusters except as may be necessary to get the vehicle off the road for service."[47] In the same publication, under questions and answers, the following question appears: "If automatic adjustment stops, can I operate it as a manual brake adjuster?" The answer provided in the manual is: "No. Completely check

[46] Gunite Corporation, *Automatic Slack Adjuster Service Manual*, publication ASA-100-1, dated June 1994.

[47] *Haldex Service Manual for Automatic Brake Adjusters*, publication L30033HBS, dated November 11, 2001.

out foundation brake and adjuster to determine the cause of the problem. Repair or replace as needed to restore automatic adjustment."

According to the ASA manufacturers, one of the reasons that ASAs should not be manually adjusted is that every time the adjusting nut is turned in a counterclockwise direction, the internal components experience additional wear. For the majority of ASAs, regular manual adjustment will cause premature wearing of the internal clutch, potentially reducing the effectiveness of the internal clutch operation, which is necessary for the automatic adjustment feature to work properly.[48]

Other Industry Views on Manual Adjustment of ASAs. Through the Truck Manufacturers Association, Safety Board investigators queried medium-heavy truck manufacturers to determine what information, if any, they provide about the manual adjustment of ASAs. Only Freightliner[49] responded to the inquiry. Freightliner indicated that its manuals do not currently address manual adjustment of ASAs but stated that when it next updates its driver, maintenance, and service manuals, it will revise them to include warnings about manually adjusting ASAs.

Over the past 2 years, Safety Board investigators have asked truck mechanics, on a random basis, whether they manually adjust ASAs. The majority indicated that they manually adjust ASAs when they are out of adjustment.

Brake Information in State Driver's Manuals

Every State produces a basic driver's handbook or manual on obtaining a driver's license. Each State is required to produce a CDL manual to provide information, specific knowledge, and details about testing procedures.[50] The State manuals are based on models developed by the American Association of Motor Vehicle Administrators (AAMVA).[51]

The truck driver in the Glen Rock accident had a Maryland driver's license (not a CDL). The *Maryland Driver's Handbook* provides general information about the rules of the road and the operation of passenger cars. The handbook does not address driving on hills or mountains. It does address the topic of brake failure in "Special Driving Situations," subsection "Emergencies."[52] The action suggested in case of brake failure is pumping the

[48] Manual adjustment will cause additional wear on the internal clutch on most ASAs because the adjusting hex has to be rotated counterclockwise. Rockwell (now ArvinMeritor) has a special pawl that can be removed in older adjusters or pulled in new models, which will release the clutch and no damage will occur. Crewson Industries has recently introduced a new adjuster with a "push pin" release that also releases the clutch.

[49] Headquartered in Portland, Oregon, Freightliner Group is a leading North American truck and specialty vehicle manufacturer.

[50] Title 49 CFR 383.131.

[51] Founded in 1933, the AAMVA is a voluntary, tax-exempt, nonprofit, educational organization that develops model programs affecting motor vehicle administration, police traffic services, and highway safety and provides information concerning these disciplines. It also represents the U.S. and Canadian State and Provincial officials who administer and enforce motor vehicle laws.

[52] *Maryland Driver's Handbook*, 48.

brakes. (Cars are equipped with hydraulic brake systems. For a hydraulic braking system, pumping the brakes may compress air in the line or free a restricted braking component. If a hydraulic system is breached, pumping the brakes may provide some braking until there is a complete loss of fluid.) No sections in this handbook address air brakes.

The *Maryland CDL Manual*[53] addresses mountain driving, providing information about using lower gears to descend a hill and maintaining a maximum safe speed that will not exceed the vehicle braking limits. The manual states, "When you reach your maximum safe speed apply your brakes sufficiently enough to decrease your speed by 5 mph." It also cautions about brake fade and the need for frequent brake adjustment checks.

In its section on air brakes, the *Maryland CDL Manual* describes the air brake system and how it works. It has specific information on low air pressure warnings and air reservoir gauges, inspection of an air brake system to ensure that it is functioning and adjusted properly, and brake lag time and the additional travel distance it entails until effective braking takes place. The manual indicates that a brake lag time of 0.50 second or more is possible.

The *Maryland CDL Manual* contains "Test Your Knowledge" features following its information sections. The "Test Your Knowledge" segment for the air brake section addresses (1) low pressure warning lights, (2) using brakes on downgrades, (3) the causes of brake failure, and (4) reducing gear before descending a hill.

Submission to the AAMVA for the Model Commercial Driver License Manual

The AAMVA publishes a model *Commercial Driver License Manual* that all 50 States use; few, if any, States make specific changes for their State manuals. The manual was last published 10 years ago.[54] In August 2004, a coalition of five ASA manufacturers[55] endorsed inclusion of the following language regarding ASAs in the new model *Commercial Driver License Manual*, which was distributed on January 3, 2006.

> All airbrake vehicles manufactured since October 20, 1994 are required to have automatic brake adjusters, also known as ASAs.
>
> Automatic adjusters should not have to be manually adjusted except when performing maintenance on the brakes and during the installation of the brake adjusters. In a vehicle equipped with automatic adjusters, when the pushrod stroke exceeds the legal brake adjustment limit, it is an indication that a mechanical problem exists in the adjuster itself, a problem with the related foundation brake components, or that the adjuster was improperly installed.

[53] Maryland Department of Transportation, Motor Vehicle Administration, *Maryland CDL Manual* (Glen Burnie, MD: Maryland Department of Transportation, April 1994).

[54] *Commercial Driver License Manual*, Version 2.0. (AAMVA, 1996).

[55] The five manufacturers are ArvinMeritor, Bendix, Crewson, Gunite, and Haldex. Although Bendix Spicer markets an ASA, the adjuster is manufactured by Haldex. Bendix Spicer deferred to Haldex to comment on the proposed wording of the new text to be included in the manual.

> The manual adjustment of an automatic adjuster to bring a brake pushrod stroke within legal limits is generally masking a mechanical problem and is not fixing it. Further, routine adjustment of most automatic adjusters will likely result in premature wear of the adjuster itself. It is recommended that when brakes equipped with automatic adjusters are found to be out of adjustment, that the driver take the vehicle to a repair facility ASAP to have the problem corrected.
>
> The manual adjustment of an automatic adjuster should only be used as a temporary measure to correct the adjustment in an emergency situation, as it is likely the brake will soon be back out of adjustment since this procedure usually DOES NOT fix the underlying adjustment problem.
>
> (Note: Automatic brake adjusters are made by different manufacturers and do not all operate the same. Therefore, the manufacturer's Service Manual for the specific automatic adjuster being used should be consulted prior to troubleshooting a brake adjustment problem.)

According to the AAMVA, this language is included in the new model *Commercial Driver License Manual*.

Commercial Vehicle Inspection Programs

Both the FMCSA and some States require commercial vehicle inspections. The FMCSA requires every commercial vehicle (engaged in interstate commerce) to undergo an annual inspection.[56] This Federal requirement can be fulfilled in three different ways. The first method is by a State inspection. The District of Columbia and 21 States, including Pennsylvania, require commercial vehicles (engaged in intrastate or interstate operations) to undergo annual vehicle inspections; 3 States[57] have voluntary commercial vehicle inspection programs. In these 25 jurisdictions that have a qualifying inspection program, the Federal requirement can be met by a State inspection.[58] To implement its inspection program, the State either operates its own inspection stations or, as in Pennsylvania, the State authorizes privately owned and operated garages and repair facilities to conduct the inspections.

The second method by which the Federal inspection requirement can be met applies in those States without a qualifying State inspection program. In such States, a motor carrier can either conduct the inspection itself or have it conducted at a repair facility. In either case, to meet the Federal requirement, the individuals performing the inspection must be qualified under 49 CFR 396.19.

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[56] See 49 CFR 396.17 and the FMCSRs, appendix G to subchapter B, *Minimum Periodic Inspection Standards*.

[57] Arkansas, Illinois, and Oklahoma.

[58] A State inspection will fulfill the Federal inspection requirement if the vehicle is inspected under a mandatory State inspection program in Alabama, California, Connecticut, Hawaii, Louisiana, Maine, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, West Virginia, Wisconsin, or the District of Columbia. (Of these, Alabama, California, Connecticut, Michigan, Minnesota, New Jersey, New York, Ohio, and Wisconsin have inspection programs that do not cover all commercial motor vehicles.) In the three States with voluntary State inspection programs—Arkansas, Illinois, and Oklahoma—the voluntary State inspection will also satisfy the Federal inspection requirement.

The third way the Federal annual inspection requirement can be fulfilled is through a State or other jurisdiction's roadside inspection,[59] as long as it meets the minimum requirements found at 49 CFR 396.17. The CVSA North American Standard Inspection procedures developed by the CVSA and the FMCSA fulfill these minimum requirements, and the CVSA procedures are to be used by all roadside inspectors. The Safety Board reviewed the North American Standard Inspection training materials developed and maintained by the CVSA and the FMCSA's National Training Center and found that they do not address the subject of manual adjustment of ASAs.

Inspector and Mechanic Certification Requirements

The ASAs on the accident truck were manually adjusted at different times by at least two individuals—a former Blossom Valley driver, who was a truck mechanic with 20 years' experience, and the mechanic from the Beasley Ford dealership in York, Pennsylvania. Both individuals were Pennsylvania State-certified truck inspection mechanics; the Ford dealership mechanic was also ASE certified.

Pennsylvania State-Certified Truck Inspection Mechanics. Two classes of inspectors perform annual vehicle inspections in Pennsylvania under PennDOT direction. Class 1 inspectors inspect cars and trucks under 17,000 pounds and class 3 inspectors inspect trucks and buses over 17,000 pounds and trailers over 10,000 pounds. Community colleges and private driving schools provide inspector training. According to Pennsylvania Code Section 175.28 "Certified inspection mechanics. (d) Certification requirements,"

> A mechanic desiring to become certified: shall (1) be 18 years of age or older, (2) have a valid driver's license for each class of vehicle which the mechanic will inspect, (3) have attended an approved 9-hour certification course and successfully completed the required written examination, (4) pass the required tactile test administered by a certified/qualified automotive instructor at an approved education facility. Recertification requires a mechanic to pass the required written examination every 3 years.

According to PennDOT, the instruction necessary to become a class 3 truck inspector requires an additional 3 or 4 hours, includes a practical test, and gives special attention to air brake systems. PennDOT officials told Safety Board investigators that inspectors are taught to recognize whether something is broken or not functioning, but they are not taught how to diagnose brake component problems.

The ASE. The ASE is an independent, nonprofit organization established in 1972 to improve the quality of vehicle repair and service through the testing and certification of repair and service professionals. According to the ASE, about 420,000 professionals hold current certifications and work in every segment of the automotive service industry, including car and truck dealerships, independent garages, fleets, service stations, and franchises. Certification requirements include passing 1 of the ASE's 40 exams and proving relevant work experience. To remain certified, those with ASE credentials must be retested every 5 years.

[59] Title 49 CFR 396.23.

The ASE medium-heavy truck test catalog contains eight tests, including test "T4-Brakes." A review of the test specifications and task list indicates that air brake diagnosis and repair make up 56 percent of the ASE brake test. Section 2 of this test, "Mechanical/Foundation," includes item 3, termed "Inspect, adjust, repair, or replace manual and automatic slack adjusters." The sample test questions do not address the manual adjustment of ASAs.

The ASE does not publish or endorse study guides for its tests, but several automotive repair guide companies do publish ASE study guides. One company's ASE T4-Brake test study guide states, "Automatic slack adjusters may require periodic adjustment. The method varies by manufacturer." Safety Board investigators reviewed all available ASA manufacturers' service manuals; none suggest that ASAs may require periodic adjustment.

American Trucking Associations Technology and Maintenance Council

The American Trucking Associations, Inc., (ATA) Technology and Maintenance Council publishes recommended truck maintenance practices. Its Recommended Practice 609B (RP 609B) document, *Manual and Automatic Slack Adjuster Removal, Installation and Maintenance,* provides information regarding the removal, installation, operation, maintenance, and selection of heavy-duty vehicle manual slack adjusters and ASAs. The following statements appear in this document:

> {CAUTION} Self-adjusting brake adjusters do not eliminate or reduce the need for periodic inspection and maintenance of the adjuster components and attaching hardware.
>
> However, manual adjustment can be made temporarily to get a vehicle to a maintenance facility for inspections and repair, if necessary.
>
> A self-adjusting brake adjuster should not have to be manually adjusted except for installation and at brake reline.

RP 609B also provides a preventative maintenance schedule for both manual slack adjusters and ASAs.

Owner-Operator Independent Driver Association Survey

In 2000, the Owner-Operator Independent Drivers Association (OOIDA) conducted a 13-question driver survey of its membership and found that 65 percent of owner-operator drivers and 59 percent of company drivers had ASAs on their equipment.[60] When asked, "What brake maintenance do you personally perform?," 75 percent of the owner-operators and 57 percent of the company drivers indicated that they adjust their brakes. Almost 20 percent of all responding drivers indicated that ASAs are the biggest problem with current brake systems. Drivers said ASAs are unreliable, excessively depended upon, maintained improperly, and more difficult to adjust than manual slack adjusters are.

[60] Rick Craig, "The Driver Perspective," *Report of Proceedings of the North American Brake Safety Conference, September 15-16, 2000* (Toronto, Canada: CVSA, 2001) 57.

Operation Air Brake

The CVSA and the Canadian Council of Motor Transport Administrators (CCMTA)[61] sponsor the Operation Air Brake campaign, which consists of 2 days of brake inspections (1 day of announced and 1 day of unannounced inspections) conducted annually by CVSA member agencies. Since 1998, the CVSA has gathered statistics from Operation Air Brake that show that inspected brakes equipped with ASAs are placed out of service between 3.5 and 4.2 percent of the time, and inspected brakes equipped with manual slack adjusters are placed out of service between 8.3 and 9.1 percent of the time.

