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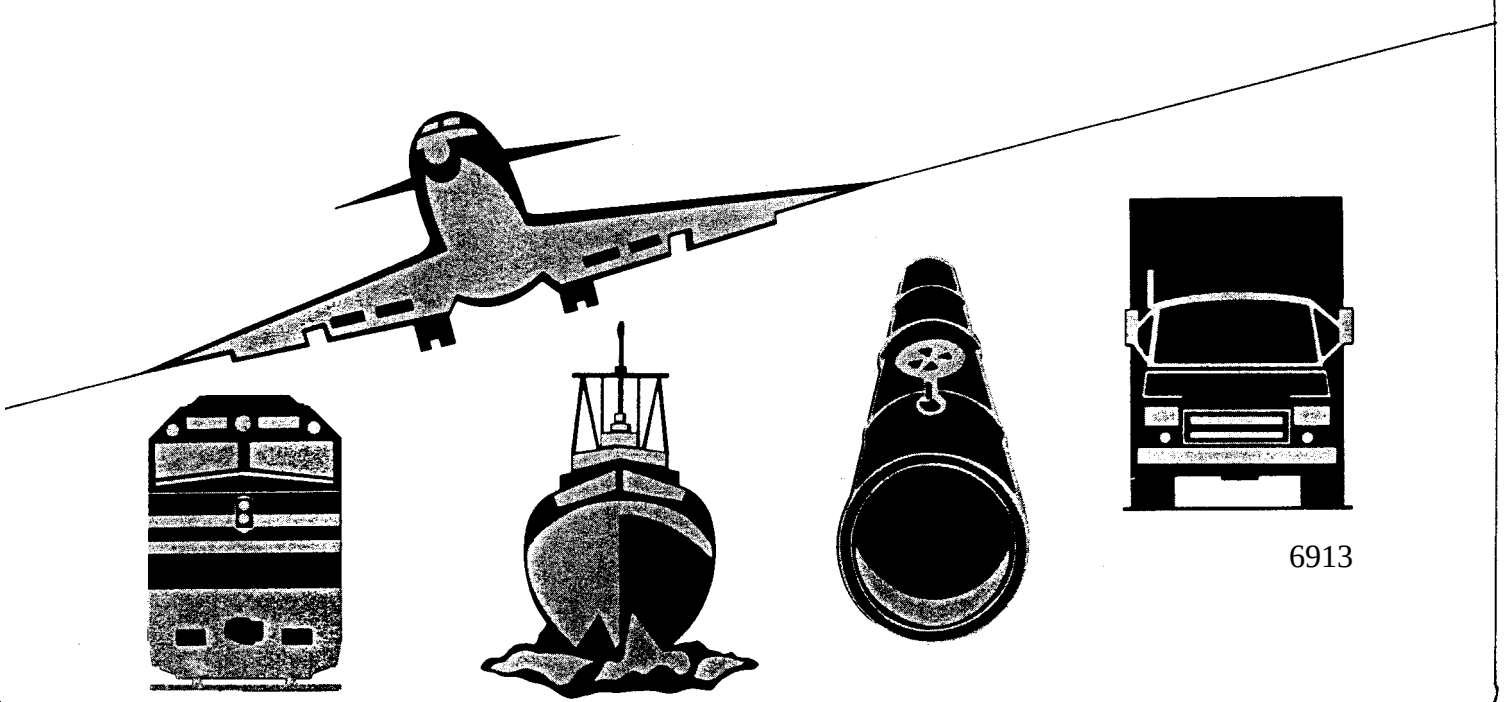
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT SUMMARY REPORT

TRUCK LOSS OF BRAKING CONTROL ON STEEP DOWNGRADE AND COLLISION WITH A VEHICLE NEAR PLYMOUTH MEETING, PENNSYLVANIA ON APRIL 25, 1996



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Abstract: On April 25, 1996, a truck with a concrete mixer body, unable to stop, proceeded through an intersection and collided with and overrode a passenger car near Plymouth Meeting, Pennsylvania. The driver of the car was fatally injured, and the truckdriver sustained minor injuries.

The major safety issues discussed in this report are the maintenance and truck inspection practices of JDM Materials Company, Inc., and the adequacy of Federal and State guidelines for conducting truck air brake system inspections.

As a result of its investigation, the Safety Board issued recommendations to the Federal Highway Administration; the Commercial Vehicle Safety Alliance; the American Trucking Associations, Inc.; the National Ready Mix Concrete Association; the JDM Materials Company, Inc.; the Pennsylvania Department of Transportation; the Truck Manufacturers Association; the National Highway Traffic Safety Administration; and the Society of Automotive Engineers.

