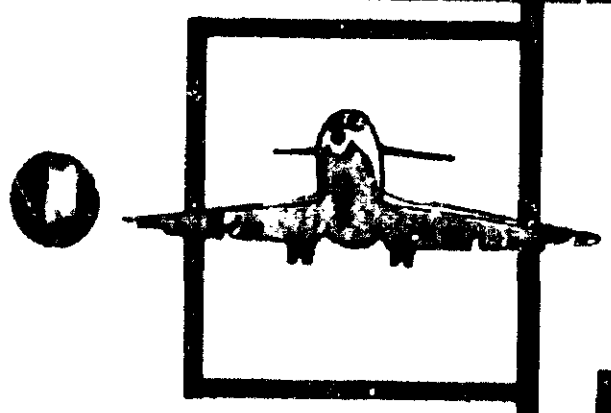

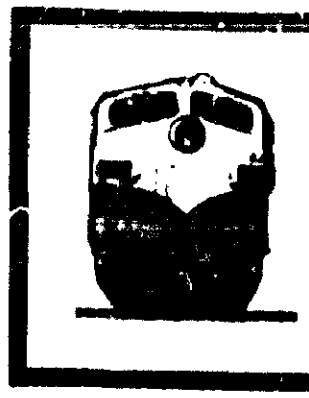

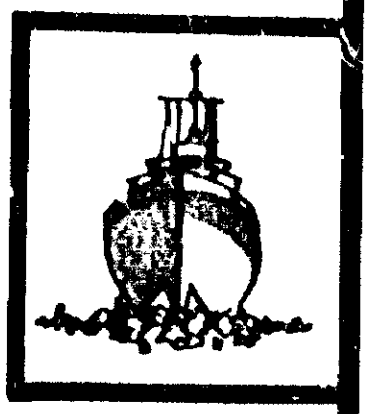

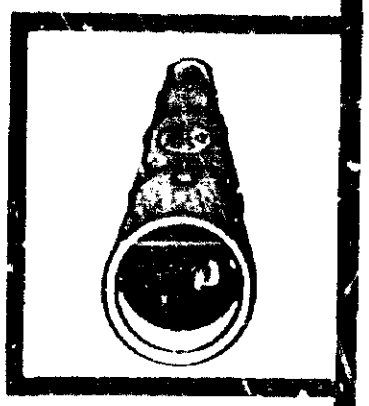

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

KOHLER COMPANY
TRACTOR-SEMITRAILER/PICKUP TRUCK
COLLISION, N.C. ROUTE 226
NEAR MARION, NORTH CAROLINA
JANUARY 25, 1978

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes

16. Abstract

About 10:00 a.m. e.s.t., on January 25, 1978, a Kohler Company tractor-semitrailer, carrying a 43,000-lb cargo of feldspar, was southbound on North Carolina Route 226. As it descended a steep grade, braking capability was lost because the brakes were out of adjustment. The operator steered the tractor-semitrailer into the northbound lanes at a blind curve and struck a northbound pickup truck headon. A passenger in the pickup truck was killed; both drivers and a second passenger in the pickup were injured.

The National Transportation Safety Board determines that the probable cause of this accident was: (1) The loss of truck braking capability because the brakes were out of adjustment and (2) the southbound truckdriver's poor judgment in steering into the northbound lanes at a blind curve and into the path of the pickup truck. Contributing to the cause of the accident was an inadequate, preventive maintenance program by the carrier.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: September 21, 1978

KOHLER COMPANY TRACTOR-SEMITRAILER/ PICKUP TRUCK COLLISION N.C. ROUTE 226, NEAR MARION, NORTH CAROLINA JANUARY 25, 1978

SYNOPSIS

About 10:00 a.m. e.s.t., on January 25, 1978, a Kohler Company tractor-semitrailer, carrying a 43,000-lb cargo of feldspar, was southbound on North Carolina Route 226. As it descended a steep grade, braking capability was lost because the brakes were out of adjustment. The operator steered the tractor-semitrailer into the northbound lanes at a blind curve and struck a northbound pickup truck head on. A passenger in the pickup truck was killed; both drivers and a second passenger in the pickup truck were injured.

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INVESTIGATION

The Accident

About 9:30 a.m., e.s.t. 1/, on January 25, 1978, a tractor-semitrailer (truck) transporting 43,000 lbs of feldspar 2/ departed Spruce Pine, North Carolina, en route to Spartanburg, South Carolina. This was the final leg of a 1,400-mile trip that had orginated at Spartanburg on January 22. Before leaving Spruce Pine, the driver, the sole occupant of tha truck, stated that he conducted a pre-trip inspection of the truck brakes by bringing the truck to a stop from a slow roll using the trailer brake only. He then performed a similar test for all service brakes. Satisfied with the operating condition of the equipment, the truckdriver departed.

1/ All times herein are eastern standard.
2/ Feldspar is a crystalline mineral used for making ceramic fixtures.

About 10:00 a.m., after the truck had traveled about 10 miles, it began to descend a 4-mile-long, steep winding grade on North Carolina Route 226, near Marion, North Carolina. The driver stated that he began descending the grade at 20 to 25 mph. After driving through the first few curves, he looked through his rearview mirror and noticed that the trailer brakes were smoking. He tried to slow the vehicle and intended to pull off the road, but the brakes were not effective, and the truck began to accelerate. The driver stated that, since he knew he could not make it all the way down the grade, and he did not want to drive off the ledge down a steep embankment on the right, he steered to the left across the centerline into the northbound lanes. He intended to stop the truck by scraping it against the steep vertical cut on the east side of the road. At this point, the truck had descended 1.1 mile of the hill and was traveling 35 to 40 mph. After the truckdriver steered across the centerline and into the northbound lane, it collided head on with a pickup truck. Neither driver could see the other's vehicle, because each approached the other at a 211-ft radius, blind curve.

After colliding with the pickup, the tractor struck the steep vertical cut on the east side of the road, and the tractor and trailer turned over onto the right side and came to rest on the roadway. The pickup truck rotated clockwise 185° and was driven back 85 ft in a southwesterly direction. There it struck and came to rest against the guardrail on the west side of the road. (See figure 1.) A passenger in the pickup truck was killed; both drivers and a second passenger of the pickup truck were injured.

The driver of the pickup truck stated that he didn't see the truck until it was upon him, and that just before the crash, he turned his wheels left in an attempt to avoid the collision.

Witnesses in a passenger car behind the truck stated that the truck was going downhill about 5 to 10 mph; they thought the truck was in low gear because of the engine sound. They saw the brake light go on and off several times as if the driver were pumping his brake at the curves. Then, the brakes began to smoke. It appeared to witnesses that the truck was going to pull off the road, since it had slowed to about 2 or 3 miles per hour. Then, suddenly it began to accelerate.