The 2003 Operation Air Brake campaign included a driver survey on air brake adjustment knowledge. The survey, conducted during the brake check days and other enforcement activities, included 11 questions, and 4,055 professional drivers responded. According to preliminary results,[62] "The responses reveal an overwhelming level of misunderstanding about the importance of brake adjustment and correct methods to inspect the adjustment on their vehicles." About three-quarters of the drivers who responded indicated they were company drivers and the rest indicated they were owner-operators. The average experience level of both groups was 14.8 years of driving.

The survey asked the drivers what source they rely on the most for providing reliable information about air brakes. The sources identified by the drivers were classroom training (28 percent); their company (30 percent); books, manuals, and videos (32 percent); and other drivers (10 percent). The Operation Air Brake Committee indicated that the drivers who identified books, manuals, and videos as their source of information regarding air brakes seemed to have a better understanding of the proper operation of air brakes than the other drivers and had fewer brake out-of-service violations.

In addition, the survey asked drivers a question about their beliefs concerning ASAs. Figure 11 shows the results.

In 2004, the CVSA, recognizing the importance of air brake education and proper brake adjustment, included a special education component in Operation Air Brake. On September 5, 2004, CVSA inspectors conducted demonstrations and provided educational materials to drivers and mechanics about achieving proper brake operation, recognizing potential brake problems, and understanding the need for properly maintained brakes. Some of the educational efforts took place at the 10 TravelCenters of America truck stops in Ohio; the Husky Truck Stop near Regina, Saskatchewan; and the TravelCenters of America truck stop near Baltimore, Maryland.

[61] The CCMTA is the official organization in Canada for coordinating all matters dealing with the administration, regulation, and control of motor vehicle transportation and highway safety. The CCMTA includes members from all Canadian governments (Provincial, Territorial, and Federal), as well as associate members from transportation-related organizations. See <http:www.ccmta.ca>.

[62] From Operation Air Brake campaign—*Report of Driver Survey on Air Brake Adjustment Knowledge 2003*, draft.

According to the CVSA,[63] brake-related defects continue to be the most significant and frequent violations that safety inspectors discover during roadside inspections.

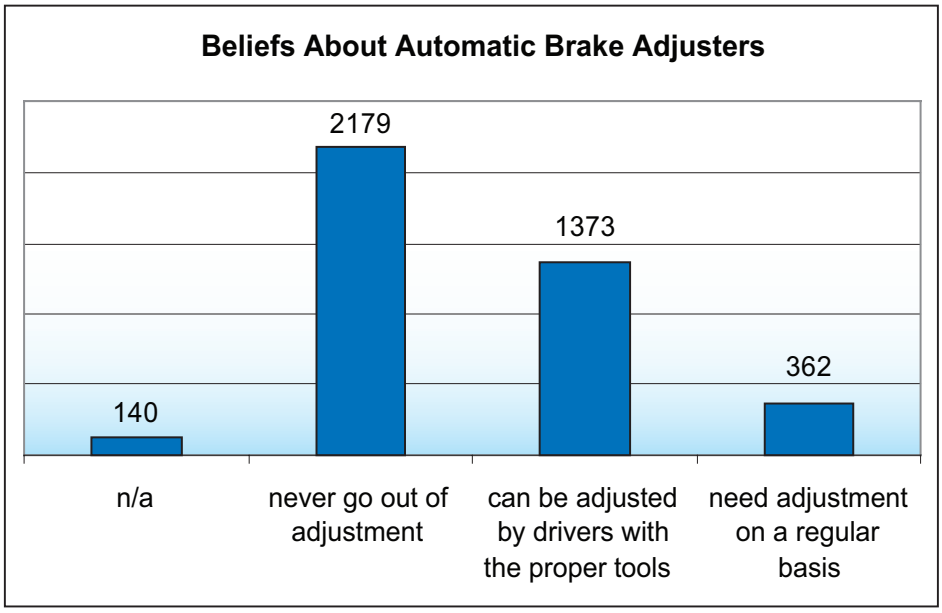

Figure 11. Responses to 2003 Operation Air Brake driver survey question about automatic slack adjusters. (Source: Commercial Vehicle Safety Alliance)

The CVSA also developed a pamphlet on air brake adjustment for distribution during the 2004 Operation Air Brake campaign. (See appendix C for a photocopy of the pamphlet, entitled *Air Brake Adjustment—Why is it so important?*) The CVSA told Safety Board staff that it has printed 35,000 copies of the pamphlet, and demand for the pamphlet has been strong. The pamphlet includes the following language:

> READJUSTING AUTOMATIC BRAKE ADJUSTERS
>
> Automatic brake adjusters normally don't require manual readjustment. If you have a brake that is over-stroking and it has an automatic brake adjuster, you have a problem with the brake or the adjuster. If you readjust it, you aren't really fixing the problem. The same is true if someone else only readjusts it, the problem is still there.
>
> A manual readjust may bring the brake back into compliance and improve the way the brake operates, but it will only be temporary.

Table 7 shows the results of the 2005 Operation Air Brake unannounced brake inspections, indicating the out-of-service rates in the United States and Canada and the percentage of manual and automatic slack adjuster-equipped brakes found out of adjustment.

[63] See additional information at <http://www.cvsa.org/programs/04operation_airbrake.html> and <http://www.cvsa.org/latestnews/cvsa_latestnews.html>.

Table 7. Summary of May 5, 2005, CVSA Operation Air Brake results (unannounced inspections).

Location	Number of trucks checked	Percent out of service for brake adjustment	Percent out of service for brake components	Percent out of service for brakes	Percent of brakes out of adjustment	
					Manual	Auto
Canadian jurisdictions (10 Provinces)	2,857	6.3	6.1	12.1	7.1	2.8
U.S. jurisdictions (27 States)	14,479	12.0	8.8	18.4	8.9	4.6
Total	17,336	11.1	8.4	17.4	8.7	4.2

The Operation Air Brake Committee determined that, based on the success of the 2004 Operation Air Brake education event, a major education and awareness campaign directed at drivers and mechanics would help address the chronic problems associated with air brake compliance, inspection, and maintenance. In 2005, the committee dedicated August 28 through September 3 as Brake Safety Awareness week. This event replaced the Operation Air Brake annual announced brake check day for 2005. The committee asked that each jurisdiction conduct one or more educational or awareness events during Brake Safety Awareness week.

Commercial Vehicle Statistics

Preliminary data from the FMCSA's study on large truck crash causation[64] indicate that in multivehicle crashes in which the truck was at fault, 38 percent involved vehicle equipment problems. Earlier data from Michigan[65] suggest that truck brake conditions may have a role in crashes in which trucks strike other vehicles. In rear-end crashes in which the truck was the striking vehicle, the incidence of defective or poorly adjusted truck brakes was almost twice as high as in cases in which other vehicles struck trucks. A 2003 General Accounting Office analysis[66] of NHTSA crash data for all vehicles during the period 1997 to 2001 found about 778,000 crashes in which police identified a

[64] Briefing by Ralph Craft of the FMCSA during Session 119 of the Transportation Research Board's annual meeting, held on January 9, 2005, in Washington, D.C.

[65] The Fatal Accident Complaint Team, Michigan State Police Motor Carrier Enforcement Division, project involved investigating fatal commercial vehicle crashes in Michigan from 1996 to 2001 to determine why the crashes occurred. Each truck was subjected to a North American Standard Inspection (CVSA level 1), evaluating its precrash compliance with motor vehicle and driver regulations. Ralph Craft, FMCSA Analysis Brief, *Rear-End Crashes Involving Large Trucks*, FMCSA-RI-03-019.

[66] U.S. General Accounting Office, *Highway Safety: Research Continues on a Variety of Factors that Contribute to Motor Vehicle Crashes*, GAO-03-436 (Washington, DC: GAO, March 2003). (Note: The General Accounting Office has since changed its name to the Government Accountability Office.)

specific vehicle feature that might have contributed to the crash. Of those 778,000 crashes, brake systems were identified as a contributing factor 29 percent of the time.

In addition, an examination[67] of NHTSA's 1998 National Automotive Sampling System/General Estimate System data shows that, in crashes involving a commercial vehicle, when vehicle defect was a likely factor, an estimated 36 percent of the crashes involved the braking system. These same data indicate that crashes involving the brake system as a contributing factor accounted for 49 percent of the injuries associated with commercial vehicle crashes.

The Glen Rock accident involved a straight truck. UMTRI data[68] for the year 2000 indicate that straight truck power configurations accounted for 33.3 percent of the 5,275 trucks involved in fatal accidents. In addition, 433 of these straight trucks (24.7 percent) were dump trucks. The drivers of 34.2 percent of the straight trucks and 32.9 percent of the straight trucks with trailers did not have CDLs.

The Safety Board canvassed the heavy truck manufacturers through the Truck Manufacturers Association to determine how many trucks weighing less than 26,000 pounds are equipped with air brakes. Only International and Freightliner responded. International indicated that in 2004 it sold about 15,000 class 6 (19,501- to 26,000-pound) vehicles, about 40 percent of which were equipped with air brakes. Table 8 shows the information provided by Freightliner.

Table 8. Domestic Freightliner vehicles built in the past 2 years.

Class (weight in pounds)	Air brakes	Hydraulic brakes	Total	% air brakes
Class 4 (14,001–16,000)	0	7	7	0
Class 5 (16,001–19,500)	32	696	728	4
Class 6 (19,501–26,000)	10,852	2,644	13,496	80
Class 7 (26,001–33,000)	16,685	356	17,041	98
Class 8 (33,001 and up)	97,360	0	97,360	100

In the past 2 years, Freightliner has built 14,231 vehicles that weigh less than 26,000 pounds, and 84 percent of these vehicles had air brakes. The 1997 U.S. vehicle inventory and use survey[69] indicated that 729,300 vehicles in the light-heavy or class 6 category (19,501 to 26,000 pounds) were in use. The recent Freightliner and International data show that many of these vehicles have air brakes. The latest U.S. vehicle inventory

[67] U.S. Department of Transportation, Federal Motor Carrier Safety Administration, *On-Board Sensors for Determining Brake System Performance*, Task Order 3 of the Commercial Motor Vehicle Technology Diagnostics and Performance Enhancement Program, FMCSA-PSV-04-001 (Washington, DC: USDOT, December 2003).

[68] Anne Matteson and Dan Blower, *Trucks Involved in Fatal Accidents Factbook 2000*, Center for National Truck Statistics, University of Michigan Transportation Research Institute, UMTRI 2003-20 (Ann Arbor, MI: July 2003).

[69] This regularly conducted survey provides information on the physical and operational characteristics of the Nation's truck population. See U.S. Department of Commerce, U.S. Census Bureau, *1997 Economic Census, Vehicle Inventory and Use Survey*, EC97TV-US, issued October 1999.

and use survey, conducted in 2002,[70] included a question about brakes. Evaluation of the survey's raw data showed that 516,110 (30 percent) of the 1,709,574 vehicles in the 19,501- to 26,000-pound weight class were equipped with air brakes.

El Cerrito, California, Accident

Since the Glen Rock accident, the Safety Board has investigated another accident involving loss of braking capability on a steep incline, out-of-adjustment brakes, and ASAs. About 1:26 p.m., Pacific daylight time, on August 26, 2003, a 3-axle Kenworth dump truck, in combination with a 2-axle transfer-bin semitrailer,[71] had been hauling hot asphalt to a construction site on top of a mountainous hillside in El Cerrito, California. The truck driver drove the truck to the top of Moeser Lane, unhooked the transfer-bin semitrailer, and started down Moeser Lane to a construction site 3 or 4 blocks from the top of the hill. The downgrade on the hill varied between 15 and 20 percent. According to the truck driver, he attempted to downshift to a lower gear and thought he had the truck in gear, but the sound of the engine indicated that the truck was stuck in neutral. The truck started to speed up, and the driver was unable to bring it under control using the service brakes. He recalled that he was getting some braking, but it did not slow the truck enough to bring it under control. The truck continued down the hill, while the driver sounded the truck's horn. The truck struck six vehicles, injuring some of the occupants. About a mile down the hill, the truck ran off the right side of the roadway at the corner of Moeser Lane and Richmond Street and struck a utility pole, a gas line, and a house before coming to rest on its left side near the house.

During the collisions and rollover, most of the hot asphalt from the bed of the truck was scattered, and some of it landed in the adjacent street and neighboring yards. The gas line the truck had struck ruptured and ignited. The fire destroyed the house that had been struck and the front of the accident truck; it also damaged gas and electric utility systems, resulting in a local power outage to about 20,000 homes. As a result of this accident, seven people were injured.

Truck Information. The accident truck was a 1991 Kenworth model T-600A, 3-axle dump truck, with a sleeper cab. (The truck was originally manufactured as a 3-axle truck tractor, but it had been converted to a dump truck.) It was equipped with a Detroit Diesel Series 60 engine with a Jacobs Engine Brake, an Eaton-Fuller RTX14609BP 9-speed transmission, a Ross TAS65 power steering gearbox, and a rear axle with a 3.90 ratio. The factory-listed GVWR for the truck was 50,000 pounds. The truck was equipped with a standard air brake system with S-cam brakes. It did not have an ABS. Only the second axle (first drive axle) was equipped with spring parking/emergency brakes. The truck was equipped with Gunite ASAs.