TRUCK LOSS OF BRAKING CONTROL

ON STEEP DOWNGRADE

AND COLLISION WITH A VEHICLE

NEAR PLYMOUTH MEETING, PENNSYLVANIA

APRIL 25, 1996

HIGHWAY ACCIDENT SUMMARY REPORT

Adopted: October 17, 1997
Notation 6913

NATIONAL
TRANSPORTATION
SAFETY BOARD

Washington, DC 20594

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National Transportation Safety Board
Washington, DC 20594

HIGHWAY ACCIDENT SUMMARY

Motor Carrier: JDM Materials Company, Inc.
Vehicle 1: 1988 Mack four-axle truck with a concrete mixer body
Vehicle 2: 1985 Subaru sedan

Accident Type: Loss of braking control leading to vehicle collision
Location: Plymouth Meeting, Pennsylvania

Date: April 25, 1996
Time: 3:25 p.m.

Injuries: One fatal and one nonfatal

On April 25, 1996, about 3:25 p.m., a 1988 Mack truck with a concrete mixer body was unable to stop as it approached a "T" intersection at the bottom of an exit ramp in Plymouth Meeting, Pennsylvania. As the truck proceeded through the intersection, it collided with and overrode a 1985 Subaru passenger car. The Subaru driver was killed; the truckdriver sustained minor injuries. The truckdriver was unrestrained; the Subaru driver was found restrained in her vehicle. The weather was clear and dry. No fire ensued, and no other vehicle occupants were involved in the accident.

In its investigation of the accident, the Safety Board identified as safety issues the maintenance and truck inspection practices of JDM Materials Company, Inc., (the owner of the truck) and the adequacy of Federal and State guidelines for conducting truck air brake system inspections. The following discussion includes a narrative description of the accident and the events leading to it, a discussion of the safety issues, and a list of conclusions and safety recommendations developed to help prevent future accidents of this type.

INVESTIGATION

Preaccident Events

On April 25, 1996, about 6:30 a.m., the truckdriver reported for work at JDM Materials Company, Inc., in Plymouth Meeting, Pennsylvania. The truckdriver's duties consisted of delivering concrete to customer locations in the Philadelphia metropolitan area. At 7 a.m., the truckdriver departed the JDM yard in the truck that had been assigned to him for the previous 4 years, a 1988 four-axle Mack truck with a concrete mixer body.

The truckdriver delivered several loads of concrete during the morning hours. In the early afternoon, he departed Philadelphia International Airport en route back toward the JDM terminal. The truck at that time was loaded with about 7 yards of concrete. The truckdriver traveled south on Interstate 95 and entered State Route (SR) 476 north at the Plymouth Meeting interchange. The truckdriver reported that, after traveling about 6 miles on SR 476, he ran over a truck tire carcass that was lying in the road. He said he did not notice anything unusual about the operation of his truck after he struck the tire carcass.

The Accident

About 3:25 p.m. and about 12 miles past the location where the truck had struck the object in the roadway, the truckdriver entered the deceleration lane for the off ramp leading to a "T" intersection with Chemical Road. The truckdriver stated that he downshifted into fourth gear and was traveling about 35 mph near the top of the exit ramp. A witness in the second car behind the truck estimated the truck's speed to be between 30 and 35 mph at that point. The truckdriver stated that he began applying brakes about half way down the ramp, about 300 feet from the intersection. The driver stated that, as his truck descended the ramp, which was on a 6-percent grade, the truck brakes felt "spongy" and the truck did not slow down. He said he applied the brakes several more times and pulled on the hand control valve,[1] but the truck still did not slow down. He said that the engine brake[2] was in the "on" position.

According to the truckdriver, as the truck came within about 150 feet of the intersection, he realized that he would not be able to stop at the bottom of the ramp. He said that he normally turns to the right (southbound) onto Chemical Road, but he had to move to the left lane to avoid hitting several cars that were stopped in the right traffic lane and directly in front of him. He entered the intersection, where he planned to negotiate a 90 degree left turn (northbound). A witness[3] estimated that the truck's speed was 25 mph as it approached the intersection. As the truck crossed the intersection, it struck a 1985 Subaru sedan that had been proceeding southbound on Chemical Road. The truck stuck the automobile on the passenger side, overrode it, and dragged it across the intersection before the truck overturned and came to rest on its right side. Both vehicles came to rest on the east side of the intersection. (See figures 1 through 3 for details at the accident scene.)

Postaccident Events

The truckdriver was transported to Suburban General Hospital in Norristown, Pennsylvania, where he was determined to have sustained minor contusions to his chest and legs and where a drug test was administered. The toxicological tests results were negative for alcohol and other specified drugs. Postaccident toxicology testing on the automobile driver was also negative for alcohol and other specified drugs.

The chief mechanic for a local towing company (who was a certified Pennsylvania State vehicle safety inspector) conducted a

[1]The hand control valve applies the rear axle brakes.

[2]An engine retarder that acts to slow the vehicle

[3]The same witness who had estimated the truck's speed at the top of the ramp.

Figure 1 -- Accident scene, T-intersection, and off-ramp.
(Photograph courtesy of Plymouth Township police.)