One witness stated that when the truck slowed down he could hear the engine "rev up" and then slow down, as though the driver were trying to get it into gear.

At the accident scene, the truckdriver stated to the police that he started his descent in fourth gear at the top of the mountain and then tried to downshift; but he couldn't. He said that the brakes failed, and that he was looking for a wide place in the roadway to pull off.

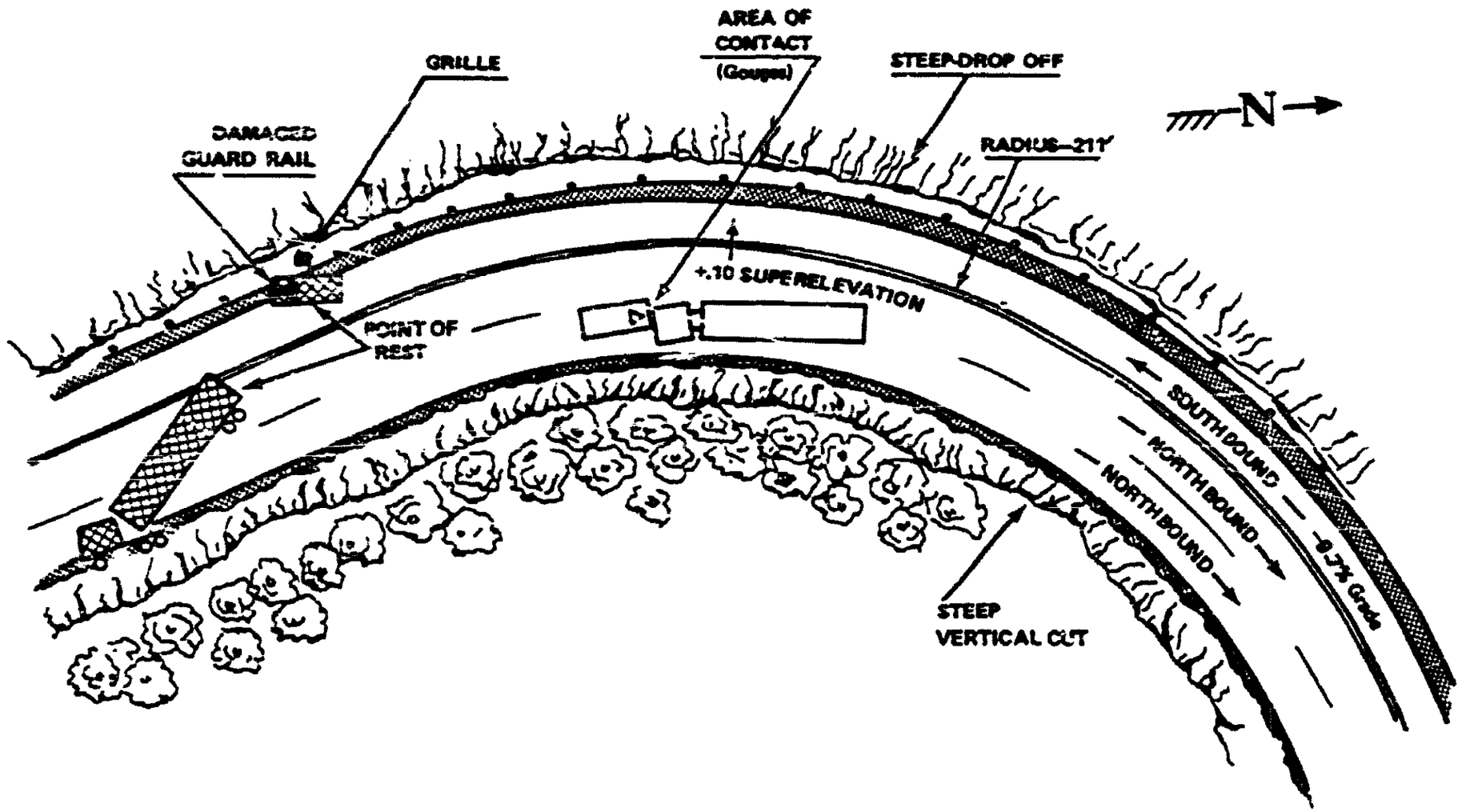

Figure 1. Diagram of accident.

Vechicle positions are approximate.

A mechanic, who was called to the scene to remove the tractor and trailer, stated that he entered the tractor and put the gear selector in neutral. Before he moved it, he noted that the gear shift lever was in the rearward position, that the low/high range button was down (in low), and that the gear shift lever was in either 1st, 3rd, or 5th gear. He believed it to be in 5th gear.

Injuries to Persons

Injuries	Drivers	Passengers
Fatal	0	1
Nonfatal	2	1
Minor/none	0	0

Vehicle Information

The truck was a 1977 GMC tractor owned by Ryder Truck Rental and leased to Kohler Company of Spartanburg, South Carolina, and a 1972 Fruehauf van-type trailer owned by Kohler Company. The gross vehicle weight (GVW) was 65,832 lbs.

The tractor, VIN No. TDC 927V590971, was a 3-axle, diesel-powered, cab over engine, Astro 95 model with a 10-speed standard transmission. The odometer read 62,334, and the tare weight was 14,050 lbs.

It was equipped with air mechanical "S" cam-type brakes on all three axles. The front (steering) axle had 15- x 3-1/2 inch brakes with type-16 chambers and 5 1/2-inch slack adjusters. Two rear (bogie) axle brakes were 16 1/2 x 7 inches with type-30 chambers; each had a spring-actuated dual split system brake (piggyback spring brake) and 6-inch slack adjusters. The brake system on the two bogie axles included Federal Motor Vehicle Safety Standard (FMVSS) 121 anti-lock hardware manufactured by the Eaton Corporation.

The visual inspection of the two bogie axle brake drums and linings revealed no deficiencies that would adversely affect braking capability. The brake lining thickness at all bogie axle brake positions measured 18/32 inch to 19/32 inch. When new, the linings measured 24/32 inch. The brake linings were original equipment on the tractor.

The brake adjustments on all six tractor wheels were at the upper limitations at, or close to, the maximum stroke capability. The front wheel brake slack adjuster strokes measured 2 1/4 and 2 5/16 inches compared to the maximum stroke capability of 2 1/4 (± 1/16) inches. The bogie axle stroke measurements were 2 7/16, 2 1/4, 2 5/16 and 2 9/16 inches; maximum stroke capability was 2 1/2 (± 1/16) inches. The manufacturer recommends that the front axle brakes be adjusted when the stroke reaches 1 3/4 inches and the bogie axle brakes, when the stroke reaches 2 inches. (See table 1.)