[70] The U.S. Census Bureau conducts a Vehicle Inventory and Use Survey every 5 years, during years ending in "2" and "7." The Safety Board analyzed the raw data from the *2002 Economic Census, Vehicle Inventory and Use Survey*, using the GVWR information from the Vehicle Identification Numbers. (See <http://www.census.gov/suds/www/vius/2002.html>.)

[71] The transfer bin in this case was a 2-axle dump semitrailer that requires the load from the powered dump truck to be dumped first. Subsequently, by utilizing a ramp and cables, the bin body of the semitrailer is pulled onto the dump truck and dumped in the normal fashion, by raising the truck bed.

Brake Inspection and Testing. The California Highway Patrol obtained the brake pushrod measurements summarized in table 9 on scene. No further measurements were possible due to the slack adjusters being "backed off" so that the brake drums could be removed for inspection.

Table 9. El Cerrito Kenworth truck brake test summary.

Axle	Air chamber size	Slack arm length[A]	Pushrod stroke	Adjustment limit[B]	Rated stroke[C]
Left front	T-16	5 1/2 in.	Damaged	1 3/4 in.	2 1/4 in.
Right front	T-16	5 1/2 in.	1 1/2 in.[D]	1 3/4 in.	2 1/4 in.
Left rear	T-30	5 1/2 in.	2 1/2 in.	2 in.	2 1/2 in.
Right rear	T-30	5 1/2 in.	1 7/8 in.	2 in.	2 1/2 in.
2nd left rear	T-30	5 1/2 in.	2 5/8 in.[E]	2 in.	2 1/2 in.
2nd right rear	T-30	5 1/2 in.	2 3/8 in.	2 in.	2 1/2 in.

[A]The distance between the center of the splined camshaft and the center of the clevis pin, which secures the pushrod to the slack adjuster; also known as the "lever arm length."

[B]The maximum pushrod stroke permitted. The values used for the "brake adjustment limit" are those in the *CVSA North American Standard Out-of-Service Criteria*. (Revised edition, April 2003.)

[C]The total length the pushrod can travel inside the air chamber. (When the "pushrod stroke" is equivalent to the "rated stroke," generally no braking forces are obtained when the brakes are applied.)

[D]Due to fire damage, this brake was measured using a steel bar to pry back the slack adjuster arm and, as measured in this manner, it was in legal adjustment. However, due to inherent variables, including the length and positioning of the bar and the amount of force exerted by the inspector, the measurement method lacked the consistency obtained when making a measurement pneumatically. A slightly higher pushrod stroke is usually obtained by using 80 to 100 psi of air.

[E]This brake was completely "bottomed out" during a static cool stroke, indicating that it was not providing any braking force, even without being heated or overheated.

All six wheels on the truck were equipped with Gunite ASAs. Safety Board investigators and Gunite representatives examined and tested the slack adjusters and found that the adjustment clutch was worn out for four of the six adjusters (left front, left rear, second left rear, and second right rear). Examination of the date codes and serial numbers revealed that five of the six adjusters were original equipment and had been on the truck since it was manufactured in 1991. The adjuster on the right rear, which was in adjustment, was the only one that had been replaced since the truck was new.

Driver Information. The 24-year-old truck driver was the owner of the accident truck. He held a valid CDL with a March 26, 2006, expiration date, and a valid medical certificate with an April 25, 2005, expiration date. He had graduated from the A. B. Truck Driving School in San Jose, California, on August 23, 2001.

The driver stated that on the morning of the accident, he had [manually] adjusted the brakes on the tractor and transfer-bin dump trailer. He said he had used a 9/16-inch wrench on the trailer[72] and a smaller one for the dump truck brakes.[73] In addition, the driver stated that his father was also a truck driver and had told him that bad brakes could

[72] The transfer bin semitrailer had manual slack adjusters and required the use of a 9/16-inch wrench to adjust them. A 9/16-inch wrench is the normal adjusting tool for manual slack adjusters.

[73] According to Gunite's *Automatic Slack Adjuster Service Manual*, ASA 100-1 (June 1994), a 7/16-inch wrench is used for the hex-adjusting nut.

mean his life. The driver said that he [manually] adjusted the brakes twice a week. The driver also said that he did not know he was not supposed to [manually] adjust an ASA.

Other Investigations

In four additional recent accident investigations, the Safety Board has encountered different brake maintenance problems involving ASAs found out of adjustment or not functioning. These accidents involved ASAs produced by several different manufacturers. Table 10 lists the investigations and the maintenance problems.

Table 10. Recent investigations involving ASA maintenance problems.

Accident investigation		Automatic slack adjuster	
Date	**Location**	**Manufacturer**	**Maintenance problem**
May 31, 2001	Mountainburg, Arkansas[A]	Rockwell	A broken spring brake and incorrect installation of a brake chamber
April 16, 2003	Hebron, Kentucky[B]	Haldex and Bendix	Worn clevis and clevis pins
March 12, 2004	Gardens Corner, South Carolina[C]	Crewson	Two adjusters on two different school buses lacked grease
July 16, 2004	Chelsea, Michigan[D]	Haldex	Worn teeth on exterior control arm

[A]National Transportation Safety Board, *Collision Between Truck-Tractor Semitrailer and School Bus Near Mountainburg, Arkansas, May 31, 2001*, Highway Accident Report NTSB/HAR-02/03 (Washington, DC: NTSB, 2002).
[B]Public Docket HWY-03-M-H028.
[C]Public Docket HWY-04-M-H018.
[D]Public Docket HWY-04-M-H031.

Analysis

The Glen Rock accident involved an untrained truck driver operating an overloaded, air brake-equipped vehicle with poorly maintained, out-of-adjustment brakes on a steep and weight-restricted hill, over which the truck was not permitted to travel. This analysis first discusses the factors and conditions the Safety Board was able to exclude as neither causing nor contributing to the accident. It then provides a brief overview of the accident events and a detailed discussion of the following major safety issues: (1) maintaining air brakes equipped with ASAs, (2) knowledge and skills needed to drive air brake-equipped vehicles, and (3) motor carrier oversight.

Exclusions

The accident occurred on a 3.4- to 13-percent grade on Church Street in the Borough of Glen Rock. Church Street had a load weight restriction, which was properly signed. The driver passed several load weight restriction signs before encountering the hill. First responders were on scene within 1 minute, and local fire departments and three ambulance services transported patients to area hospitals. Therefore, the Safety Board concludes that although the highway's design included a steep grade, it was appropriately signed and, therefore, was not a factor in the accident; also, the emergency response was effective and appropriate.

Accident Discussion

The 1995 Ford dump truck was overloaded by 600 pounds (or about 2.3 percent of its GVWR of 26,000 pounds) and was proceeding southbound on Church Street, which has a steep downgrade. Safety Board-conducted computer simulations showed that the overloaded condition of the truck made a 5° F difference in brake temperature (final brake temperature of 456° F at 26,600 pounds and 451° F at 26,000 pounds) and did not noticeably affect the braking capability of the truck.

The driver stated that he was traveling 25 to 35 mph, that he stopped the truck at the top of the hill, that he did not select a lower gear, and that, as he started down the hill, he pumped his brakes but the truck would not slow and instead began to speed up. He also said that about a quarter of the way down the hill, he lost his brakes, and the brake light began to flash.[74] He knew the flashing light meant he had brake problems, because his

[74] Postaccident testing showed that the red brake warning light would come on when the brake air pressure dropped below 70 psi, and the rear parking brakes would have been applied when the pressure dropped below 40 psi. However, because the rear brakes were so far out of adjustment, the parking brakes would have had little or no effect on slowing the truck.

boss and a coworker had told him that if the brake light flashed, he did not have enough [air brake] pressure. Unfortunately, as he later told investigators, he did not know that pumping the brakes depleted the air pressure. Postaccident examination of the truck brakes showed that both rear brakes were significantly out of adjustment (they exceeded the adjustment limit by 1/2 inch), which would have resulted in little or no brake force for the rear wheels, even with enough air. The front brakes were well within adjustment limits. However, without sufficient air pressure, the front brakes would also have been ineffective. Computer simulations confirmed that the rear brakes provided little or no braking force but that the truck might have been stopped with the front brakes if the driver had not depleted the air pressure by pumping the brakes.

Therefore, the Safety Board concludes that, based on the truck driver's statements about pumping the brakes, postaccident examination of the brakes, and results from computer simulations, the accident truck did not have sufficient braking capability to stop before the initial impact with the stopped cars.

In the course of its investigation, the Safety Board considered whether the truck driver's condition might have affected the outcome of the accident. According to the SRPD, the Glen Rock accident truck driver admitted previous use of cocaine, heroin, rock cocaine, hydrocodone, and marijuana. Postaccident toxicological tests found morphine,[75] metabolites of cocaine,[76] and a metabolite of marijuana[77] in the truck driver's urine. Postaccident testing results for alcohol were negative. The toxicological findings indicated that, in all likelihood, the driver had consumed cocaine and heroin[78] in the 2 days preceding the accident, despite his statement that he had last used cocaine about 2 weeks before the accident. However, testing limitations (blood and urine were drawn 3 and 3 1/4 hours, respectively, after the accident, and the sample sizes were insufficient to permit additional testing)[79] preclude a determination as to whether the driver was under the influence of cocaine and morphine at the time of the accident. The effects of cocaine vary among individuals; the drug's manifestations can include restlessness, increased risk-taking, and excitement and/or aggression. Cocaine also interferes with sleep. Morphine is noted for causing drowsiness, nausea, and respiratory depression, in addition to its

[75] Morphine, a narcotic analgesic, is both a commonly used prescription pain reliever and the active ingredient in several common prescription medications and drugs of abuse. Morphine has a plasma half-life of about 2 to 3 hours. Following an oral dose, about 60 percent is excreted in the urine within 24 hours, and about 3 percent of the dose is excreted as free morphine within 48 hours. Morphine is initially eliminated from the blood fairly quickly. (*Clarke's Analysis of Drugs and Poisons,* London: Pharmaceutical Press. Electronic version, 2004.)

[76] Cocaine has a plasma half-life of 0.7 to 1.5 hours, depending on the dose. Elimination of cocaine and its metabolites from the urine is typically complete within 48 hours of ingestion. In plasma, it is usually eliminated within 18 to 24 hours. (See *Clarke's Analysis*.)

[77] Marijuana, a psychomimetic/mild hallucinogen, is a common drug of abuse. Its active ingredient, Δ^9-THC, can be measured in plasma within seconds after inhalation. It has a plasma half-life of about 2 hours among frequent users, or about 1.5 hours otherwise. Its active metabolite, 11-hydroxy-Δ^9-THC, has a half-life of about 120 to 144 hours, depending on frequency of use, with the longer half-life typical of infrequent users. Δ^9-THC metabolites have been detected in urine for up to 12 days following a single oral dose. (See *Clarke's Analysis.)*

[78] Morphine is the primary active metabolite of heroin.

[79] The driver's blood was not tested for cocaine, cocaine metabolites, or morphine.

analgesic properties. The presence of THC metabolites in the driver's urine but not the plasma indicates the driver had consumed marijuana in the days (or weeks) preceding the accident but was not under the influence of the drug at the time of the collision.

The Safety Board also considered the possibility that fatigue could have affected the truck driver's performance. Because the driver operated within a 100-mile radius of the home terminal and returned to that location every day, he was not required to maintain status-of-duty records. When requested by the Safety Board, Blossom Valley was unable to provide the driver's time records, despite being required by regulation to maintain such records. Consequently, the driver's work schedule could not be established. In addition, the Safety Board could not adequately assess the impact of the driver's drug use on his sleep patterns.

The accident driver's self-reported actions at the time of the accident suggest that he was alert and oriented toward the immediate situation. The driver stated that as he started down the hill, he pumped the brakes but could not stop the truck. In addition, he said that when he saw children at the bottom of the hill, he leaned out of the window and yelled, "No brakes, get out of the way." Such actions do not indicate that his alertness was impaired or that drugs or fatigue affected his response to the emergency. The 35-mph impact speed, derived from the physical evidence, suggests that the truck driver attempted to brake the truck as it sped down the hill. Had he been so impaired by drugs or fatigue that he made no effort to brake the truck as it traveled down the hill, the speed of the truck would have been greater. Given the out-of-adjustment rear brakes and the truck driver's lack of experience using air brakes, which resulted in his pumping the brakes, the truck did not have sufficient braking capability to stop. Therefore, the Safety Board concludes that although it cannot be determined if drugs or fatigue impaired the driver's performance, he most likely could not have stopped the truck before the accident occurred.

Air Brakes

The rear air brakes of the accident truck were out of adjustment to the point that they had little or no braking capability. The Safety Board has found poorly maintained air brakes to be a causal factor in previous accident investigations[80] and has been concerned about the

[80] (a) National Transportation Safety Board, *Francisco Flores Truck/Pickup Truck with Camper and Trailer Collision, U.S. Route 395, Bishop, California, June 29, 1974*, Highway Accident Report NTSB/HAR-75/05 (Washington, DC: NTSB, 1975). (b) *Texas Bus Lines, Inc., Charter Bus State Route 7, Near Jasper, Arkansas, June 5, 1980*, Highway Accident Report NTSB/HAR-81/01 (Washington, DC: NTSB, 1981). (c) *Direct Transit Lines, Inc., Tractor-Semitrailer/Multi-Vehicle Collision and Fire, U.S. Route 40, Frostburg, Maryland, February 18, 1981,* Highway Accident Report NTSB/HAR-81/03 (Washington, DC: NTSB, 1981). (d) *Eureka Springs, Arkansas, September 13, 1985*, Highway Accident/Incident Summary Report NTSB/HAR-87/01/SUM (Washington, DC: NTSB, 1987). (e) *Braking Deficiencies on Heavy Trucks in 32 Selected Accidents*, Safety Study NTSB/SS-88/06 (Washington, DC: NTSB, 1988). (f) *Collision Between Mission Consolidated Independent School District School Bus and Valley Coca-Cola Bottling Company, Inc., Tractor-Semitrailer, Intersection of Bryan Road and Texas Farm-To-Market Road 676, Alton, Texas, September 21,* 1989, Highway Accident Report NTSB/HAR-90/02 (Washington, DC: NTSB, 1990). (g) *Heavy Vehicle Airbrake Performance*, Safety Study NTSB/SS-92/01

proper operation of air-braked vehicles for more than 30 years. As a result of previous investigations, the Board has made recommendations about disseminating information regarding on-road brake adjustment,[81] distributing appropriate brake maintenance materials,[82] equipping air-braked vehicles with visible adjustment indicators,[83] making pretrip brake inspections,[84] and establishing brake inspector qualifications.[85] (Appendix D provides a history of previous Safety Board brake adjustment recommendations.)