Figure 2 -- Accident truck.

Figure 3 -- Accident vehicles at final rest position.
(Photograph courtesy of Plymouth Township police.)

postaccident examination of the truck during the retrieval operation. The parking brake knob on the truck instrument panel was found in the depressed (off) position. The examination revealed that the drain valve located on the bottom of the air reservoir tank for the truck's secondary air system was broken off, and the air in the tank was depleted. (See figure 4.) A fractured piece of the valve was still threaded into the drain port. Scrape marks were visible on the underside of the tank in the area of the drain valve port.

A search of the accident scene failed to locate the missing broken drain valve. Employees of JDM returned to the area where the truckdriver said he struck a tire carcass a short time before the accident. The employees reported finding a tire carcass measuring 146 inches long, 12 inches wide, and 1 1/2 inches thick, but they did not find the broken valve.

The day after the accident, the fractured drain valve was replaced, and the truck's secondary air system was recharged. The truck's entire air brake system was then tested by the chief mechanic of the towing company and found to be in compliance with Pennsylvania State safety inspection standards. Also, the Pennsylvania State Police conducted a separate inspection of the truck using the Federal Motor Carrier Safety Assistance Program (MCSAP) criteria. The MCSAP program, which is administrated by the Federal Highway Administration, has adopted the Commercial Vehicle Safety Alliance out-of-service criteria for air brake inspections of large trucks. The inspection criteria have been adopted by most States, including Pennsylvania. The accident vehicle, including the air brake system, passed the Pennsylvania State Police postaccident MCSAP inspection.

Truckdriver Information

The 54-year-old truckdriver lived in Norristown, Pennsylvania, and had been employed by JDM as a truckdriver since March 1980. He possessed a valid medical certificate and Pennsylvania commercial driver license that certified him to operate the accident truck. The truckdriver stated that he had rested comfortably at home the night before the accident, and a check of his work history for the previous 7 days indicated that he was in compliance with Federal Motor Carrier Safety Regulations regarding hours of service.

Motor Carrier Information

JDM is a Pennsylvania corporation that has served eastern Pennsylvania and New Jersey with ready mix concrete and quarry stone products since 1956. At the time of the accident, the company employed between 180 and 200 employees: 120 to 125 were full-time truckdrivers, and 15 were full-time mechanics at various company garages. The company operated 165 trucks equipped with concrete mixer bodies and 25 tractor semi-trailers of various configurations. JDM is registered with the U.S. Department of Transportation as an interstate commerce motor carrier. However, according to the JDM operations officer, about 90 percent of the company's business is conducted intrastate, and the truckdriver that was involved in the accident was on an intrastate trip. All the trucks are dispatched daily and return nightly to their assigned garage.

Truck Inspections and Maintenance

JDM truckdrivers are required to conduct daily pre and posttrip inspections of their assigned vehicles. Any repairs or deficiencies are recorded and forwarded to the garage mechanics, who then schedule the truck for the needed repair. Additionally, trucks are subject to a Pennsylvania State inspection every 6 months. Between March 23, 1994, and April 25, 1996, (the day of the accident) the accident truck successfully passed four Pennsylvania State safety inspections.

According to the JDM shop supervisor, about 90 percent of all repairs to the company's trucks are performed by JDM mechanics. Preventative maintenance is scheduled for each truck after every 300 to 400 hours of operation. Service and repair records indicated that a malfunctioning air brake treadle (foot pedal) valve on the accident truck was replaced by JDM mechanics on March 23, 1994. This was the only documented maintenance performed on the treadle valve of the accident vehicle. Except for service brake adjustments, no other repairs were recorded as having been performed on the air brake lines of the accident truck between

1994 and the date of the accident. The service brakes were last adjusted before the accident on March 14, 1996. On the morning of the accident, the driver performed part of his pretrip inspection by pulling the truck forward and applying the parking brakes to stop the truck. He reported that he had no problems with the brakes.

Air Brake System Operation

The truck was equipped with a dual air brake system consisting of a primary and a secondary air system. The primary and secondary systems operate independently, and each has its own air tanks and air brake lines. As designed, the primary brake system delivers air to the rear axle service brakes, and the secondary system provides air to operate the front axle service brakes. When the driver presses the brake pedal, both air systems are activated, applying both front and rear brakes simultaneously. Additionally, the truck was equipped with a spring brake system (parking brake).

In heavy trucks, the majority of the braking ability comes from the rear axle brakes. Thus, most trucks are equipped with a safety device designed to provide "backup" braking in the event of a loss of air supply to the rear brakes. In the accident truck, this safety device, a spring brake inversion valve, monitored air pressure in the primary air system. If the inversion valve detected a loss of primary air pressure, it was designed to direct air from the secondary air system brake tank to the rear axle spring brake control. The spring brake control would then automatically apply the parking brakes whenever the driver depressed the brake pedal, thus providing some braking capability. The secondary air system, because it was designed to operate the less-safety-critical front brakes, was not equipped with an inversion valve or any other backup device.