Table 1.--Brake Adjustment Information

(Tractor)	Brake Chamber Push Rod (Slack Adjuster) Stroke Measurement 1/ After Crash		Recommended Maximum Stroke At Which Brakes Should Be Readjusted 2/	Maximum Brake Chamber Push Rod Stroke Capability ± 1/16 inch
	Left Wheel (Inches)	Right Wheel (Inches)	(Inches)	(Inches)
Front Axle	2 1/4	2 5/16	1 3/4	2 1/4
1st Bogie Axle	2 7/16	2 1/4	2	2 1/2
2nd Bogie Axle	2 5/16	2 9/16	2	2 1/2
(Trailer)				
1st Tandem Axle	2 1/4	2 5/8 3/	2	2 1/2
2nd Tandem Axle	2 11/16 3/	2 3/16	2	2 1/2

1/ All stroke measurements made with at least 80 lbs air pressure--except for measurements of the right wheel on the front tractor axle.

2/ Manufacturers recommended practice.

3/ Excess stroke movement as a result of push rod bottoming against brake chamber.

The tone generator, an audible warning device for low air pressure, low oil pressure, and high water temperature, was missing from the vehicle. Tape partially covered the related warning lights.

The FMVSS-121 brake anti-lock warning light in the cab was not functioning because of an open circuit. The three electrical threaded couplings had been disconnected from the anti-lock control box on the rear bogie axle. (See figure 2.) The anti-lock connections on the front bogie axle were intact. (See figure 3.) The steering axle was not equipped with FMVSS-121 anti-lock hardware. An electronic test of the FMVSS-121 anti-lock brake system on the first bogie axle indicated that the system was functioning properly. A similar test at the second bogie axle after the three electrical couplings were connected indicated that it was also functioning properly.

The semitrailer was a 45-foot-long, tandem axle, exterior post van, serial No. CHP152003. It was equipped with air mechanical "S" cam type brakes. The brakes were 16 1/2 x 7 inches with type-30 chambers. The trailer was not equipped with FMVSS-121 anti-lock brake hardware.

The brake lining thickness varied between 3/8 inch and 9/16 inch. There were no significant brake-lining or brake-drum deficiencies which would have adversely affected braking capability.

The brake adjustments on all four trailer wheels were at, or close to, the maximum available brake chamber push rod stroke. The front tandem axle brake chamber push rod strokes measured 2 1/4 and 2 5/8 inches, and the rear axle brake measured 2 11/16 and 2 3/16 inches compared to the maximum brake chamber push rod stroke of 2 1/2 inches (+ 1/16). The manufacturer recommends that the brakes be readjusted when the stroke reaches 2 inches.

Ryder Truck Rental, the carrier's agent, provided maintenance for both the tractor and trailer. Service records indicate that the tractor brakes were inspected eight times since August 2, 1977, and were adjusted four times; three of these were the result of a preventive maintenance inspection, and one on November 1, 1977, was in response to a driver's request. At that time, the odometer reading was 38,443; the brakes had been inspected and found "OK" 4,608 miles before. According to the records, the last brake adjustment was made on December 6, 1977, at 49,576 miles. Records indicate that they were inspected again on January 11, 1978, at 58,277 miles and were found to be properly adjusted.

Trailer maintenance records indicate that since March 19, 1977, the brakes were adjusted 11 times. The last brake adjustment was made on December 29, 1977. The Ryder policy, is to adjust the chamber push rod (slack adjuster) to 1 1/4 to 1 1/2 inches.

Figure 2. Disconnected couplings on brake anti-lock control box at rear bogie axle.

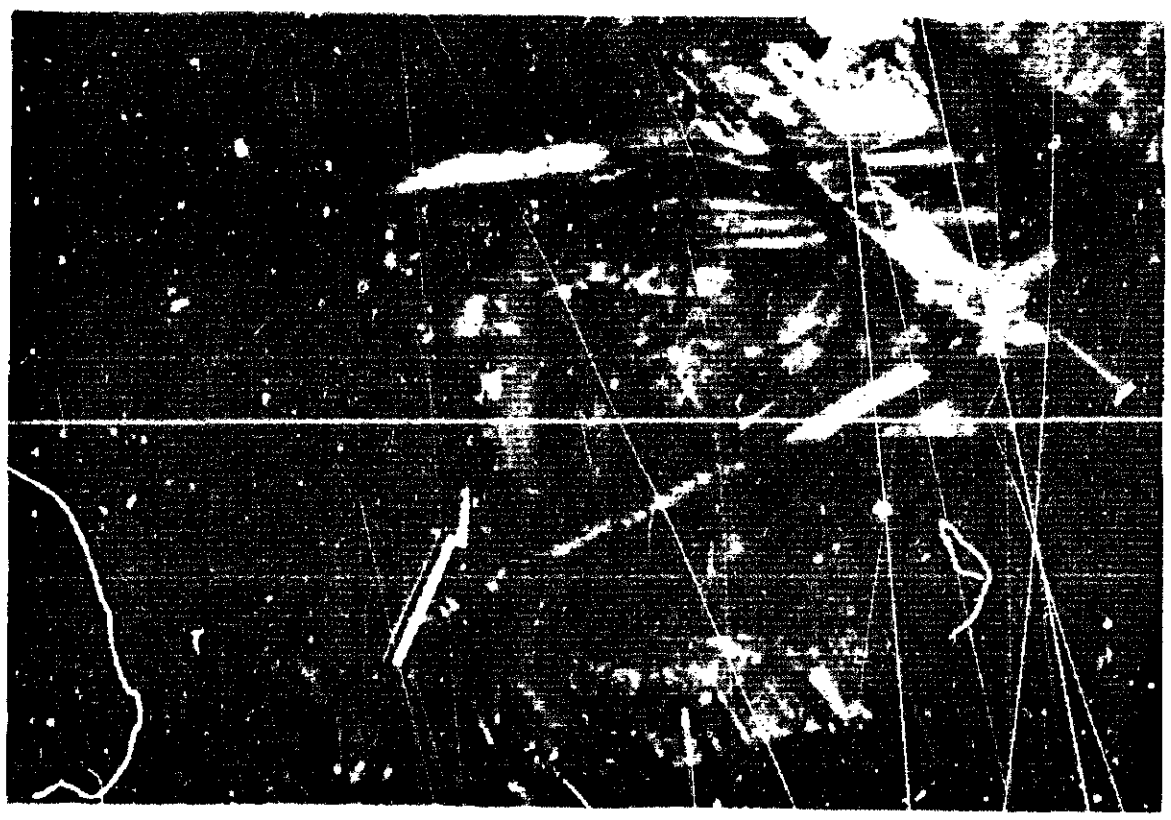

Figure 3. Connected couplings on brake anti-lock control box at front bogie axle.