Maintaining Air Brakes Equipped with Automatic Slack Adjusters

The majority of heavy trucks on the road are equipped with ASAs. All air-braked vehicles manufactured after 1994 are required to have them and, in 1992, the Safety Board found that about 65 percent of the vehicles inspected during the *Heavy Vehicle Airbrake Performance* safety study[86] were already equipped with ASAs. These safety devices were introduced without a concentrated education effort being employed.

Problems Caused by Manually Adjusting ASAs. The postaccident inspection of the Glen Rock accident truck revealed that the two rear axle brakes were out of adjustment and produced little or no braking force. The front axle air chambers, which were slightly more than half the size of the rear chambers, were in proper adjustment. Yet, because the larger T-30 rear brakes produced little or no braking force, excessive strain was placed on the significantly smaller T-16 front brakes, which caused them to quickly overheat, resulting in severely diminished truck braking capability.

The truck was equipped with Gunite ASAs on all four brakes. After the accident, when the two rear adjusters were tested at the Gunite facility with the worn "quick-connect" clevises and clevis pins from the accident truck, the pushrod stroke would not go below 2 1/2 inches, which is outside the adjustment limits, rendering the system incapable of producing braking force. However, when the ASAs were tested with new clevises and clevis pins, they functioned properly and the adjustment stayed well under 2 inches, which is within the

(Washington, DC: NTSB, 1992). (h) *Mayflower Contract Services, Inc., Tour Bus Plunge from Tramway Road and Overturn Crash, Palm Springs, California, July 31, 1991*, Highway Accident Report NTSB/HAR-93/01 (Washington, DC: NTSB, 1993). (i) *Truck Loss of Braking Control on Steep Downgrade and Collision With a Vehicle Near Plymouth Meeting, Pennsylvania, April 25, 1996*, Highway Accident Report NTSB/HAR-97/02 (Washington, DC: NTSB, 1997). (j) *Motorcoach Loss of Control and Overturn, New Mexico State Route 475, March 2, 1999*, Highway Accident Brief NTSB/HAB-01/01 (Washington, DC: NTSB, 2001). (k) *Collision Between Truck-Tractor Semitrailer and School Bus Near Mountainburg, Arkansas, May 31, 2001*, Highway Accident Report NTSB/HAR-02/03 (Washington, DC: NTSB, 2002). (l) Highway Accident Investigation HWY-02-MH-003 concerning an October 2001 work zone collision accident in Monaca, Pennsylvania. The Safety Board is also investigating an accident involving braking issues that took place in Sulphur Springs, Texas, in 2004.

[81] Safety Recommendation H-75-17. See appendix D for more information.

[82] Safety Recommendations H-92-67, -72, and -74. See appendix D for more information.

[83] Safety Recommendations H-92-50, -51, and -57. See appendix D for more information.

[84] Safety Recommendation H-02-15. See appendix D for more information.

[85] Safety Recommendations H-02-17 and -18. See appendix D for more information.

[86] NTSB/SS-92/01.

adjustment limits and would provide adequate braking forces. Therefore, the Safety Board concludes that at the time of the accident, the ASAs for all four of the accident truck's brakes were capable of working properly; however, the quick-connect clevises and clevis pins for both rear brakes were worn to the extent that they prevented the ASAs from properly adjusting the brakes, thereby reducing the capability of the rear brakes.

The Safety Board reviewed the maintenance and inspection history of the accident truck, which had undergone four vehicle inspections between 2001 and the April 2003 accident—three Pennsylvania State annual inspections (August 2001, March 2002, and January 2003) and one roadside inspection (April 2002). During two of these inspections—the 2002 roadside inspection and the 2003 State annual inspection—the rear brakes were found to be out of adjustment. After the 2002 roadside inspection, when the accident truck was placed out of service for out-of-adjustment brakes, the driver of the vehicle, who was also a truck mechanic, manually adjusted the ASAs. The Safety Board could find no record of further examination of the brakes by the company or the mechanic to discover why the brakes had been out of adjustment. During the 2003 State annual inspection, a Ford dealership mechanic found the rear brakes to be out of adjustment, and he manually adjusted the ASAs. In an interview with Safety Board investigators, he said he had adjusted the brakes and thought he had fixed the problem. Had he performed a more in-depth examination of the brake system, he probably would have found and replaced the worn clevises and clevis pins, which would have enabled the ASAs to adjust the brakes properly and might have prevented the accident.

The Gunite service manual gives specific instructions on how to conduct a torque test by turning the adjustment nut. If the Ford dealership mechanic had done a torque test, he might have realized that the adjuster itself was working properly. In addition, the Gunite service manual indicates that mechanics should "check the foundation brake for proper function; worn cam bushings, pins and rollers, broken springs, worn quick-connect clevis, worn clevis bushings and clevis pins. Repair as necessary and repeat the function test."[87]

One reason that ASAs should not be manually adjusted is that every time the adjusting nut is turned in a counterclockwise direction, the internal components experience additional wear because the action abrades the internal adjusting mechanism. In the El Cerrito, California, accident, the driver stated that he manually adjusted the slack adjusters twice a week and had done so on the morning of the accident. Postaccident testing of the El Cerrito accident truck at the Gunite factory showed that three of the adjusting clutches were worn to the point that they could not hold an adjustment, probably due to their age and the deterioration caused by frequent manual adjustment. For the majority of ASAs, regular manual adjustment will cause premature wearing of the internal clutch, which is a necessary component for the automatic adjustment feature to work properly.[88]

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[87] Gunite *Automatic Slack Adjuster Service Manual*, ASA 100-1 (Gunite Corporation, June 1994) 7.

[88] Manual adjustment will cause additional wear on the internal clutch on most ASAs, as the adjusting hex has to be rotated counterclockwise. Rockwell (now ArvinMeritor) has a special pawl that can be removed in older adjusters or pulled in new models, which will release the clutch so no damage will occur. Crewson Industries has recently introduced a new adjuster with a "push pin" release that also releases the clutch.

Various brake component problems can cause a pushrod stroke to go beyond the limits for producing adequate braking capability, causing the brakes to be out of service. These problems include, but are not limited to, worn cam bushings, worn or broken pins and rollers, broken springs, worn clevises (both quick-connect and standard), and worn clevis bushings and pins. When a driver or mechanic finds a pushrod stroke to be long and manually adjusts an ASA to correct the long stroke, he or she is masking the true problem with the brake, not fixing it. In all likelihood, the adjustment will be temporary. ASA manufacturers Gunite, Haldex, and Bendix indicated to Safety Board investigators that they do not know how long (how many brake applications) a manually adjusted ASA will hold an adjustment.

The drivers and mechanics who manually adjusted the ASAs on the trucks involved in the Glen Rock and El Cerrito accidents apparently did not understand that they were not fixing the underlying problem with the braking systems. They did not appreciate that when an ASA does not hold an adjustment, something is wrong with the adjuster itself or with some other foundation brake component. Therefore, the Safety Board concludes that the drivers and mechanics who manually adjusted the ASAs on the trucks involved in the Glen Rock and El Cerrito accidents did not look for underlying problems with the adjusters or related foundation brake components; consequently, they misdiagnosed the brake problems, probably because they were not properly educated on the function and care of ASAs and how they relate to foundation brake systems.

Manually adjusting ASAs to fix an out-of-adjustment brake is a dangerous practice that can have serious consequences. If an ASA is manually adjusted, the operator may wrongly assume the adjustment has "fixed" the braking problem, which gives the operator a false sense of security about the effectiveness of the braking system. The operator may believe that the brakes are fully reliable, when in fact they can go out of adjustment at any time, particularly in the case of vehicles that operate in hilly or mountainous environments. As the Glen Rock and El Cerrito accidents demonstrate, manually adjusting ASAs can create a situation in which brakes will not be capable of responding properly when they are desperately needed.

Insufficient Industry Awareness of the Risk Posed by Manually Adjusting ASAs. Although the CVSA's Operation Air Brake data indicate that trucks with ASAs are placed out of service for out-of-adjustment brakes only half as frequently as those with brakes that have manual adjusters, ASA-equipped trucks are still being placed out of service for this deficiency, which suggests that ASAs have not solved the problem of out-of-adjustment brakes. Lack of knowledge about ASAs is one reason for the continuing problem. Since the Glen Rock and El Cerrito accidents, Safety Board investigators have questioned a number of randomly selected mechanics on the practice of manually adjusting ASAs. The majority indicated that they manually adjust ASAs when they are out of adjustment, a practice that ASA manufacturers neither suggest nor endorse.

In addition, results of the driver survey conducted in 2000 by the OOIDA[89] showed that a majority of drivers, particularly owner-operators, are performing brake adjustments

[89] "The Driver Perspective," *Report of Proceedings of the North American Brake Safety Conference, September 15-16, 2000*.

on both manual slack adjusters and ASAs. The 2003 Operation Air Brake driver survey showed that about half of the drivers responding believed that ASAs never go out of adjustment and about one-third thought that a driver with proper tools could readjust ASAs. The Safety Board therefore concludes that the warnings in existing materials available to owners, drivers, mechanics, and inspectors of air-braked vehicles equipped with ASAs have not been successful in communicating the inherent dangers of manually adjusting ASAs to correct out-of-adjustment brakes. Operation Air Brake Committee members told Safety Board investigators that during the 2003 Operation Air Brake driver survey, drivers who obtained information about air brakes from manuals, rather than classroom training, their companies, or other truckers, knew more about the safe operation of air-braked vehicles and had fewer brake out-of-service violations.

Educational and maintenance materials regarding vehicle components should be based on manufacturers' recommendations because manufacturers are in the best position to understand how their products work. The service manuals of ASA manufacturers provide instructions on how to troubleshoot for a brake with excessive pushrod stroke. None of the manufacturers recommends manual ASA adjustment as a means to correct this problem. Most of the manufacturers explicitly state in their literature that an ASA should not have to be manually adjusted except at the time of brake installation. Nevertheless, only one manufacturer (Haldex) indicates in its literature that manual adjustment should not be undertaken to correct out-of-adjustment brakes and that this condition requires brake system troubleshooting. The other manufacturers do not definitively state that adjusting an ASA is the wrong way to remedy excessive pushrod stroke.

The Safety Board believes that ASA manufacturers and marketers[90] should revise their product literature to include conspicuously placed wording that clearly states that ASAs should not be manually adjusted in an effort to correct excessive pushrod stroke, because this condition indicates that a problem exists with the automatic adjuster, with the installation of the adjuster, or with related foundation brake components, which manual adjustment will not fix. Further, the literature should state that manual adjustment of ASAs is a dangerous practice that could have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon.

In August 2004, a coalition of five ASA manufacturers endorsed and submitted to the AAMVA language about ASAs to be included in the AAMVA's new model *Commercial Driver License Manual*, which was distributed on January 3, 2006. The new manual includes language on manual adjustment of ASAs stating (in part) that ASAs should not have to be manually adjusted except during the installation of the ASAs and when performing brake maintenance. It also states that manual adjustment of an ASA to bring a brake pushrod stroke within legal limits is masking a mechanical problem, not fixing it, and that manual adjustment of most ASAs is likely to result in premature wear of the adjuster. Further, the new language states that manual adjustment of an ASA should be

[90] Including Bendix Spicer, which markets ASAs manufactured by Haldex.

used only in an emergency, as a temporary measure to correct the adjustment, because the brake will soon be back out of adjustment, given that manual adjustment will not fix the underlying braking problem.

The Safety Board commends both the ASA manufacturers and the AAMVA for adding this language to the model manual. However, the new language concerning ASAs omits one vital element. It should also state that the manual adjustment of ASAs is actually dangerous because it gives the operator a false sense of security about the effectiveness of the braking system. The Safety Board understands that the AAMVA revises the model *Commercial Driver License Manual* about every 10 years and the 2005 version has already been distributed, so it is not possible to add this language to the current version. All 50 States use the information in the AAMVA model manual. Because the new model manual has only recently been distributed, the States probably have not yet been able to adopt it for their use. Therefore, to ensure that the State CDL manuals reflect the full range of risks posed by manual adjustment of ASAs, the Safety Board believes that when the 50 States and the District of Columbia incorporate the information on ASAs from the new AAMVA model *Commercial Driver License Manual* into their CDL manuals, they should include a statement that the manual adjustment of ASAs is dangerous because it gives the vehicle operator a false sense of security about the effectiveness of the braking system. In addition, the Safety Board will write a drop-in article for the AAMVA's *Move* magazine. The article will explain that the States need to include material in their CDL manuals stating that manual adjustment of ASAs is a dangerous practice that can have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon.