An air pressure gauge mounted on the instrument panel in front of the driver displayed air pressure in both the primary and secondary air systems. The single gauge had separate needles for each system. The truck was also equipped with a instrument-panel-mounted low-air-pressure warning light and buzzer that were designed to alert the truckdriver in the event of a loss of air pressure in either the secondary or primary air tanks. The light and buzzer could be activated by either of two (one for primary and one for secondary) low-air-pressure warning switches.

Safety Board Tests and Calculations

Several days after the accident, a Safety Board investigator, the chief mechanic for the towing agency, and a representative of Mack Truck, Inc., conducted another postaccident inspection of the accident truck's air brake system. The inspection revealed several anomalies, including the fact that two air lines connected to the brake treadle valve had been reversed. (See figure 5.) Because of the reversed connections, on the day of the accident, the accident truck's rear brakes were being operated by the secondary air system, and the front brakes by the primary air system. The reversed air lines were not detected during the Pennsylvania State inspections before the accident or during the postaccident inspections conducted by the police or the local mechanic.

The Safety Board tested the two low-air-pressure switches to determine if they were operating properly. When air pressure was completely exhausted from the secondary air tank, the low-air-pressure warning light and buzzer on the truck instrument panel did not activate. The tests of the low-air-pressure switch that normally monitored air pressure in the primary air system found this switch to be inoperative. However, because of the reversed connections, this switch was monitoring air pressure in the secondary system. The switch that normally monitored pressure in the secondary air tank (but that was actually monitoring pressure in the primary air tank) was tested and found to be operating properly.

JDM provided a similar (to the accident truck) make and model truck from its fleet to be used as an exemplar vehicle during the investigation. A 1988 Mack truck with a concrete mixer body was selected at random and delivered to the inspection area. Safety Board inspection of the air brake system on that truck revealed that its air lines had been reversed in an area where repairs had been made to the truck's frame. The JDM service records for this truck revealed that the repairs to the frame and air

Figure 4 -- Location of missing drain valve indicated by arrow.