The pickup truck, a 1974 Chevrolet, Cheyenne 10 model, VIN X-CCY144F449586, was owned by Greene McKinney, an automobile dealership in Spruce Pine, North Carolina. The odometer reading was 61,595. No mechanical defects were found.

Damage to Vehicles

The tractor-semitrailer -- The tractor was damaged from three sources; the collision with the pickup truck, the collision with the vertical cut, and the overturn. (See figure 4.)

The right front corner of the tractor in the area of the headlight was pushed back toward the rear, and paint transfers from the pickup truck were found in this area on the right front headlight rim and body. The front bumper was dented and bent, and the front grille was dented at the lower right side. The right front door was scraped and pushed in laterally, and the door vent was missing. The two right side mirrors were broken and pushed against the right door. The air cleaner, located on the right side below the cab, was dented and displaced rearward into the front surface of the right fuel tank. The right "saddle-mount" fuel tank was displaced to the rear against the right wheel flap and bracket, which was also displaced rearward. The right side of the front windshield was missing, and the right door window was broken completely out. The left side "saddle-mount" fuel tank had a downward dent on the top rear of the tank. Neither fuel tank leaked as a result of damage. The left front corner of the tractor had a puncture and dent above and to the rear of the left front headlight.

The bottom of the tractor was heavily splattered with mud. The air-brake hose on the left front wheel had been torn away, and the tie rod was bent. The third leaf of both front springs protruded forward of the front bumper.

The trailer was scraped, and it bulged out on the right side; a dent was noted and a small section of seam had separated at the top center of the right side.

The pickup truck -- The pickup truck had been damaged heavily on the right front. (See figure 5.) The right front fender, grille frame, hood, and radiator were pushed back, and the grille was missing. The right front headlight housing was displaced rearward 4.1 ft.

The right front tire was flat, and the right upper and lower control arms were pushed back. The front bumper was bent in and down; a tire scrub mark was on the right side of a plate attached to the center of the bumper.

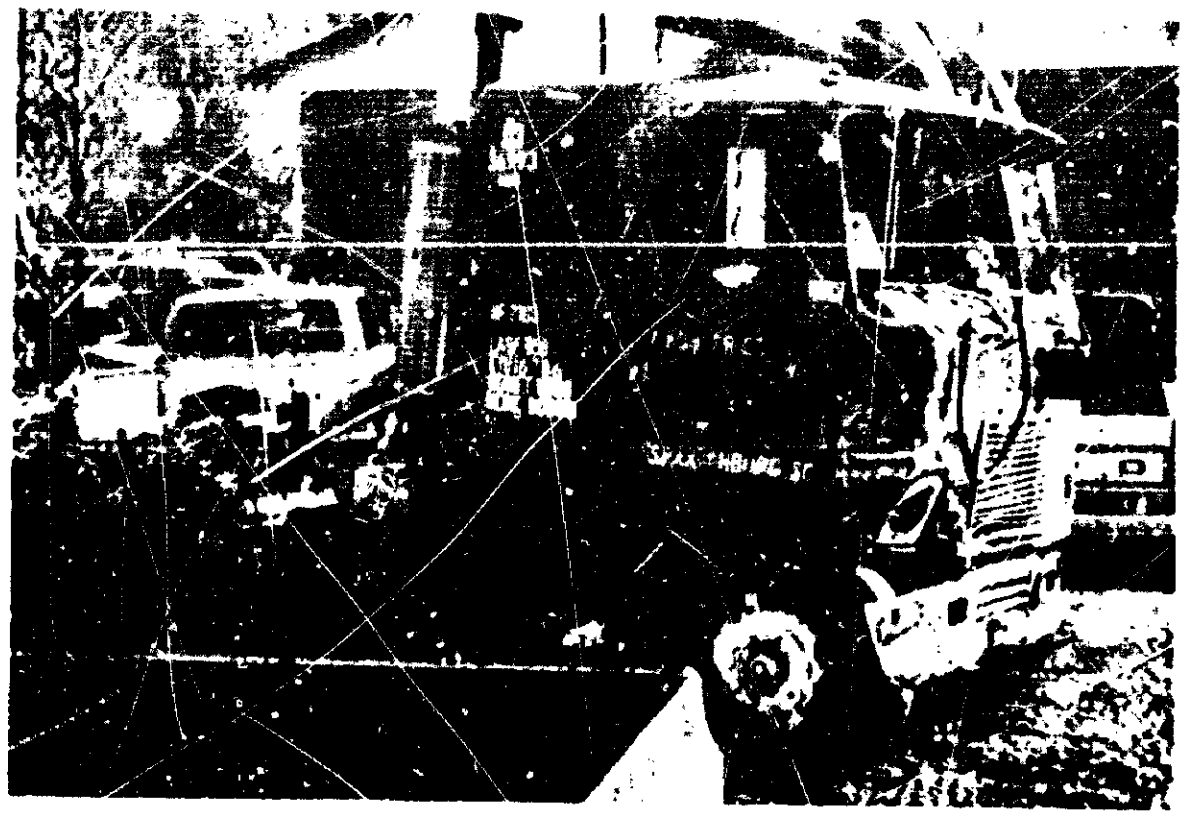

Figure 4. Right side and right front of tractor.