The revision of the model CDL manual should help ensure that new CDL drivers are cautioned against manually adjusting ASAs, because drivers seeking CDLs usually use the manual to prepare for CDL qualification. However, the U.S. Department of Labor estimates that the total number of active CDL holders is about 2.9 million, and recent OOIDA and CVSA survey results suggest that a high proportion of experienced CDL drivers do not understand ASAs. In addition, about one-third of the brakes placed out of service for being out of adjustment have ASAs, which indicates that brake adjustment remains a serious maintenance and safety problem. As the Glen Rock, El Cerrito, and other accidents demonstrate, truck drivers, mechanics, and inspectors need to be better informed about the proper operation and maintenance of air brakes in general and ASAs in particular.

The CVSA has recognized the importance of air brake education and proper brake adjustment. It developed and, during the 2004 and 2005 Operation Air Brake campaigns, distributed a pamphlet entitled *Air Brake Adjustment—Why is it so important?* The pamphlet includes clear language warning that manually adjusting an ASA is a temporary way to bring a brake into compliance (with out-of-service adjustment limits) but will not fix the underlying problem. The Safety Board commends this effort and encourages the CVSA to give additional emphasis to this critical safety issue. The Safety Board believes that the CVSA should revise its pamphlet, *Air Brake Adjustment—Why is it so important?*,

to emphasize that the manual adjustment of ASAs is a dangerous practice that can have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon. In addition, in a further effort to reach drivers, operators, mechanics, and others in the trucking industry, the Safety Board will write a drop-in article for *Transport Topics*, the magazine of the ATA, which has wide distribution in the general trucking industry. The article will include information about the risks associated with manually adjusting ASAs.

Some drivers and owners of vehicles equipped with air brakes may not interact with the CVSA, the FMSCA, or the ATA. They include fire departments, construction workers and companies, nursery and landscaping companies, and recreational vehicle owners. To reach these drivers and owners, the Safety Board will contribute drop-in articles on the risks associated with manually adjusting ASAs to industry, trade, and other groups, including the International Association of Fire Chiefs, the American Nursery and Landscape Association, the National Private Truck Council, the National Recreational Vehicle Owners Club, and the Associated General Contractors of America, for their publications. In addition, the CVSA air brake adjustment pamphlet could be distributed at campgrounds and recreational vehicle parks.

The ASE certifies brake repair and service professionals who maintain trucks, and its medium-heavy truck tests include test T4 for brakes. Given the widespread lack of awareness of the problems associated with manually adjusting ASAs in the trucking industry, the ASE should emphasize the risks associated with manually adjusting ASAs in its testing materials. As far as the Safety Board can determine, the T4 certification test does not currently address the manual adjustment of ASAs. Therefore, the Safety Board believes that the ASE should include the following information in its T4 brake certification testing materials: manually adjusting ASAs is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most ASAs, which may lead to failure of this brake component.

The ASE does not publish study guides or manuals on its certification tests, but several companies do publish such guides.[91] The Safety Board's examination of several private study guides for the ASE's medium-heavy truck T4 brake test showed that they inadequately cover the maintenance of ASA-equipped brakes, and some contain incorrect information. One study guide wrongly states, "Automatic slack adjusters may require periodic adjustment." Many mechanics use the study guides as a source of general maintenance information, as well as for test preparation, making it imperative that these guides contain thorough and accurate information about ASAs. Therefore, the Board believes that the publishers of ASE certification test study guides should include the following information in their guides: manually adjusting ASAs is dangerous and should

[91] The leading publishers are Motor Age, Mitchell 1, and Thompson Delmar Learning.

not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most ASAs, which may lead to failure of this brake component.

Evidence from the Glen Rock accident suggests that some truck inspectors who carry out State annual inspections do not understand that if an ASA-equipped brake is out of adjustment, something is wrong with the adjuster or another foundation brake component and that manually adjusting the ASA merely masks the problem. Two different mechanics manually adjusted the ASAs on the Glen Rock accident truck several times. Both mechanics were Pennsylvania State-certified truck inspectors. Truck inspectors who perform annual inspections in the 23 other States (and the District of Columbia) that have State commercial vehicle inspection programs may be similarly unaware that manually adjusting ASAs is a dangerous and inappropriate response to an out-of-adjustment brake. Therefore, the Safety Board believes that the District of Columbia and the 24 States that have commercial vehicle inspection programs should include in their truck inspector training courses a module on ASAs that emphasizes that manually adjusting ASAs is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most ASAs, which may lead to failure of this brake component.

During a Maryland roadside inspection on April 10, 2002, the Glen Rock accident truck was placed out of service for out-of-adjustment brakes. The driver at the time manually adjusted the brakes before departing the inspection site, an action that is not uncommon. The Safety Board found no indication that the brakes were subsequently examined to determine why they had gone out of adjustment. The inspector who conducted the roadside inspection evidently did not indicate that troubleshooting should be conducted to determine the underlying problem that was causing the brakes to be out of adjustment.

The CVSA has recognized the importance of air brake education and proper brake adjustment and has distributed materials informing drivers that manually adjusting an ASA will not remedy the underlying problem with an out-of-adjustment brake and is only a temporary fix; however, the CVSA North American Standard Inspection materials used to train roadside inspectors are silent on the subject. CVSA-trained roadside inspectors should be educated about the dangers of manually adjusting ASAs. The CVSA and the FMCSA National Training Center maintain the North American Standard Inspection training materials. Therefore, the Safety Board believes that the CVSA and the FMCSA should work together to develop and add to the North American Standard Inspection training materials a module that emphasizes that manually adjusting ASAs is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address

the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most ASAs, which may lead to failure of this brake component.

Truck manufacturers' manuals afford yet another means of improving industry awareness of the risks associated with manually adjusting ASAs. The Ford owner's manual for a model 2003 F650/750, which is similar to the Glen Rock accident truck, states that ASAs should be checked for adjustment every 4 months, or 20,000 miles, and more frequently if operated in hilly or mountainous regions or in mud. It does not inform drivers or mechanics about the dangers involved in adjusting ASAs. The Safety Board, through the Truck Manufacturers Association, queried medium-heavy truck manufacturers to determine what information, if any, they provide regarding the manual adjustment of ASAs. Freightliner, the only manufacturer to respond to the inquiry, indicated that its manuals are silent on the subject. Freightliner advised Safety Board investigators that it will revise its driver, maintenance, and service manuals to include cautions about manually adjusting ASAs when it next updates its manuals.

To ensure that the manufacturers of vehicles equipped with air brakes provide appropriate guidance to vehicle operators, the Safety Board believes that the manufacturers should revise their product manuals to include conspicuously placed wording that clearly states that ASAs should not be manually adjusted in an effort to correct excessive pushrod stroke, because this condition indicates that a problem exists with the automatic adjuster, with the installation of the adjuster, or with related foundation brake components, which manual adjustment will not fix. Further, the product manuals should state that manual adjustment of ASAs is a dangerous practice that could have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon.

Knowledge and Skills Needed to Drive Air Brake-Equipped Vehicles

Although the Glen Rock accident driver said that he slowed the truck before starting down the hill, he did not select a lower gear, which would have provided engine braking, an action recommended by the AAMVA model *Commercial Driver License Manual* and experienced truck drivers. Had he used a lower gear, the vehicle would have slowed due to normal engine compression. In addition, he pumped the brakes, reducing the capability of the front brakes and exacerbating the loss of braking capability in the out-of-adjustment rear brakes. Until recent widespread use of ABS brakes, drivers of hydraulically braked vehicles (passenger cars, sport utility vehicles, and pickups and other light-duty trucks) were taught to pump their brakes in emergencies.[92] But in an air-braked vehicle, pumping the brakes depletes the air pressure, thereby drastically reducing the brakes' capability.

[92] Although ABS brakes were introduced in the 1970s, they were not widely used until the 1990s. ABS brakes are designed to help prevent a vehicle from skidding. The brakes are controlled by a computer that senses whether the tires are maintaining friction with the pavement or are sliding. For ABS brakes, steady brake pedal pressure is prescribed. Pumping the brake pedal defeats the purpose of ABS.

The Glen Rock accident driver did not hold a CDL and he had not passed an air brake knowledge test; neither was required by regulation for him to drive the accident truck. The Glen Rock accident truck had a GVWR of 26,000 pounds and, for CDL licensing purposes, 49 CFR 383.5 defines a commercial vehicle as a motor vehicle that has a GVWR of 26,001 pounds or more. Consequently, the accident driver was not required to have a CDL to drive the accident truck. According to his statement, the driver had never received instruction on air brake operation. Also, although a road test is required by regulation, the motor carrier had not given the driver such a test in the accident truck. The accident driver said that he had been told that if the brake light came on, he had no [air] pressure, but it is not clear whether he understood what this meant. Therefore, the Safety Board concludes that the Glen Rock accident driver lacked the knowledge and skills required to safely drive an air brake-equipped vehicle; as a result, he did not select a lower gear before proceeding down the hill and he pumped the brakes, which depleted the available brake air pressure.

Air brakes and hydraulic brakes operate differently. Because of these differences, drivers of air-braked vehicles need special instruction about how they function. In the United States, licensed drivers who do not hold CDLs are not typically given information about the operation of air brake systems, and they are not tested about air brakes before they are permitted to drive vehicles equipped with them. In contrast, the CDL licensing program recognizes that drivers need to be aware of the special characteristics of air brake systems and has established knowledge and skill requirements for operating them safely.

The AAMVA model *Commercial Driver License Manual* contains a section that specifically addresses air brake knowledge. If a CDL applicant wants to be licensed to drive an air brake-equipped vehicle, the applicant is required[93] to take a separate knowledge test and demonstrate proficiency in the inspection and operation of air brake systems. If a CDL applicant fails to pass the air brake knowledge and skills tests, the applicant is prohibited from driving vehicles with air brake systems. However, a non-CDL driver is not restricted from driving an air brake-equipped vehicle, whether in commercial or noncommercial use. Thus, no measures are in place to ensure that the drivers of air brake-equipped vehicles weighing less than 26,000 pounds have the knowledge and skills necessary for their safe operation.

Canada has recognized the importance of air brake system proficiency in its licensing system. Since 2001, Transport Canada has required that all drivers who drive any vehicle equipped with air brakes obtain an air brake endorsement. Transport Canada reports that Canada has experienced a reduction in brake-related accidents since the adoption of this requirement. Also, between September 1999 and September 2004, Canada experienced a 25-percent reduction in brakes found to be out of adjustment to the point of being out of service.[94]

U.S. accident statistics show that about one-third of straight truck accidents involve drivers who do not have CDLs.[95] Studies suggest that a significant portion of these

[93] Title 49 CFR 383.95 and 383.113(c).

[94] From Operation Air Brake data for 1999 through 2004.

[95] Matteson and Blower, *Trucks Involved in Fatal Accidents Factbook 2000*.

accidents involve braking problems.[96] Data from the 2002 vehicle inventory and use survey[97] indicate that at least 30 percent (516,110) of trucks in the 19,501- to 26,000-pound weight class are equipped with air brakes. In addition, Freightliner and International data for new vehicles indicate that about 80 percent and 40 percent, respectively, of these manufacturers' new vehicles in this weight class are equipped with air brakes. These vehicles are in operation today (both in commercial and noncommercial use), and drivers without CDLs may legally operate them. Therefore, the Safety Board concludes that more than 500,000 vehicles equipped with air brakes may be operated by drivers who, like the Glen Rock truck driver, have no air brake training and thus may not be able to operate their vehicles safely.

To summarize, under the CDL program, each State has an air brake testing requirement, information in its CDL manual concerning air brakes, and a test for air brake systems. However, non-CDL drivers are not required to fulfill any air brake knowledge or testing requirement before driving an air brake-equipped vehicle. Further, a CDL is not required to drive a commercial vehicle with a GWVR of 26,000 pounds or less. So two major categories of drivers—commercial drivers who are not required to hold CDLs and noncommercial drivers—may not receive any air brake training or testing before they drive air brake-equipped vehicles.

As this accident demonstrates, all drivers should receive specialized training in using air brakes before driving a vehicle equipped with them. The FMCSA regulates commercial vehicle operations and commercial driver licensing. Therefore, the Safety Board believes that the FMCSA should require drivers of commercial vehicles that weigh less than 26,000 pounds and are equipped with air brakes to undergo training and testing to demonstrate proficiency in the inspection and operation of air-braked vehicles; the training should emphasize that manually adjusting ASAs is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility. Further, to address the issue of untrained noncommercial drivers driving air brake-equipped vehicles, the Safety Board believes that the 50 States and the District of Columbia should adopt an air brake endorsement for drivers' licenses that would require training and testing of drivers who drive air brake-equipped vehicles to ensure their proficiency in the operation of air-braked vehicles; the training should emphasize that manually adjusting ASAs is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility. Currently, the States are equipped to provide air brake testing for CDL drivers who wish to remove the air brake restriction from their licenses. The States could extend such testing to commercial drivers of vehicles that weigh less than 26,000 pounds and are equipped with air brakes, as well as to noncommercial drivers who drive air-braked vehicles. In addition, 32 States have a classified license system, which should facilitate the implementation of air brake knowledge and skills testing for noncommercial drivers.

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[96] GAO-03-436, March 2003, and FMCSA-PSV-04-001, December 2003.

[97] The Safety Board analyzed the raw data from the *2002 Economic Census, Vehicle Inventory and Use Survey*, using the GVWR information from the Vehicle Identification Numbers.