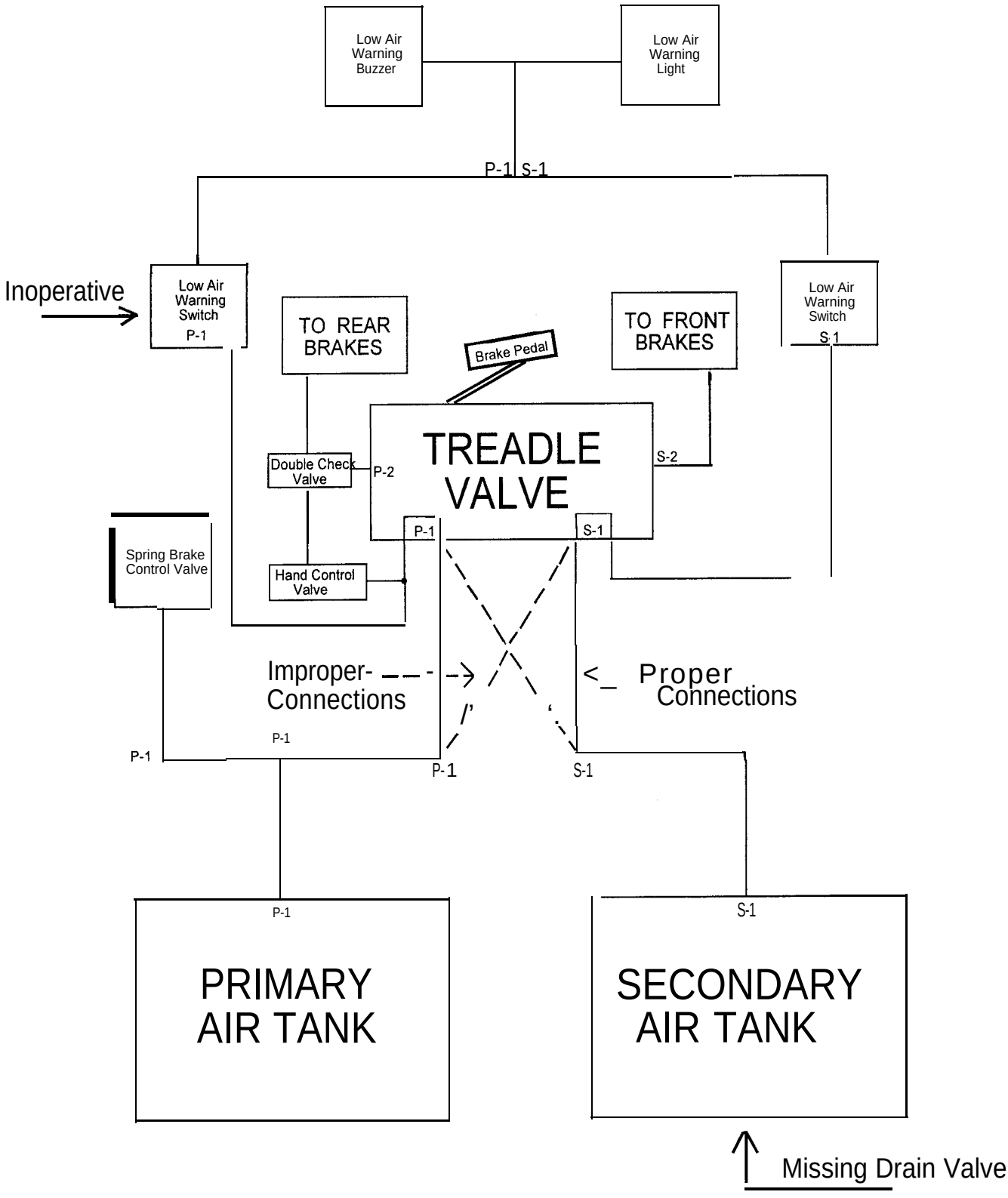

Figure 5- Air brake system diagram.
(Simplified for illustration only.)

brake lines had been performed on February 29, 1996. On March 16, 1996, this truck passed a Pennsylvania State safety inspection.

At the Safety Board's request, JDM inspected its entire fleet to determine if any more vehicles had reversed air brake lines and/or inoperative low-air-pressure warning switches. This inspection of the company's 165-truck fleet revealed that two additional trucks had reversed air lines, and 12 additional trucks had inoperative low-air-pressure warning switches. The company reported that all defective air systems were repaired and tested in accordance with the brake manufacturer's guidelines.

The Safety Board performed brake efficiency calculations[4] for the accident truck to determine its braking capability with only front brakes operational, with only rear brakes operational, and with both front and rear brakes operational. Brake efficiencies and vehicle stopping distances were calculated and adjusted for the estimated speed, heat generated by overworking the front brakes, and minimum engine retarder use.[5]

Calculations using the front axle brakes with minimum engine retardation indicated that the accident truck had a braking efficiency range from 17 to 21 percent and required between 408 and 453 feet to stop. Calculations using rear brakes with minimum engine retardation indicated that the truck had an approximate braking efficiency of 54 percent and would have required between 123 and 157 feet to stop. Calculations using full braking capability indicated that the braking efficiency for that truck ranged from 96 to 100 percent and that the truck would have needed between 72 and 92 feet to stop. Calculations using front axle brakes with minimum engine retardation and the rear spring brakes indicated that the truck needed between 314 and 340 feet to stop.

[4]National Transportation Safety Board, *Safety Study, Heavy Vehicle Air brake Performance*, NTSB/SS-92/01, and Ronald Heusser, "Heavy Truck Deceleration Rates as a Function of Brake Adjustment," Society of Automotive Engineers, 1991.

[5]Engine retarders can provide some speed reduction when the vehicle first starts to slow before making a stop; however, engine rpm drops quickly as the vehicle comes to a stop, and the retarder will provide very little engine braking.

SAFETY ISSUES

In its investigation of this accident, the Safety Board determined that neither weather nor highway conditions were causal factors. Additionally, the truckdriver was not fatigued, impaired, or suffering from any medical conditions that may have influenced his performance in this accident. Postaccident examination and testing of the accident truck operating systems revealed that the only deficiencies were in the truck's braking system, specifically, a broken drain valve on the secondary air brake air reservoir tank, an inoperative low-air-pressure warning switch, and reverse-connected air brake lines at the truck's treadle valve. Assuming that all three of these conditions existed at the time the truck entered the exit ramp for Chemical Road, the truck would have been without rear brakes as the truckdriver attempted to slow and stop at the Chemical Road intersection. The Safety Board attempted to determine if these conditions existed before the accident.

Because the broken drain valve was never located, it could not be immediately determined when the damage had occurred; however, if the drain valve had been fractured during the impact sequence, the driver would have had full braking (front and rear brakes) as he descended the exit ramp leading to Chemical Road. Instead, the truckdriver applied the available service brakes as he approached the intersection, but he stated that the brakes felt spongy and that he was unable to stop the truck in time to avoid the collision. Thus, it is unlikely that he had full braking on the downgrade.

If the drain valve had been fractured while the truck was en route to the accident site, the truckdriver, because of the reversed air line connections, would not have been able to apply his rear brakes after the air pressure was depleted from the secondary air tank. A Mack Truck engineer confirmed that the truckdriver's account of the spongy brakes was consistent with what would have occurred if the truck had had limited braking (front brakes and minimum engine retardation). The Safety Board therefore concludes that the drain valve on the secondary air supply tank was probably fractured when the truck struck a tire carcass while en route to the accident site.