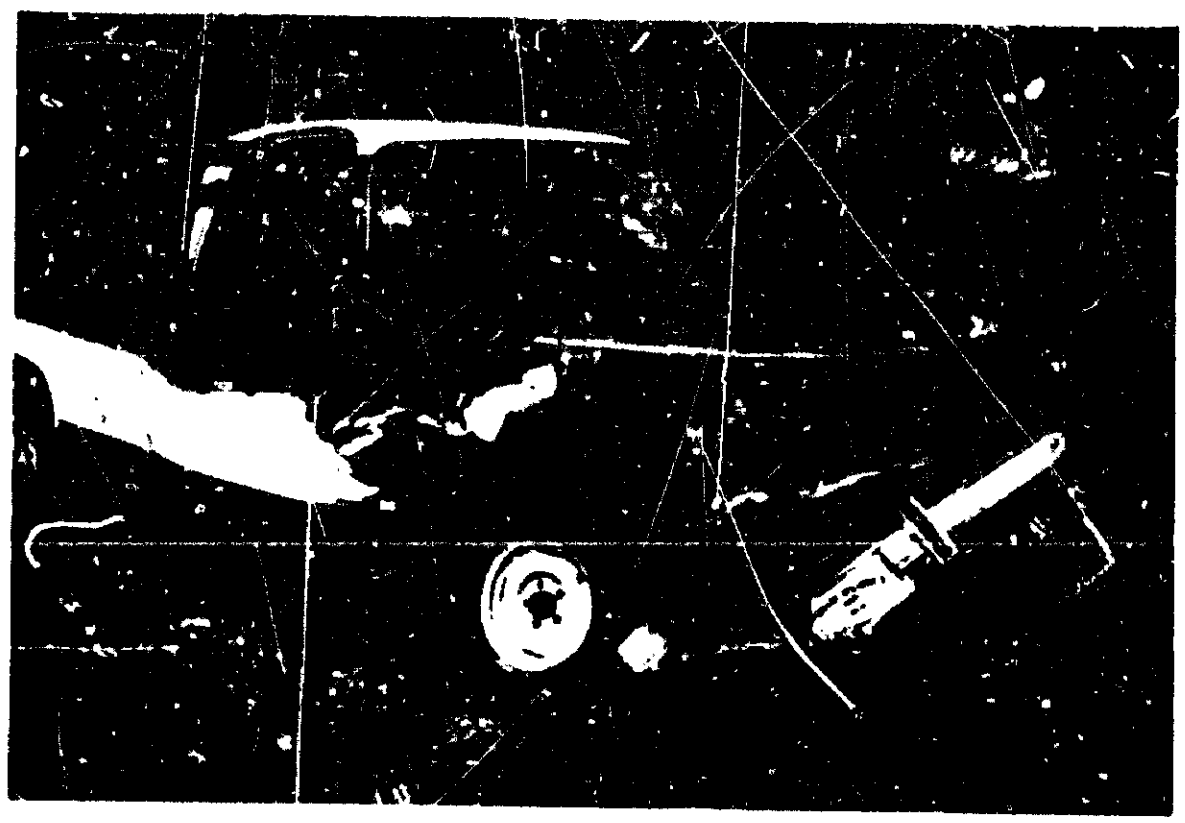

Figure 5. Right side and front of pickup truck.

The front windshield was broken, and the rear window was missing. The right A-pillar and the right side of the dashboard were pushed back; the floorboard on the right was pushed up. The left front fender was bent and pulled to the right.

Driver Information

Truckdriver -- The 22-year-old truckdriver was a resident of Campobello, South Carolina, and had a valid South Carolina license authorizing him to drive the vehicle. There were no restrictions on his license, and he was certified as medically qualified to drive in interstate and intrastate commerce as required by Federal Motor Carrier Safety Regulations (FMCSR). A check of his driving record revealed two traffic violation convictions -- "disobey sign" in 1975, and "speeding" in 1976. He completed an 8-week truckdriver training course in 1976 at Greenville Technical Institute. In April 1977, he was employed by Manpower, Inc., as a truckdriver for the Kohler Company.

His driving log was current. For 24 hours before the accident, it showed that the truckdriver went on duty at 9:00 a.m. on January 24; left Allentown, Pennsylvania, at 9:30 a.m. with an empty truck; went off duty from 11:00 a.m. to 12 noon; drove from 12 noon to 8:30 p.m.; went into the sleeper berth at 8:30 p.m. until 4:30 a.m. on January 25; and drove from 4:30 a.m. until 9:00 a.m. when he arrived at Spruce Pine.

The truckdriver stated that he had never driven down this hill before, but knew of other drivers who had. He stated, "I know all the drivers have had trouble up on that mountain -- their brakes heat up on them."

The truckdriver did not know that the anti-lock brake system had been disconnected on his tractor. In fact, he did not know that the tractor was equipped with an anti-lock brake system. He was assigned to the tractor on January 8, 1978, and had driven it 2,686 miles on five previous trips.

Pickup truckdriver -- The 63-year-old driver was a resident of Spruce Pine, North Carolina, and had a valid driver's license to operate the vehicle. A check of his driving record revealed no traffic violation convictions or accidents and no license restrictions. The operator was "trying out" the pickup truck, because he had intended to purchase it.

Roadway Information

North Carolina Route 226 is a north/south State highway, which connects the cities of Spruce Pine and Marion. This highway is designated Federal-aid primary. (See figure 6.) The average daily traffic count was 2,650 vehicles.

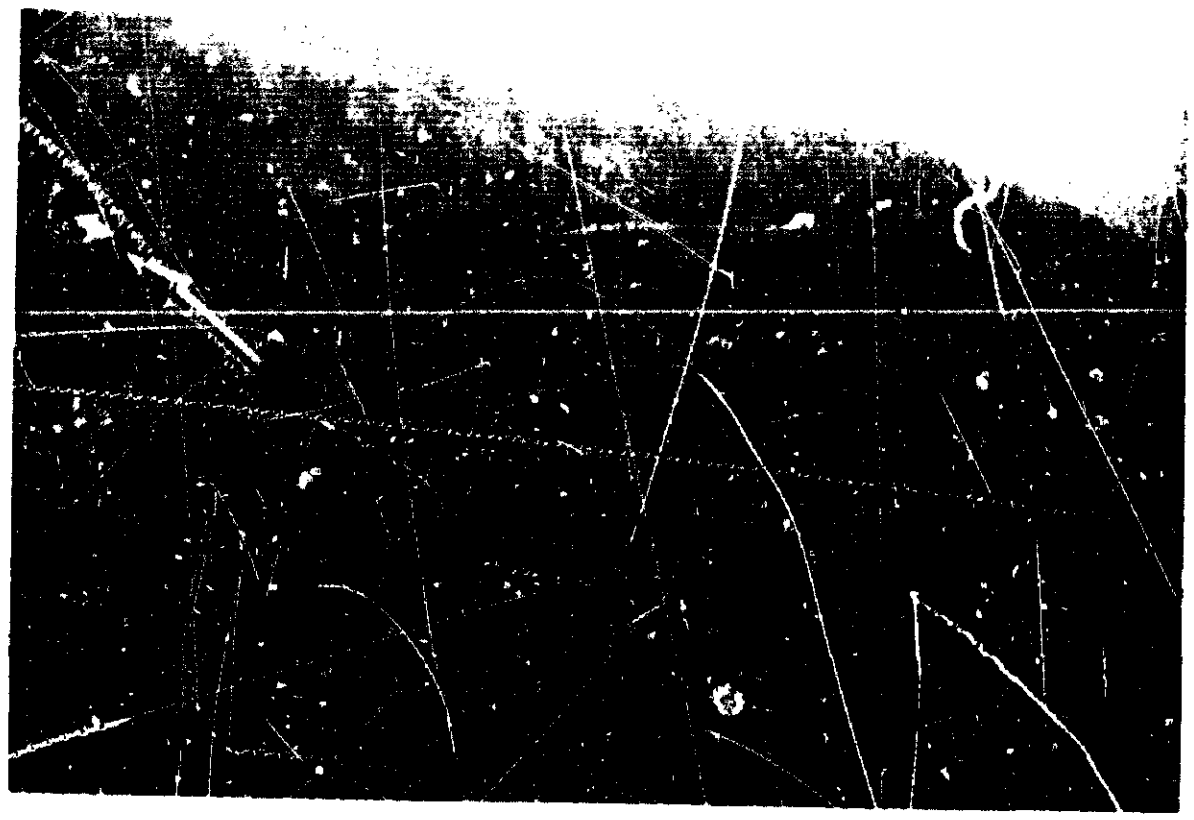

Figure 6. Aerial view of Route 226 in the area of accident. Arrow indicates crash site.