Motor Carrier Oversight

Blossom Valley

Blossom Valley employed a driver who had no experience driving air brake-equipped vehicles, did not train him in air brake use or pretrip inspection, and put him on the road in an air brake-equipped vehicle with out-of-adjustment rear brakes. In addition, the truck was loaded beyond its rated weight, and the driver was dispatched on a route that included a section of road the vehicle was not permitted to be on even when empty. (Apparently, the carrier ignored this routing prohibition after the accident as well. On March 10, 2004, another Blossom Valley truck was ticketed for traveling overweight down Church Street.) Moreover, the carrier did not have a scheduled maintenance program for its vehicles, did not have a drug and alcohol testing program, and did not maintain driver qualification files or keep time records on its drivers, all of which the FMCSA requires motor carriers to do. The Safety Board concludes that Blossom Valley did not exercise proper oversight of its drivers, vehicles, or operation, as evidenced by its sending an untrained truck driver in an overloaded vehicle with out-of-adjustment brakes on a route over a weight-restricted street; the carrier also failed to implement a scheduled vehicle maintenance program and to fulfill drug and alcohol testing and record-keeping requirements. In 2005, Blossom Valley Farms, Inc., in Pennsylvania was sold, and the new nursery does not make deliveries.

Educating Motor Carriers

The owner of Blossom Valley knew enough about motor carrier operational requirements to register with the USDOT. To obtain operating authority, the owner had to sign an FMCSA Form 150, *Motor Carrier Identification Report* (application for a USDOT number), which contains a statement indicating that the carrier understands the FMCSRs (and/or the Federal Hazardous Materials Regulations). However, Blossom Valley's owner told investigators that, before the accident, he was unaware of the FMCSRs' requirements as they applied to Blossom Valley operations. Consequently, the carrier did not adhere to the FMCSRs.

The FMCSA has taken steps to educate carriers about their responsibilities under the FMCSRs. For instance, since January 1, 2003, all new motor carriers (private and for-hire) operating in interstate commerce must apply for registration (obtain a USDOT number) as a "new entrant." According to the FMCSA,[98] after the carrier receives its new entrant registration, it is subject to an 18-month-long safety-monitoring period, during which it will receive a safety audit and have its roadside crash and inspection information closely evaluated. The carrier will be required to demonstrate that it has the necessary systems in place to ensure basic safety management controls. Failure to do so may result in the carrier having its new entrant registration revoked. In FY 2003–2004, the FMCSA and the States, respectively, conducted 7,205 and 25,316 new entrant safety audits. Blossom Valley had registered with the USDOT in 1987, about 16 years before the FMCSA's new entrant program was implemented and so was not subject to a safety-monitoring period.

[98] See <http://www.fmcsa.dot.gov/registration-licensing/registration/new-entrant.htm>.

The FMCSA's compliance monitoring activities can also be helpful in instructing carriers about their responsibilities, because FMCSA inspectors generally treat a first compliance review as an educational visit. However, recent compliance monitoring activity indicates that the FMCSA and the States together conduct only about 11,300 compliance reviews each year. In FY 2004, active interstate truck and bus companies numbered 677,249, many of which were unrated carriers. Thus, FMCSA compliance activities affecting unrated carriers are limited and may not serve to educate many small, private motor carriers about the requirements they must meet. In fact, the FMCSA had not conducted a compliance review of Blossom Valley before the accident (nor assigned it a safety rating), so Blossom Valley was an unrated carrier, and this program did not enhance the carrier's understanding of its responsibilities under Federal regulations.

The FMCSA also has educational material on its Web site, including a link to *A Motor Carrier's Guide to Improving Highway Safety.* This booklet provides information for commercial vehicle owners unfamiliar with the FMCSA and addresses the Federal regulations applicable to commercial vehicle operation.

Despite the FMCSA's educational efforts, Blossom Valley was evidently unaware of, and failed to fulfill, its responsibilities as a motor carrier under the FMCSRs. Given Blossom Valley's deficient understanding of its responsibilities as a motor carrier, the Safety Board concludes that the FMCSA's efforts to educate motor carriers about their responsibilities under Federal safety regulations have not reached all small, private, unrated carriers.

The Safety Board recently issued a report on an accident in Tallulah, Louisiana,[99] involving a motorcoach operated by a church group that did not realize it qualified as a motor carrier under Federal regulations. As a result of the October 13, 2003, accident, eight motorcoach passengers sustained fatal injuries, and the motorcoach driver and six passengers received serious injuries. On April 27, 2005, the Safety Board issued the following safety recommendation to the FMCSA:

> H-05-2
>
> Develop and distribute educational materials for nontraditional commercial vehicle owners, such as church groups, on how to comply with the *Federal Motor Carrier Safety Regulations*; at a minimum, the materials should be posted on the Federal Motor Carrier Safety Administration Web site.

The category "nontraditional commercial vehicle owners" includes small, private carriers such as Blossom Valley, and vigorous implementation of this recommendation may improve compliance with the FMCSRs on the part of such carriers. In a letter dated September 30, 2005, the FMCSA responded to Safety Recommendation H-05-2, indicating that it is "developing an educational brochure to increase the safety awareness and regulatory compliance of private motor carriers of passengers." The Safety Board is reviewing the response.

[99] National Transportation Safety Board, *Motorcoach Run-Off-The-Road Accident, Tallulah, Louisiana, October 13, 2003*, Highway Accident Report NTSB/HAR-05/01 (Washington, DC: NTSB, 2005).

FMCSA Carrier Safety Rating Systems

On April 10, 2002, about 1 year before this accident, the accident truck underwent a CVSA level 1 roadside inspection and was placed out of service. This roadside inspection was the only one conducted on a Blossom Valley vehicle in 2002, so the FMCSA's SafeStat records showed the carrier with a 100-percent out-of-service rate for the year. However, the ISS-2 data for the carrier would not have included Blossom Valley's out-of-service rate because the carrier had not undergone a FMCSA compliance review during its 16 years of operation; consequently, the system considered Blossom Valley "not rated." Thus, Blossom Valley would have had an ISS-2 inspection value of 65 (inspection optional) a few weeks before the accident, based on "insufficient information," because the carrier had not undergone a compliance review and was unrated at the time.

A postaccident ISS-2 query for Blossom Valley conducted on September 19, 2003, indicated that the carrier's inspection value was 82 (inspection warranted), as a result of the carrier's postaccident compliance review safety rating of "Conditional," which derived from an "Unsatisfactory" rating in the vehicle factor. Since the Glen Rock accident, two Blossom Valley vehicles have undergone roadside inspections that resulted in out-of-service vehicles, maintaining the carrier's 100-percent out-of-service rate, and Blossom Valley's safety rating remains "Conditional." However, because the ISS-2 system automatically reduces an infraction score over time, a September 23, 2005, ISS-2 query indicated that the carrier's inspection value was 73, placing it in the "inspection optional" category even though nothing about its safety posture had changed. The SafeStat system still showed the carrier with an out-of-service rate of 100 percent, and the compliance review rating was still "Conditional." The ISS-2 system gives the carrier the benefit of the doubt and assumes it will improve its safety standing, regardless of whether it does so. The Safety Board therefore concludes that the FMCSA's ISS-2 system does not always give an accurate and timely picture of a carrier's safety posture, thereby reducing its effectiveness as a screening mechanism.

The Safety Board understands that, in response to a recent USDOT, Office of the Inspector General, report,[100] the FMCSA is making changes to the SafeStat and ISS-2 systems. The Safety Board's report of the June 23, 2002, Victor, New York, motorcoach accident[101] thoroughly discussed the inadequacies of SafeStat and the ISS-2 system, as well as the Inspector General's recommendations.

The facts about Blossom Valley's FMCSA safety rating uncovered during the Glen Rock investigation underscore the Safety Board's concerns, expressed in the Victor report, about the limitations of the FMCSA's safety rating systems for motor carriers. The comparatively positive inspection value that Blossom Valley continues to maintain in the ISS-2 system, despite the carrier's clear safety inadequacies, emphasizes the need for the FMCSA to improve its carrier safety rating systems.

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[100] U.S. Department of Transportation, Office of the Inspector General, *Improvements Needed in the Motor Carrier Safety Status Measurement System*, Audit Report MH-2004-034 (Washington, DC: USDOT, 2004).

[101] National Transportation Safety Board, *Motorcoach Run-off-the-Road and Rollover Off Interstate 90, Victor, New York, June 23, 2002*, Highway Accident Report NTSB/HAR-04/03 (Washington, DC: NTSB, 2004).

Conclusions

Findings

1. Although the highway's design included a steep grade, it was appropriately signed and, therefore, was not a factor in the accident; also, the emergency response was effective and appropriate.

2. Based on the truck driver's statements about pumping the brakes, postaccident examination of the brakes, and results from computer simulations, the accident truck did not have sufficient braking capability to stop before the initial impact with the stopped cars.

3. Although it cannot be determined if drugs or fatigue impaired the driver's performance, he most likely could not have stopped the truck before the accident occurred.

4. At the time of the accident, the automatic slack adjusters for all four of the accident truck's brakes were capable of working properly; however, the quick-connect clevises and clevis pins for both rear brakes were worn to the extent that they prevented the automatic slack adjusters from properly adjusting the brakes, thereby reducing the capability of the rear brakes.

5. The drivers and mechanics who manually adjusted the automatic slack adjusters on the trucks involved in the Glen Rock and El Cerrito accidents did not look for underlying problems with the adjusters or related foundation brake components; consequently, they misdiagnosed the brake problems, probably because they were not properly educated on the function and care of automatic slack adjusters and how they relate to foundation brake systems.

6. The warnings in existing materials available to owners, drivers, mechanics, and inspectors of air-braked vehicles equipped with automatic slack adjusters have not been successful in communicating the inherent dangers of manually adjusting automatic slack adjusters to correct out-of-adjustment brakes.

7. The Glen Rock accident driver lacked the knowledge and skills required to safely drive an air brake-equipped vehicle; as a result, he did not select a lower gear before proceeding down the hill and he pumped the brakes, which depleted the available brake air pressure.

8. More than 500,000 vehicles equipped with air brakes may be operated by drivers who, like the Glen Rock truck driver, have no air brake training and thus may not be able to operate their vehicles safely.

9. Blossom Valley Farms, Inc., did not exercise proper oversight of its drivers, vehicles, or operation, as evidenced by its sending an untrained truck driver in an overloaded vehicle with out-of-adjustment brakes on a route over a weight-restricted street; the carrier also failed to implement a scheduled vehicle maintenance program and to fulfill drug and alcohol testing and record-keeping requirements.

10. The Federal Motor Carrier Safety Administration's efforts to educate motor carriers about their responsibilities under Federal safety regulations have not reached all small, private, unrated carriers.

11. The Federal Motor Carrier Safety Administration's Inspection Selection System does not always give an accurate and timely picture of a carrier's safety posture, thereby reducing its effectiveness as a screening mechanism.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the lack of oversight by Blossom Valley Farms, Inc., which resulted in an untrained driver improperly operating an overloaded, air brake-equipped vehicle with inadequately maintained brakes. Contributing to the accident was the misdiagnosis of the truck's underlying brake problems by mechanics involved with the truck's maintenance; also contributing was a lack of readily available and accurate information about automatic slack adjusters and inadequate warnings about the safety problems caused by manually adjusting them.

Recommendations

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

To the Federal Motor Carrier Safety Administration:

Work with the Commercial Vehicle Safety Alliance to develop and add to the North American Standard Inspection training materials a module that emphasizes that manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most automatic slack adjusters, which may lead to failure of this brake component. (H-06-1)

Require drivers of commercial vehicles that weigh less than 26,000 pounds and are equipped with air brakes to undergo training and testing to demonstrate proficiency in the inspection and operation of air-braked vehicles; the training should emphasize that manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility. (H-06-2)

To the District of Columbia and the 50 States:

When you incorporate the information on automatic slack adjusters from the new American Association of Motor Vehicle Administrators model *Commercial Driver License Manual* into your Commercial Driver's License manual, include a statement that the manual adjustment of automatic slack adjusters is dangerous because it gives the vehicle operator a false sense of security about the effectiveness of the braking system. (H-06-3)

Adopt an air brake endorsement for drivers' licenses that would require training and testing of drivers who drive air brake-equipped vehicles to ensure their proficiency in the operation of air-braked vehicles; the training should emphasize that manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility. (H-06-4)

To the District of Columbia and the 24 States (Alabama, Arkansas, California, Connecticut, Hawaii, Illinois, Louisiana, Maine, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, West Virginia, and Wisconsin) that have commercial vehicle inspection programs:

Include in your truck inspector training courses a module on automatic slack adjusters that emphasizes that manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most automatic slack adjusters, which may lead to failure of this brake component. (H-06-5)

To the Commercial Vehicle Safety Alliance:

Revise your pamphlet, *Air Brake Adjustment—Why is it so important?*, to emphasize that the manual adjustment of automatic slack adjusters is a dangerous practice that can have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon. (H-06-6)

Work with the Federal Motor Carrier Safety Administration to develop and add to the North American Standard Inspection training materials a module that emphasizes that manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most automatic slack adjusters, which may lead to failure of this brake component. (H-06-7)

To Haldex Brake Products Corporation, Bendix Commercial Vehicle Systems LLC, Bendix Spicer Foundation Brake LLC, Gunite Corporation, ArvinMeritor, Inc., and Crewson Industries, Inc. (manufacturers and marketers of automatic slack adjusters):

Revise your product literature to include conspicuously placed wording that clearly states that automatic slack adjusters should not be manually adjusted in an effort to correct excessive pushrod stroke, because this condition indicates that a problem exists with the automatic adjuster, with the installation of the adjuster, or with related foundation brake components, which manual adjustment will not fix. Further, the literature

should state that manual adjustment of automatic slack adjusters is a dangerous practice that could have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon. (H-06-8)