Safety Board calculations indicated that the accident truck with front brakes operational and minimum engine retardation had a braking efficiency range from 17 to 21 percent. With this level of braking efficiency, the cargo load, and the 6-percent downgrade, the accident truck would have needed between 408 and 453 feet to stop. With full front and rear brakes operating, the truck's braking efficiency ranged from 96 to 100 percent, and it would have been able to stop within 92 feet. The driver indicated that he began applying his brakes about 300 feet from the intersection. Based on all available information, the Safety Board concludes that the accident truck probably had only its front brakes operational with minimum engine retardation when it reached the intersection and that it was therefore unable to stop in time to avoid the accident.

On the accident truck, the low-air-pressure warning switch for the primary air system was monitoring pressure in the secondary air supply, but because this switch was inoperative, it did not warn the truckdriver when the secondary air supply tank became depleted. The Safety Board concludes that had both low-air-pressure warning switches on the accident truck been operable, the truckdriver would have had earlier warning of the depleted air supply and may have been able to stop the truck and avoid the accident.

The spring brake system (parking brake) on a heavy truck can be manually applied at any time. The truckdriver could have applied the parking brakes as he descended the grade, and this may have slowed the truck. However, the truckdriver stated that he had already applied the foot brake and pulled the hand control valve to apply the rear axle brakes and that the truck was not slowing. About 150 feet from the intersection, the truckdriver chose to steer

around the stopped traffic. The brake calculations performed by the Safety Board revealed that at this point the truckdriver would not have been able to stop the truck with the parking brake in combination with the front axle brakes and minimum engine retardation.

In its investigation, the Safety Board identified as safety issues the maintenance and truck inspection practices of JDM Materials Company, Inc., and the adequacy of Federal and State guidelines for conducting truck air brake system inspections.

Motor Carrier's Truck Maintenance and Inspection Practices

The air brake lines on the accident vehicle were most likely reversed during March 1994 when JDM mechanics performed the only documented maintenance on the treadle valve of the accident truck. At no time before the accident did the motor carrier's mechanics detect the reversed air lines, even though the accident truck was in service in this condition for almost 2 years before the accident.

So long as both of the truck's air systems remained intact, the operation of the truck's brakes appeared normal; however, the reversed air lines bypassed a vital backup in the air brake system. The rear axle spring brakes, which automatically activate when a loss of air occurs in the primary air system, did not activate in this accident, because the primary air system remained intact. The secondary air system, which on the accident truck was providing air to operate the rear brakes, was not equipped with a backup system. The Safety Board concludes that the motor carrier's improper installation of the treadle valve air lines on the accident truck effectively bypassed an important safety feature and resulted in reducing the truck's braking capability under certain emergency conditions.

JDM officials told the Safety Board that its mechanics use service manuals provided by component manufacturers and by Mack Truck in performing vehicle repairs and periodic maintenance. Mack Truck publishes an air brake service manual that also contains individual component maintenance information. The brake maintenance section of the Mack maintenance and lubrication manual includes brake adjustment procedures and specifications; however, the manuals in use before this accident did not contain procedures for comprehensively testing the operation of dual-circuit brake systems. Also, the Mack Truck air brake service manual did not provide any system function test procedures that would have detected reversed lines or malfunctioning low-air-pressure warning switches.

The treadle valve manufacturer publishes an air brake troubleshooting guide (see appendix A) that outlines a test procedure that would have detected reversed treadle valve air line connections and inoperative low-air-pressure warning switches. The Safety Board concludes that if JDM employees had followed the treadle valve manufacturer's installation tests and inspection procedures when performing maintenance on the treadle valve of the accident truck, they would probably have recognized the improper installation problems and/or inoperative brake components, and the accident may have been prevented.

The Safety Board discussed with representatives of Mack Truck the fact that the company's maintenance manuals did not contain information on installing and testing a dual-circuit brake system. As a result of these discussions, the 1997 model year Mack Truck maintenance and lubrication manual includes a dual-circuit brake system function test for detecting reversed air lines and inoperative low-air-pressure warning switches. (See appendix B.)

The Safety Board notes JDM's prompt postaccident inspection of its entire truck fleet as a result of the preliminary findings of this accident investigation. However, to further improve the effectiveness of the company's maintenance procedures, the Safety Board believes that JDM should implement procedures that will ensure that air brake manufacturers' suggested installation, inspection, and functional test procedures are adhered to by company mechanics performing maintenance on the company's truck brake systems.

The repair and installation problems highlighted in this accident are not unique to Mack Truck vehicles. The air brake system configuration used on the accident truck is

similar to that used on other trucks with concrete mixer bodies. According to the Bureau of the Census, about 61,000 such trucks are in operation nationwide. The JDM fleet inspection found that about 1 percent of its trucks had air lines reversed and about 7 percent had inoperative low-air-warning switches. Based on these findings, the Safety Board concludes that a significant number of dual-air-brake-system-equipped trucks nationwide may have undetected air brake deficiencies similar to those found on the accident truck. The Safety Board believes that the American Trucking Associations, Inc., and the National Ready Mix Concrete Association should notify their members of the circumstances of this accident and urge them to implement procedures that will ensure that air brake manufacturers' suggested installation, inspection, and functional test procedures are adhered to during and after routine maintenance on truck air brake systems.