In the vicinity of the accident, Route 226 is a steep, winding asphalt road with dropoffs on one side of the road and vertical banks on the other. The asphalt road surface was in fair condition. The 4-mile southbound descent begins as a two-lane, two-way road divided by double yellow centerlines. At the crash site, however, there are two northbound (uphill) lanes and one southbound (downhill) lane; the two northbound lanes are separated by broken white lanelines, and the north and southbound lanes are separated by double yellow centerlines. Downhill toward the crash site, the road curves left at a 211-ft radius. (See figure 7.) The roadway at the crash site is 42 ft wide; the northbound lane adjacent to the shoulder is 11 ft wide; the northbound lane adjacent to the centerline is 13 ft wide; and the southbound lane is 18 ft wide. The maximum superelevation at the curve is .10, and the grade is 9.7 percent.

The road is bounded by dirt shoulders of varying widths, and the pavement edges are delineated by solid white lines, obliterated by an accumulation of dirt. (See figure 8.) Highway Safety Program Manual, Standard No. 12, 3/ recommends that every State and local agency have a maintenance program that will provide for the "clearing of debris from pavement surface, shoulder and drainage facilities."

3/ Highway Safety Program Manual for Standard No. 12, "Highway Design, Construction, and Maintenance." National Highway Traffic Safety Administration, p. IV - 20.

Figure 7. Southbound approach to accident site. Point of impact is around curve.

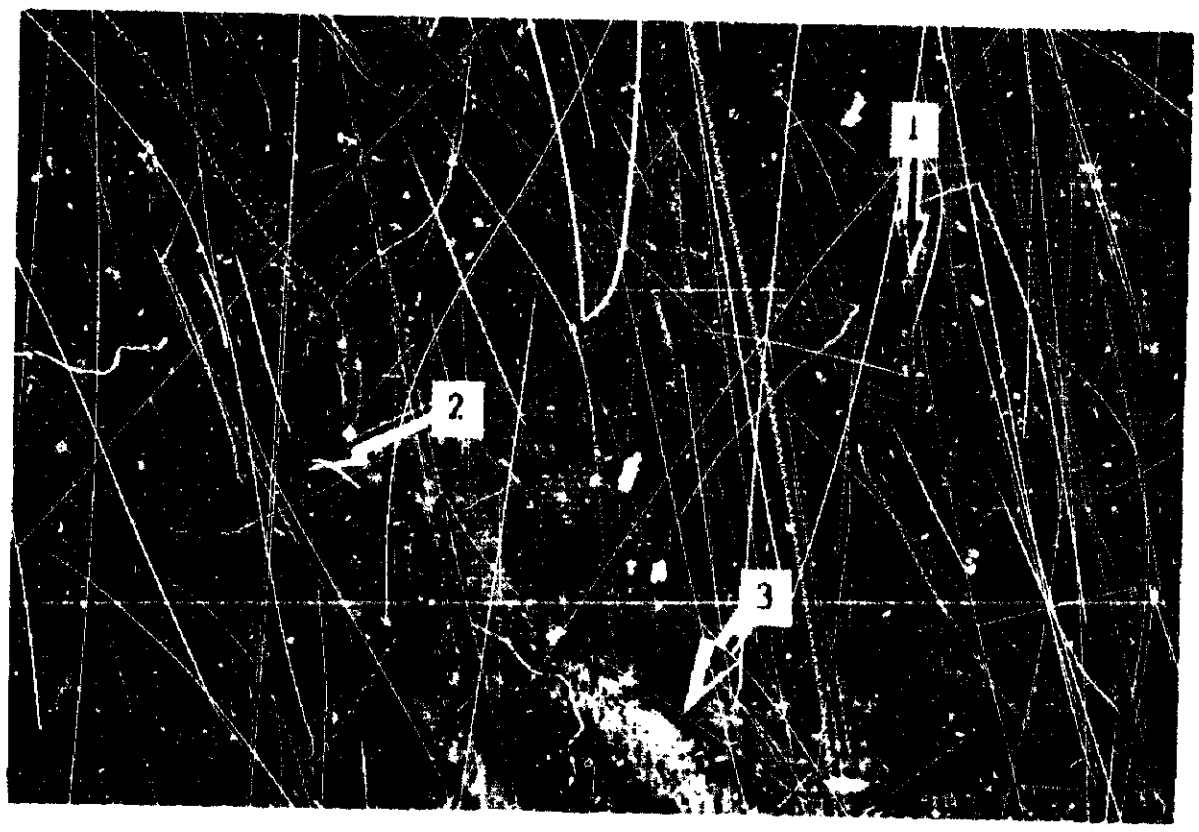

Figure 8. View of the accident site from the south.
(1) Approximate location of gouges in roadway;
(2) damaged guardrail;
(3) obliterated white edge line.

At the outer circumference of the curve, there is a single "W" beam guardrail, the top of which varies in height from 1 ft to 2 ft above the level of the roadway. The guardrail was set back 2 1/2 ft from the road edge. (See figure 9.) American Association of State Highway and Transportation Officials (AASHTO) Guide 4/ recommends a minimum height of 27-inches for guardrail on the shoulder of the road.

The road surface of the northbound lane adjacent to the vertical cut had 2 gouges and multiple scratches located 2 ft east of the broken white lanelines and 265 ft south of the point of curvature.

The guardrail on the west side of the road, 353 ft south of the point of curvature, was deformed and had paint transfers on it that apparently came from the pickup truck.

There were three warning signs between the start of the descent and the crash site -- a distance of 1.1 miles. The first, located at the start of the grade, was a symbol "hill" sign with a message plate which stated "Steep Grade 4 Miles." The second sign, located about 200 ft south of the first, was a winding road warning sign. The third sign, located about 1,500 ft south of the first, was a left curve warning sign with a 20-mph advisory speed plate.

A speed limit sign was posted on southbound route 226, 1 mile north of the "steep grade" sign. The sign stated, "Speed Limit 55, Trucks 55." On February 14, 1978, the southbound truck speed limit was changed to 25 mph, and six speed regulatory signs -- "Truck Speed Limit 25" -- were installed. The first sign was placed at the top of the mountain, and the other signs were placed at 1/2-mile intervals on the descending grade.