To Freightliner LLC, Mack Trucks, Inc., International Truck and Engine Corporation, Kenworth Truck Company, Peterbilt Motors Company, Volvo Trucks North America, Inc., Ford Motor Company, General Motors Corporation, Hino Motor Sales U.S.A., Inc., and Nissan Diesel America Incorporated (manufacturers of vehicles equipped with air brakes):

Revise your product manuals to include conspicuously placed wording that clearly states that automatic slack adjusters should not be manually adjusted in an effort to correct excessive pushrod stroke, because this condition indicates that a problem exists with the automatic adjuster, with the installation of the adjuster, or with related foundation brake components, which manual adjustment will not fix. Further, the product manuals should state that manual adjustment of automatic slack adjusters is a dangerous practice that could have serious consequences, because it gives the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon. (H-06-9)

To the National Institute for Automotive Service Excellence:

Include the following information in your T4 brake certification testing materials: manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes abnormal wear to the internal adjusting mechanism for most automatic slack adjusters, which may lead to failure of this brake component. (H-06-10)

To Motor Age, Mitchell 1, and Thompson Delmar Learning (publishers of National Institute for Automotive Service Excellence certification test study guides):

Include the following information in your National Institute for Automotive Service Excellence study guides: manually adjusting automatic slack adjusters is dangerous and should not be done, except during installation or in an emergency to move the vehicle to a repair facility, because manual adjustment of this brake component (1) fails to address the true reason why the brakes are not maintaining adjustment, giving the operator a false sense of security about the effectiveness of the brakes, which are likely to go out of adjustment again soon, and (2) causes

abnormal wear to the internal adjusting mechanism for most automatic slack adjusters, which may lead to failure of this brake component. (H-06-11)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Acting Chairman

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Member

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KATHRYN O'LEARY HIGGINS
Member

Adopted: February 7, 2006

Appendix A

Investigation

The National Transportation Safety Board was notified of the Glen Rock, Pennsylvania, accident on April 11, 2003. The Safety Board dispatched an investigative team on April 16, 2003, which included members from the Parsippany, New Jersey; Denver, Colorado; and Gardena, California, offices. Groups were established to investigate highway and vehicle factors, as well as motor carrier operations.

Participating in the investigation were representatives of the Federal Motor Carrier Safety Administration, the Pennsylvania Department of Transportation, the Pennsylvania State Police, the Southern Regional Police Department, and the Gunite Corporation.

Appendix B

Results of Safety Board Computer Simulations of Accident Events

Sim. no.	Initial speed (mph)	In gear (Y/N)	Brake forces (drag or pulse)	Time 10 to 15 (psi)	Time 30 (psi)	Time 50 (psi)	Highest speed (mph)	Lowest speed (mph)	Able to stop (speed end)	Length sim. (sec.)	Brake drum temp. (°F)	Brake lining temp. (°F)
1	1	Y	Drag	12	75.2	77.7	27	0	Y	92.7	737	485
2	1	Y	Drag	12	65.2	67.7	26	0	Y	82.4	676	438
3	1	Y	Drag	12	65.2	67.7	26	0	Y	81.7	669	430
4	1	Y	Drag	22	85.2	--	26	1	N (30)	86.2	588	399
5	1	Y	Drag	32	80.5	--	27	1	N (33)	81.8	546	358
6	1	Y	Drag	32	--	--	37	1	N (37)	73	540	323
7	1	Y	Drag	32	--	72	37	1	N (36)	73	516	320
8	25	Y	Drag	3	79.3	81.8	27	16	N (16)	87.7	761	500
9	25	Y	Drag	3	69.3	71.8	26	0	Y	85.1	763	506
10	25	Y	Drag	3	59.3	61.8	27	0	Y	75.2	707	458
11	25	Y	Drag	3	50.5	53	27	0	Y	66.6	656	417
12	25	Y	Drag	3	40.5	43	27	0	Y	56.6	595	370
13	25	Y	Drag	21	55.3	57.8	37	21	N (21)	67.4	768	408
14	25	Y	Drag	39.5	50.5	53	48	25	N (40)	58.2	550	259
15	25	Y	Drag	38	49	51.5	47	25	N (35)	59.1	638	289
16	35	Y	Drag	3	40.5	43	40	0	Y	54.7	918	552
17	35	Y	Drag	3	30.5	33	38	0	Y	53.9	838	489
18	35	Y	Drag	3	20.5	23	38	0	Y	42.9	733	415
19	35	Y	Drag	3	50.5	53	39	27	N (27)	60.6	850	474
20	35	Y	Drag	3	53.5	56	39	34	N (34)	59.8	746	446
21	45	Y	Drag	3	38	40.5	53	45	N (47)	45.4	771	401
22	45	Y	Drag	3	28	30.5	51	17	N (17)	53.2	1170	642
23	45	Y	Drag	3	34.5	37	52	34	N (36)	46.7	1012	489
24	55	Y	Drag	3	34.5	37	59	53	N (53)	39.2	817	402
25	55	Y	Drag	3	25.5	28	58	34	N (34)	42.1	1177	549
26	55	Y	Drag	3	26	28.5	58	35	N (35)	41.8	1158	536
27	25	N	None	--	--	--	70	25	N (70)	46.6	150	150
28	1	N	None	--	--	--	67	1	N (67)	63.9	150	150
29	1	Y/N	None	Neutral at 11.6 sec			67	1	N (67)	61.9	150	150
30	1	Y	Pulse	12	32	--	28	0	Y	80.1	570	416
31	1	Y	Pulse	12	32 (pump down)		31	1	N (31)	119.6	573	504
32	1	Y	Pulse	12	32 (pump down)		30	1	N (30)	118	543	480
33	1	Y	Pulse	12	32 (pump down)		36	1	N (36)	111.4	488	431
34	25	Y	Pulse	3	Pumped down to 0		36	25	N (36)	75.6	466	356
35	25	Y	Pulse	3	Pumped down to 0		35	25	N (35)	75.6	456	349

Appendix C

CVSA Pamphlet *Air Brake Adjustment—Why is it so important?*

Promoting
Commercial Motor Vehicle
Safety and Security

Commercial Vehicle Safety Alliance

www.cvsa.org

CONTACTS

For information about commercial motor vehicle safety & security or to inquire about inspection training needs for law enforcement and industry
Commercial Vehicle Safety Alliance (CVSA)
1101 17th Street NW
Suite 803
Washington, DC 20036
(202) 775-1623
www.cvsa.org

For further information about commercial motor vehicle safety in the U.S.
Federal Motor Carrier Safety Administration (FMCSA)
Office of Bus and Truck Standards and Operations
400 Seventh Street SW
Washington, DC 20590
(202) 366-1790
www.fmcsa.dot.gov

For further information about commercial motor vehicle safety in Canada
Canadian Council of Motor Transport Administrators (CCMTA)
2323 St. Laurent Boulevard
Ottawa, Ontario, Canada K1G 4J8
(613) 736-1003
www.ccmta.ca

For further information about commercial motor vehicle safety in Mexico
Autotransporte Federal
Secretaría de Comunicaciones y Transportes (SCT)
Czda. de las Bombas, No. 411
Coyoacan, DF Ciudad de Mexico 04920
52-55-56841514
www.sct.gob.mx

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ADJUSTMENT

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How To Tell When Your Brakes Are Out Of Adjustment

Brake adjustment is all about pushrod stroke. There's only one way to tell when you've got a brake adjustment problem. You've got to "measure the stroke."

The parts inside a brake chamber can only stroke so far before the brake chamber "bottoms out." When that happens, the brake chamber doesn't produce any more force on the brakes. To prevent chamber "bottom out," a brake's stroke must never be longer than its "adjustment limit."

You need to measure to be sure your brakes are properly adjusted and adjustment limits are different for each size and type of brake chamber. So, you need to know the size and type of brake chambers on each vehicle you're operating as well as their adjustment limit.

You can get information about the size and type of brake chambers on a vehicle from a technician, a dealer or your employer.

What About "Free-Stroke" & "Slack"

The distance you can pull the brake by hand using a bar or lever is called its "slack" or "free-stroke." This distance is generally 3/8 to 3/4 inch. You may get some indication of adjustment levels, but you can't really confirm proper brake adjustment this way. Measuring "free-stroke" or "slack" doesn't provide an accurate indication of brake adjustment.

How To "Measure The Stroke" Properly

Before doing anything, block the wheels, release the spring brakes and have a good look at the brakes. Each brake must be in its normal released position. Make sure nothing is obviously wrong or out of place. If your vehicle doesn't have stroke indicators, you'll have to mark each pushrod.

Now, to "measure the stroke" properly, you'll need to keep the spring brakes released, make sure your air pressure gauges show that you have 90 to 100 psi in the air tanks, shut the engine off and then make a full service brake application. You must have some way to hold the brake pedal down for this step.

You must measure how far each brake has stroked. Often an estimate will do, but any brake that is close to the adjustment limit must be carefully measured.

Refer to the chart below to identify the adjustment limit of each brake. Any brake that is stroking over its adjustment limit is "out of adjustment."

Why It's So Helpful To Have Stroke Indicators On Your Brakes

There are devices to help you measure pushrod stroke. Visual "stroke indicators" can be installed onto each brake to provide a moving pointer that strokes with the brake. Some stroke indicators will help you identify exactly where the adjustment limit is and whether the stroke is under or over it. Others only provide a convenient way to measure the stroke.

Checking brake adjustment generally means you have to get under the vehicle and take measurements. Using certain types of stroke indicators makes this job much easier. You can get accurate measurements without having to crawl under the vehicle.

What To Do When Your Brakes Are Out Of Adjustment

When your brakes are out of adjustment, what you do about it depends on whether your vehicle has manual or automatic brake adjusters.

Adjustment limits for clamp-type brake chambers

Check stroke with 90-100 psi in tanks and brakes fully applied

SIZE	MARKING	OUTSIDE DIAMETER	ADJUSTMENT LIMIT
6	none	4 1/2" (115mm)	1 1/4" (32mm)
9	none	5 1/4" (133mm)	1 3/8" (35mm)
12	none	5 11/16" (144mm)	1 3/8" (35mm)
16	none	6 3/8" (162mm)	1 3/4" (45mm)
16LS	Square Ports, Tag & Marking	6 3/8" (162mm)	2" (51mm)
20	none	6 25/32" (172mm)	1 3/4" (45mm)
20LS	Square Ports, Tag & Marking	6 25/32" (172mm)	2" (51mm)
24	none	7 7/32" (183mm)	1 3/4" (45mm)
24L	'L' and Stroke Tag	7 7/32" (183mm)	2" (51mm)
24LS	Square Ports, Tag & Marking	7 7/32" (183mm)	2 1/2" (64mm)
30	none	8 3/32" (205mm)	2" (51mm)
30	'DD3' (Bus/Coach)	8 1/8" (206mm)	2 1/4" (57mm)
30LS	Square Ports, Tag & Marking	8 3/32" (205mm)	2 1/2" (64mm)
36	none	9" (228mm)	2 1/4" (57mm)

READJUSTING MANUAL BRAKE ADJUSTERS

Manual brake adjusters must be readjusted on a regular basis. If your vehicle has manual brake adjusters, you can readjust them if you've had the proper training.

READJUSTING AUTOMATIC BRAKE ADJUSTERS

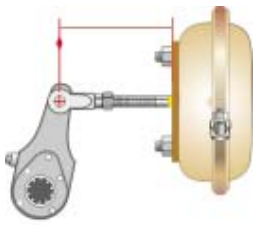
Automatic brake adjusters normally don't require manual readjustment. If you have a brake that is over-stroking and it has an automatic brake adjuster, you have a problem with the brake or the adjuster. If you readjust it, you aren't really fixing the problem. The same is true if someone else only readjusts it, the problem is still there.

A manual readjustment may bring the brake back into compliance and improve the way the brake operates, but it will only be temporary.

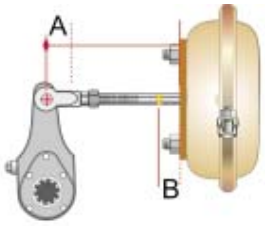
When you have automatic brake adjusters that are over-stroking, there are some things you need to know before you even think about readjusting them.

- You may be legally prohibited from readjusting automatic brake adjusters in some jurisdictions.
- Your employer may prohibit you from readjusting automatic brake adjusters.
- You shouldn't readjust an automatic brake adjuster unless you have been trained on exactly how to do it.
- Readjusting an automatic brake adjuster improperly can damage it.
- The brake will go out of adjustment again until the cause of the problem is repaired. It can go out of adjustment very quickly.
- If the brake is over-stroking, you need to check the free stroke or slack before you decide to readjust it.

FIGURES: The difference between the released and applied position of the brake linkage must be less than the adjustment limit.



Brake Released



Measure stroke at "A" or "B" with 90 to 100 psi in tank and brakes fully applied

If this distance is also longer than normal, a readjustment may temporarily correct the problem.

- You have to re-check the pushrod stroke and free-stroke or slack after re-adjusting the brake. The pushrod stroke must now be less than the adjustment limit and the free stroke or slack must be in its normal range. If either of these is not the case, do not proceed. The brake is defective.
- If you readjust the brake, you will have to take responsibility for doing so. This means you must continue to monitor it and report the problem at the first opportunity.
- If you hire someone to correct an over-stroking problem on a brake with an automatic adjuster, be sure they know what they are doing.

YOU MUST MEASURE THE STROKE TO CONFIRM THAT A BRAKE IS PROPERLY ADJUSTED.