Adequacy of State and Federal Inspection Procedures

After the treadle valve on the accident truck was replaced in 1994, the truck successfully passed four semiannual Pennsylvania State safety inspections. The reversed air brake lines were not detected during any of the inspections. The postaccident inspection of the truck was conducted by MCSAP-trained police using the Federal Highway Administration Office of Motor Carrier Safety's guidelines.

The inspections also failed to detect the inoperative low-air-pressure warning switch. The air brake testing procedures used by the State and MCSAP inspectors involves depleting the air pressure from both air brake systems simultaneously until the low-air-pressure warning buzzer sounds. Using this procedure, either both low-air-pressure warning switches or the warning buzzer or light itself would have to be inoperable for the vehicle to fail the test. The Safety Board therefore concludes that had the Pennsylvania State and MCSAP inspection procedures been adequate to detect the reversed air brake lines or the inoperative low-air-pressure warning switch or both, the air brake system deficiencies in the accident truck may have been discovered, and the accident may not have occurred. The Safety Board believes that the Pennsylvania Department of Transportation should develop an easily administered inspection protocol for detecting reversed air lines and inoperative low-air-pressure warning switches on dual air brake system vehicles.

Before the 1970s, heavy trucks were equipped with a single air brake system, and manufacturers of air brake systems developed inspection protocols for those systems. In the 1970s, as a result of Federal regulations, the single air brake system was upgraded to the dual air brake system, and the brake industry responded with the appropriate inspection procedures that would identify reversed air brake lines. However, the Federal and Pennsylvania State governments have not developed inspection protocols to accommodate dual air brake systems. The Safety Board believes that the Federal Highway Administration, in cooperation with the Commercial Vehicle Safety Alliance, should develop an inspection protocol that could be easily administered by inspection personnel for detecting either reversed air brake lines or inoperative low-air-pressure warning switches on commercial vehicles equipped with dual air brake systems.

The Safety Board further believes that the National Highway Traffic Safety Administration and the Society of Automotive Engineers should work together to develop specifications and requirements for the installation, in heavy trucks with a dual air brake system, of separate low-air-pressure warning devices that will independently alert drivers to a loss of air pressure in either system. In the meantime, the Safety Board believes that the Truck Manufacturers Association should notify its membership of the circumstances of this accident and urge them to install, on all the commercial trucks they manufacture with dual air brake systems, separate low-air-pressure warning devices that will independently alert operators to a loss of air pressure in either system.

CONCLUSIONS

Findings

1. Neither the weather or highway conditions contributed to the accident. Also, the truckdriver was not fatigued, impaired, or suffering from any medical conditions that may have influenced his performance in this accident.

2. The drain valve on the secondary air supply tank was probably fractured when the truck struck a tire carcass while en route to the accident site.

3. The accident truck probably had only its front brakes operational with minimum engine retardation when it reached the intersection, and it was therefore unable to stop in time to avoid the accident.

4. Had both low-air-pressure warning switches on the accident truck been operable, the truckdriver would have had earlier warning of the depleted air supply and may have been able to stop the truck and avoid the accident.

5. The motor carrier's improper installation of the treadle valve air lines on the accident truck effectively bypassed an important safety feature and resulted in reducing the truck's braking capability under certain emergency conditions.

6. If JDM employees had followed the treadle valve manufacturer's installation tests and inspection procedures when performing maintenance on the treadle valve of the accident truck, they would probably have recognized the improper installation problems and/or inoperative brake components, and this accident may have been prevented.

7. A significant number of dual-air-brake-system-equipped trucks nationwide may have undetected air brake deficiencies similar to those found on the accident truck.

8. Had the Pennsylvania State and MCSAP inspection procedures been adequate to detect the reversed air brake lines or the inoperative low-air-pressure warning switch or both, the air brake system deficiencies in the accident truck may have been discovered, and the accident may not have occurred.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the improper maintenance of the accident truck by the JDM Materials Company, Inc., the fracture of the drain valve, and the inoperative low-air-pressure warning switch, which resulted in the driver's loss of braking control. Contributing to the accident was the lack of Federal and State inspection procedures for commercial vehicles with dual air brake systems that can detect either reversed air brake lines or inoperative low-air-pressure warning switches.