Meteorological Information

It was daylight, the sky was overcast, and the road was wet from an earlier rain.

Other Information

Report Brake Malfunctions

In an attempt to determine why the anti-lock brake system on the tractor was disconnected, The Safety Board interviewed Ryder Truck Rental and Kohler Company personnel. Summaries of relevant statements follow:

A Ryder mechanic - "About 3 months ago, the driver who was then assigned to the accident vehicle complained that he was having problems stopping. This driver had been assigned to this tractor since it was

4/ American Association of State Highway and Transportation Officials Guide "Selecting, Locating, and Designing of Traffic Barriers," 1977.

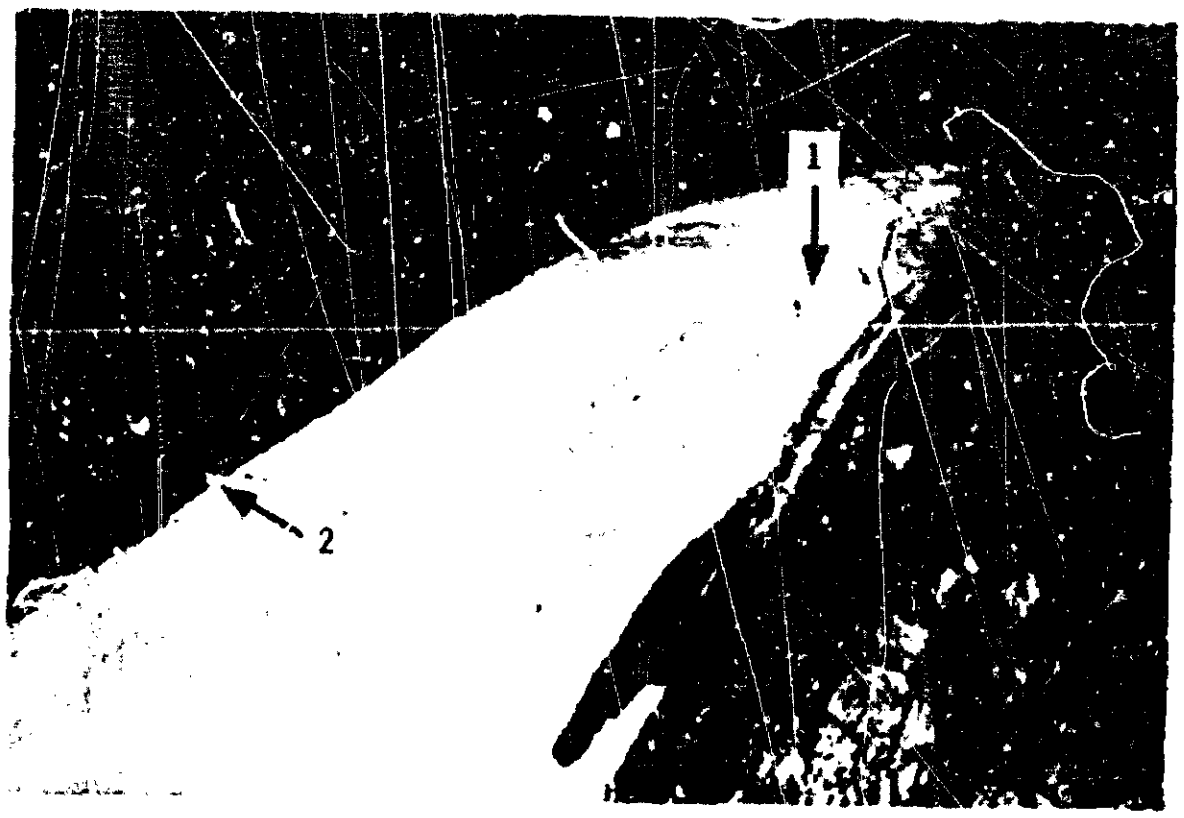

Figure 9. Top view of the (1) point of impact; (2) damaged guardrail where pickup truck came to rest.

new and his complaint was that it didn't want to stop half the time. I told him that I would do what I had done to another tractor to correct the problem, and that was to disconnect the anti-lock brake. He asked me if I would disconnect them and I did--then I told him to try it for a trip; when he came back he told me it was better, so I never bothered about doing anything else to it." (The driver who made the request was not the driver involved in this accident.)

The Ryder service manager - The service manager stated that when the anti-lock system was disconnected, the drivers described the brakes as better than anything they had driven before. "We had no complaints after the anti-lock system was disconnected." He related the following experience: A tractor was experiencing the intermittent illumination of the anti-lock warning light while the tractor was in motion. He test drove the vehicle and applied the brakes fully at 55 or 60 mph. The brakes held when first applied and then released; the vehicle coasted for 2 or 3 seconds, then the brakes came on for about a second. Then, the vehicle coasted for another 2 or 3 seconds, and the brakes locked completely. The tractor skidded sideways.

A wheel sensor was replaced, and the vehicle was road-tested three times without a malfunction. When the vehicle was put back in service the following morning, the brakes reportedly failed again in a similar manner.

Kohler Company dispatcher: "Drivers complained that when you applied the brakes, the brakes go on and off increasing their stopping distance. We advised Ryder of the situation, and they disconnected the 121 brakes."

A Ryder mechanic: "There is only one question in my mind -- when we have a dual system and the 121 fails, why doesn't the brake system revert back to the foundation brake system?"

Twelve Kohler Company truckdrivers were interviewed relative to their opinion of the effectiveness of the 121 anti-lock brake system.

One driver had never driven a truck equipped with anti-lock brakes and had no knowledge of how they worked. Three drivers who operated trucks equipped with anti-lock brakes reported no malfunctions and expressed confidence in the system; however, one of them stated, "The system needs improvement, because it never seems to operate in the same manner. Sometimes it stops immediately, and the next time it travels some before the brakes take effect." The remaining eight drivers expressed a lack of confidence in the system and cited specific incidents of brake malfunction that they attributed to the anti-lock system.

The reported incidents ranged from sudden brake grabbing to no braking capability, but most drivers complained of sporadic braking and increased stopping distance because of a lag between brake application and vehicle slowing.

Of the drivers interviewed, four had received no training on the anti-lock brake system, seven had reportedly received a 1 1/2- to 2-hour lecture, and one had attended a 6-week truckdriving course and had received both hand-on and classroom instruction on the anti-lock system.

An interview of a member of the National Highway Traffic Safety Administration (NHTSA) was conducted to determine what NHTSA's present activities are in FMVSS-121 anti-lock brakes relative to driver/maintenance personnel education and problem identification.