Why It's So Important To Keep Your Brakes Properly Adjusted

As a professional driver, you know there will be times when you really need your brakes. Having good brakes can get you out of a bad situation when another driver makes a serious driving error or some event requires extreme braking.

To be able to rely on your brakes in every driving situation, they must be properly adjusted. When your brakes aren't properly adjusted, they will let you down. Trucks that don't stop the way they should can put people's lives at risk, including your own.

Trucks and trailers that operate with brakes out of adjustment are the most common reasons that drivers and vehicle operators are charged with violations. By taking the time to properly check brake adjustment, you'll make sure your vehicle is safe and you'll also avoid being charged with a violation.

Whenever checking the brake adjustment, always be on the lookout for other defects like: damaged, broken or missing components, rusty drums and brakes that aren't working.

Appendix D

Previous Safety Board Recommendations on Brake Adjustment and Inspection Issues

Brake Adjustment Guidelines. In 1975, the Safety Board investigated an accident involving a tractor-semitrailer that lost braking capability while descending a steep grade near Bishop, California.[1] The vehicle began accelerating at a point 5 to 5 1/2 miles from a truck parking area, where the driver had stopped to adjust the brakes. While the driver was attempting to negotiate a curve, the trailer separated from the tractor, overturned in front of a pickup truck and attached camper-trailer traveling in the opposite direction, and struck the other vehicle, causing it to burst into flames. All seven occupants were killed. As a result, the Safety Board recommended that the Federal Highway Administration (FHWA):

> H-75-17
>
> Develop and disseminate throughout the motor carrier industry, an "On Guard" bulletin alerting drivers of commercial vehicles equipped with externally adjustable braking systems of: a) the need to be familiar with company policies and practices with respect to on-road adjustment of brakes; b) methods and techniques for detecting potential or existing problems in adjustment; c) the scope of the problem in insuring proper brake adjustment; d) methods or techniques for the proper on-road adjustment of braking systems currently and generally in use.

In response, the FHWA developed a bulletin entitled *Danger-Driver Adjusted Brakes*, which was circulated to all carriers for display on bulletin boards and distribution to drivers and safety supervisors. The Safety Board classified this recommendation "Closed—Acceptable Action" on October 20, 1977.

A similar recommendation resulted from the Safety Board's 1992 safety study on heavy vehicle air brake performance.[2] The Safety Board recommended that the National Private Truck Council, the Owner-Operator Independent Driver Association, and the American Trucking Associations, Inc., (ATA) work with one another

[1] National Transportation Safety Board, *Francisco Flores Truck/Pickup Truck with Camper and Trailer Collision, U.S. Route 395, Bishop, California, June 29, 1974,* Highway Accident Report NTSB/HAR-75/05 (Washington, DC: NTSB, 1975).

[2] National Transportation Safety Board, *Heavy Vehicle Airbrake Performance*, Safety Study NTSB/SS-92/01 (Washington, DC: NTSB, 1992).

H-92-67, -72, and -74

To complete and distribute to member carriers appropriate brake maintenance materials that clearly establish standard inspection techniques (including adjustment indicators), inspection and adjustment interval guidelines, and an adjustment method (covering both manual and automatic slack adjusters) for S-cam brakes on heavy vehicles. Encourage members to provide a copy of the information to each driver of a heavy vehicle and to each mechanic who services heavy vehicles.

On July 29, 2002, the Safety Board classified Safety Recommendation H-92-67 to the National Private Truck Council "Closed—Unacceptable Action/No Response Received."

In 1993, the Owner-Operator Independent Driver Association produced and distributed more than 15,000 copies of a brake videotape and accompanying booklet, entitled *What's Stopping You?*, which stressed the importance of regular preventive brake maintenance, provided an overview of roadside inspection procedures, and warned of the potentially serious consequences of mismatching brake components. Also included in the pamphlet was information from the FHWA and the University of Michigan Transportation Research Institute on downhill braking techniques. The Safety Board classified Safety Recommendation H-92-72 to the Owner-Operator Independent Driver Association "Closed—Acceptable Action" on January 30, 2001.

Through its maintenance council, the ATA developed a training video on how to conduct truck brake inspection and maintenance. In 1992, the ATA informed the Safety Board that efforts were under way with the FHWA's Office of Motor Carriers to develop a method carriers could use to establish an appropriate brake adjustment interval for their own operations. The Federal Motor Carrier Safety Administration (FMCSA) Web site now contains a comprehensive list of brake maintenance materials and guidelines. The Safety Board classified Safety Recommendation H-92-74 to the ATA "Closed—Acceptable Action" on July 16, 2002.

Automatic Slack Adjusters and Out-of-Adjustment Indicators. Beginning in 1978, the Safety Board made several safety recommendations to require that vehicles be equipped with automatic slack adjusters and out-of-adjustment indicators.[3] In 1977 and 1978, the Safety Board investigated five accidents in which commercial vehicle drivers were unable to maintain speed control on downgrades. The major causal factor in four of these accidents was improper adjustment of the vehicles' service brakes; in the fifth accident, the trailer brakes were totally inoperative. In two instances, the owners and operators had failed to ensure that the vehicles were safe for operation before they were dispatched.

In its 1992 study of heavy vehicle air brake performance,[4] the Safety Board issued safety recommendations that superseded those resulting from the investigations conducted

[3] Safety Recommendations H-78-48 and H-88-30 were superseded by Safety Recommendation H-92-50. Safety Recommendations H-81-1 and H-88-32 were superseded by Safety Recommendation H-92-51.

[4] NTSB/SS-92/01.

in the 1970s and 1980s. The Board cited numerous brake deficiencies, including serious instances of out-of-adjustment brakes, as causal or contributing factors in the accidents investigated to support the 1992 safety study. The Safety Board urged the National Highway Traffic Safety Administration (NHTSA) to

> H-92-50
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> Require that air-braked vehicles be equipped with visible adjustment indicators that will allow one person to check the level of adjustment.
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> H-92-51
>
> Expedite the proposed rulemaking to require automatic adjusters on vehicles equipped with air brake systems.

NHTSA issued a final rule on October 20, 1992, amending Federal Motor Vehicle Safety Standard 121, "Air Brake Systems," and Federal Motor Vehicle Safety Standard 105, "Hydraulic Brake Systems," to require automatic brake adjusters on all air-braked and hydraulic-braked vehicles manufactured after October 20, 1994. Consequently, the Safety Board classified both recommendations "Closed—Acceptable Action" on December 21, 1992.

The Safety Board also recommended that the FHWA

> H-92-57
>
> Encourage the installation of vehicle brake adjustment indicators on all vehicles equipped with air brake systems for easy detection of adjustment levels.

In 1995, the FHWA published a report entitled *Evaluation of Brake Adjustment Criteria for Heavy Trucks*, which presented analyses, findings, and recommendations concerning the brake adjustment criteria of the *North American Uniform Driver-Vehicle Inspection Criteria for Heavy Trucks*. The FHWA also issued a final rule requiring motor carriers that have vehicles manufactured on or after October 20, 1994, to retain automatic brake adjustment indicators. The Safety Board classified this recommendation "Closed—Acceptable Action" on February 5, 1996.

Brake Inspection. In 2002, the Safety Board issued an accident report on a May 31, 2001, accident that took place near Mountainburg, Arkansas, when a Gayle Stuart Trucking, Inc., truck-tractor semitrailer collided with a 65-passenger school bus operated by the Mountainburg, Arkansas, public schools. Three school bus passengers were fatally injured; two other passengers received serious injuries. Four passengers, the school bus driver, and the truck driver sustained minor injuries.[5]

[5] National Transportation Safety Board, *Collision Between Truck-Tractor Semitrailer and School Bus Near Mountainburg, Arkansas, May 31, 2001*, Highway Accident Report NTSB/HAR-02/03 (Washington, DC: NTSB, 2002).

One of the major safety issues discussed in the report was the poor condition of the tractor-semitrailer's brakes. In the report, the Safety Board noted that the tractor-semitrailer was equipped with manual slack adjusters on the tractor brakes and automatic slack adjusters on the trailer brakes. Postaccident, 8 of the 10 brakes were found to have been either out of adjustment or nonfunctional at the time of the accident; at least 4 brakes could not have provided any braking force. The Safety Board concluded that six brakes on the tractor were out of adjustment either because the owner had not properly adjusted them, or because the brakes went out of adjustment due to a disproportional workload, or both.

The Mountainburg driver said he visually inspected the brakes on the day of the accident and did not find them to be out of adjustment. However, during the pretrip inspection, the driver did not follow the recommended practice of pulling on the pushrod and measuring the stroke to determine whether the brakes were out of adjustment. The Safety Board concluded that the driver did not conduct a sufficiently thorough pretrip inspection on either the tractor or the trailer to discover brake deficiencies. The regulation covering pretrip driver inspections, 49 *Code of Federal Regulations* (CFR) 396.13(a), stipulates only that the driver be satisfied that the motor vehicle is in safe operating condition before beginning driving; the regulation does not specify what must be done during a pretrip inspection or which procedures must be performed daily on the vehicle. The Safety Board issued the following safety recommendation to the FMCSA:

> H-02-15
>
> Revise 49 *Code of Federal Regulations* 396.13, Driver Inspection, to require minimum pretrip inspection procedures for determining brake adjustment.

In its initial response to this recommendation, dated January 3, 2003, the FMCSA stated that it considered that Federal regulations already adequately covered the intent of this recommendation, because (under 49 CFR 396.13(a)) the driver must be satisfied that the vehicle is in safe operating condition, including (under 49 CFR 392.71) that specified parts, such as the service brakes and the hand brake, are in good working order. Following this FMCSA response, the Safety Board classified the recommendation "Open—Unacceptable Response" on July 1, 2003. The FMCSA sent another response, dated August 9, 2004, requesting reconsideration of this classification. On January 25, 2005, the Safety Board stated its classification of Safety Recommendation H-02-15 would remain "Open—Unacceptable Response."

The Mountainburg accident investigation also raised issues concerning the qualifications of brake inspectors. Title 49 CFR 396.25, "Qualification of Brake Inspectors," requires that each brake inspector successfully complete an apprenticeship or training program or have a certificate of experience totaling at least 1 year. The person responsible for maintaining the brakes on the trailer of the Mountainburg accident vehicle could prove the required experience; however, he failed to notice problems that a qualified

mechanic should have noticed during routine maintenance and inspections. The Safety Board concluded that the carrier's mechanic lacked proper training in brake maintenance and inspections, did not detect the poorly adjusted or inoperative brakes on the trailer, and did not perform recommended maintenance. Under the FMCSA's motor carrier compliance review process, a violation of 49 CFR 396.25 is not considered "Critical." Thus, if a carrier does not have a qualified brake inspector, its rating is not affected. Consequently, the Safety Board issued the following safety recommendation to the FMCSA:

> H-02-17
>
> During compliance reviews, rate companies as unsatisfactory in the vehicle factor category if the mechanics and drivers responsible for maintaining brake systems are not qualified brake inspectors.

In its initial response to Safety Recommendation H-02-17, dated January 3, 2003, the FMCSA stated that it would review its process of assessing motor carriers' safety management control activities that influence the vehicle factor of a carrier's safety rating. The Safety Board classified the recommendation "Open—Acceptable Response" on July 1, 2003. In a May 28, 2004, letter to the Safety Board concerning this recommendation, the FMCSA stated

> Because our safety fitness rating methodology is based on the overall performance (e.g., vehicle, driver, accident) of a motor carrier during a compliance review, we do not take the specific approach recommended by NTSB. We are concerned that basing the rating on only one single component of the carrier's operation—the vehicle portion—would not yield a fair determination of the carrier's overall safety fitness, and hence, would not result in increased effectiveness. FMCSA's investigators do review carrier profiles prior to each and every compliance review. As a matter of standard practice, if the profile indicates evidence of brake problems, the investigator focuses his or her investigation on the inspection and maintenance of the vehicles, including the qualifications of brake inspectors.

In its December 15, 2004, response to the FMCSA, the Safety Board indicated that the Board continues to believe that implementation of Safety Recommendation H-02-17 is necessary, given that brake failures have dire consequences for traffic safety. The Board noted that it was aware the FMCSA had published an advance notice of proposed rulemaking in 1998 that was intended to lead to a more performance-based rating system. The Board also stated that it understood from previous correspondence that the FMCSA would factor the recommendation into its plans as it proceeds to issuing a notice of proposed rulemaking (NPRM). The Board noted that it would consider the FMCSA's response acceptable if the NPRM and final rule address brake mechanic qualifications. Pending such action, the Safety Board classified Safety Recommendation H-02-17 "Open—Unacceptable Response."

Also in the Mountainburg report, to ensure that mechanics working on truck brake systems for carriers have the knowledge necessary to maintain such systems, the Safety Board issued the following safety recommendation to the FMCSA:

H-02-18

Revise 49 *Code of Federal Regulations* 396.25, Qualifications of Brake Inspectors, to require certification after testing as a prerequisite for qualification and specify, at a minimum, formal training in brake maintenance and inspection.

In its initial (January 3, 2003) response to Safety Recommendation H-02-18, the FMSCA stated that it would research the training, examination, and certification requirements of organizations that certify automotive mechanics and then evaluate the results of the research and determine the appropriate next steps. On July 1, 2003, the Safety Board classified this recommendation "Open—Acceptable Response." Subsequently, in a letter dated August 9, 2004, the FMCSA indicated that implementing Safety Recommendation H-02-18 would impose a significantly increased burden on motor carriers and suggested alternative approaches to fulfilling the intent of the recommendation. The Safety Board did not find the alternatives satisfactory and reclassified the recommendation "Open—Unacceptable Response" on January 25, 2005.