RECOMMENDATIONS

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

--to the Federal Highway Administration :

In cooperation with the Commercial Vehicle Safety Alliance, develop an inspection protocol that could be easily administered by inspection personnel for detecting either reversed air brake lines or inoperative low-air-pressure warning switches on commercial vehicles equipped with dual air brake systems. (H-97-31)

--to the Commercial Vehicle Safety Alliance:

In cooperation with the Federal Highway Administration, develop an inspection protocol that could be easily administered by inspection personnel for detecting either reversed air brake lines or inoperative low-air-pressure warning switches on commercial vehicles equipped with dual air brake systems. (H-97-32)

--to the American Trucking Associations, Inc.:

Notify your members through sources, such as the *Transport Topics* magazine, of the facts and circumstances of this accident and, in cooperation with the American Trucking Associations' Maintenance Council, urge your membership to implement procedures that will ensure that air brake manufacturers' suggested installation, inspection, and functional test procedures are adhered to during and after maintenance on truck air brake systems. (H-97-33)

--to the National Ready Mix Concrete Association:

Notify your membership through sources, such as your *Dispatcher* newsletter, of the circumstances of this accident and urge them to implement procedures that will ensure that air brake manufacturers' suggested installation, inspection, and functional test procedures are adhered to during and after routine maintenance on truck air brake systems. (H-97-34)

--to JDM Materials Company, Inc.:

Implement procedures that will ensure that air brake manufacturers' suggested installation, inspection, and functional test procedures are adhered to by company mechanics performing maintenance on the company's truck brake systems. (H-97-35)

--to Pennsylvania Department of Transportation:

Develop an easily administered inspection protocol for detecting reversed air lines and inoperative low-air-pressure warning switches on dual air brake system vehicles. (H-97-36)

--to the Truck Manufacturers Association:

Notify your membership of the circumstances of this accident and urge them to install, on all the commercial trucks they manufacture with dual air brake systems, separate low-air-pressure warning devices that will independently alert operators to a loss of air pressure in either system. (H-97-37)

--to the National Highway Traffic Safety Administration:

In cooperation with the Society of Automotive Engineers, develop specifications and requirements for the installation, in heavy trucks with a dual air brake system, of separate low-air-pressure warning devices that will independently alert drivers to a loss of air pressure in either system. (H-97-38)

--to the Society of Automotive Engineers:

In cooperation with the National Highway Traffic Safety Administration, develop specifications and requirements for the installation, in heavy trucks with a dual air brake system, of separate low-air-pressure warning devices that will independently alert drivers to a loss of air pressure in either system. (H-97-39)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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October 17, 1997

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APPENDIX A

Bendix Dual Circuit Brake System Troubleshooting Test #5

"RETEST TO CHECK ALL ITEMS REPAIRED OR REPLACED**"**

1. Drain front axle reservoir to 0 PSI.

   a. Rear axle reservoir should not lose pressure.
   b. On combination vehicles, the trailer air system shoulder remain charged.
   c. Tractor and trailer brakes should not apply automatically.

2. With no air pressure in the front axle reservoir, make a brake application.

   a. Rear axle brakes should apply and release.
   b. On combination vehicles the trailer bakes should also apply and release.
   c. The stop lamps should light.

3. Slowly drain rear axle reservoir.

   a. Spring brake push pull valve should pop out between 35 and 45 PSI.
   b. Tractor protection valve should close between 45 and 20 PSI, and trailer supply hose should be exhausted.
   c. Trailer brakes should apply after tractor protection closes.

4. Close drain cocks, recharge system, and drain rear axle reservoir to 0 PSI.

   a. Front axle reservoir should not loose pressure.
   b. On combination vehicles, the trailer air system should remain charged.

5. With no air in the rear axle reservoir, make a brake application.

   a. Front axle brakes should apply and release.
   b. On combination vehicles, the trailer brakes should apply and release.
   c. If the vehicle is equipped with an inverting relay spring brake control valve, the rear axle brakes should apply and release.

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APPENDIX B

AIR BRAKE SYSTEM

DUAL CIRCUIT BRAKE SYSTEM FUNCTION TEST

The following Dual Circuit Brake System Function Test should be performed at each C and D inspection interval, or after any air system service procedures that involve disconnecting and reconnecting air lines where incorrect reconnection, such as the treadle valve, is a possibility.

1. **Block the wheels to prevent the vehicle from moving.**
2. **Start the engine and build air system pressure to governor cut-out.**
3. **Stop the engine.**
4. **Completely drain one air reservoir.**
5. **Release the parking brakes.**
6. **Apply and hold the treadle valve.**
7. **Have an assistant check for proper results by observing the movement of the slack adjusters as indicated below**

   TRUCK:

   - **The brakes on the rear drive axle(s) should always apply as indicated by movement of the slack adjuster.**
   - **The low-air warning buzzer and warning lamp should activate for at least two of the tests.**

   TRACTOR:

   - **The brakes on either the steering axle or the rear drive should always apply as indicated by movement of the slack adjuster.**
   - **The low-air warning buzzer and warning lamp should activate for at least two of the tests.**

8. **Repeat the above procedures for the remaining air reservoirs (do not include air reservoirs for air starter if so equipped).**