It was learned that NHTSA's current program consists of: distribution of a drivers manual "Driving With the New Brakes;" development, for future distribution, two manuals -- a basic maintenance manual and a drivers manual; complaint follow-up by the Office of Defects Investigation; investigation of verified anti-lock brake involved accidents; and examination of newly purchased trucks to determine manufacturers compliance with FMVSS-12.

ANALYSIS

The Accident

The driver was qualified to operate the truck; his duty and rest periods were within BMCS requirements. The pre-trip brake test performed by the truckdriver at Spruce Pine was not sufficient to reveal the ability of the brake systems to function properly under highway operating conditions. The brake drums, apparently cool at the time of the test, provided enough brake lining to brake drum contact to bring the truck to a stop from a slow roll.

When the loaded truck began to descend the steep mountain road, friction generated by braking during the descent caused the trailer brakes to overheat and to smoke. The heat created by the friction caused the brake drums to expand. This expansion, combined with the minimum brake adjustments, left no reserve stroke available to compensate for the brake drum expansion; and all effective braking capability was lost. The truckdriver told police that he then attempted to downshift but was not successful; when he did so and to what gear he finally shifted to are unknown. As the truck continued downhill without effective braking available, the truck accelerated to an estimated 35 to 40 mph. As the truck approached the sharp left curve, the driver steered to the left of the centerline and struck the northbound pickup truck. Calculations indicate that if the truck had stayed in its lane it could have been able to negotiate the curve.

The driver not only violated the law but exercised poor judgment in steering across a double yellow centerline into the opposing traffic lanes, since his view of on-coming traffic was obstructed. The substantial risk to other road users created by this driver's actions materialized when the vehicles collided.

Sight aligment measurements and stated speeds indicated that neither driver could have seen the other until 1 1/2 seconds before the crash -- insufficient time to take evasive action.

Gouge marks in the northbound lane adjacent to the shoulder indicated the location of the crash. The type of collision, based on the damage, was an eccentric (off centered) head on; the right front of the truck contacted the right front of the pickup truck. Since the momentum of the truck was greater than that of the pickup and the collision forces were directed at the right front, the pickup truck was pushed back and rotated clockwise.

Brake Maintenance

Tractor - Although records of the last preventive maintenance inspection, at 58,277 miles, indicated that the brakes were found to be

"OK" and that no brake adjustments were made, the brakes were found to be seriously out of adjustment after the accident -- only 4,057 miles after the inspection.

The tractor brake linings were original equipment and when new were 24/32 inch thick; when inspected after the accident, they were 18/32 inch thick. About 6/32 inch had worn off in 62,334 miles, an average of .0003 inch brake wear per 100 miles.

According to the vehicle manufacturer, the ratio of brake chamber push rod stroke to brake lining wear is 25 to 1. Therefore, based on this relationship and the wear rate, the probable brake chamber push rod stroke at the time of last inspection can be calculated. These calculations indicate that at the last inspection the brake chamber push rod stroke at all tractor wheels was at, or beyond, the recommended maximum stroke at which the brakes should be readjusted. (See table 2.)

The Safety Board used a second technique to estimate the distance of brake chamber push rod travel at the last inspection. The same average brake lining wear rate and brake rod travel to lining-wear ratio was used, and then it was correlated with the Ryder policy of adjusting the brake rod travel 1.25 to 1.50 inches. Since the brakes were last adjusted at 49,576 miles and 8,701 miles later they were inspected, calculations indicate that, at last inspection, the brake chamber rod travel would have been 1.92 to 2.17 inches.

The findings using both estimating techniques were consistent and suggest, based on average lining wear, that, at the last preventive maintenance inspection, the brakes were indeed in need of an adjustment and would not reach the next scheduled preventive maintenance inspection without a predictable loss of braking capability. The next preventive maintenance would have been at 65,576 miles.

In November 1977, a comparable set of circumstances involving this vehicle existed although no accident resulted. At 26,371 miles the tractor brakes were adjusted; 7,464 miles later -- the next scheduled inspection -- the brakes reportedly did not need an adjustment. However, 4,608 miles later on November 1, before the next scheduled inspection, the operator requested a brake adjustment -- 12,072 miles after the last adjustment. Comparably, this accident occurred 12,758 miles after the last brake adjustment and 4,057 miles after the last inspection at which the brakes were not adjusted.

Trailer - According to records, on December 29, 1977, the brake linings were inspected and the brakes adjusted. Since the operating mileage of the trailer cannot be determined, the mileage traveled from the time of the last brake adjustment to the crash was estimated to be 7,500 miles by comparing it to the average tractor mileage. Computations similar to those performed for the tractor suggest that the trailer brakes either were not adjusted on December 29, 1977, as the records indicate, or the adjustments were not properly made. (See table 2.)

Table 2.--Brake Chamber Push Rod Stroke

(Tractor)	Brake Chamber Push Rod Stroke After Crash		Probable Stroke At Last Maintenance Inspection		Maximum Stroke At Which Brakes Should Be Readjusted
	Left Wheel (Inches)	Right Wheel (Inches)	Left Wheel (Inches)	Right Wheel (Inches)	(Inches)
Front Axle	2.25	2.31	1.94	2.00	1.75
1st Bogie Axle	2.43	2.25	2.12	1.94	2.00
2nd Bogie Axle	2.31	2.56	2.00	2.25	2.00

(Trailer)	Brake Chamber Push Rod Stroke After Crash		Probable Stroke After Last Adjustment		Maximum Stroke At Which Brakes Should Be Readjusted
	Left Wheel (Inches)	Right Wheel (Inches)	Left Wheel (Inches)	Right Wheel (Inches)	(Inches)
1st Tandem Axle	2.25	2.62	1.63	2.00	2.00
2nd Tandem Axle	2.68	2.18	2.06	1.56	2.00

The Safety Board, therefore concludes that both the tractor and semitrailer were put into service after their last maintenance inspection with their brakes in need of adjustment.

Highway

Highway barrier design and road surface condition were not causal to this accident. However, the height of the single W-beam guardrail at the accident site (1.1 mile south of the north intersect of route 226A)

varied from 1 ft to 2 ft above the road. The low points of the existing rail, which are at the center section of the curve, offer little retention protection to an intruding vehicle. Evidently, the road had been resurfaced, but the guardrail was not upgraded.

Since the accident, speed limit signs of 25 mph have been installed to regulate downhill truck traffic. The Board believes that, based on the location of the previous "Speed Limit 55 Trucks 55" sign both in time and distance from the start of the descending grade, an unfamiliar southbound driver was not being provided adequate speed-control information either before, or at the start of, the descending grade.

The obliterated white pavement edge lines at the site had lost their value as visual references for drivers and may also have reduced the drag factor of the road surface at the affected locations.

Other Information

Although the disconnected brake anti-lock hardware on the second bogie axle of the tractor was not a factor in this accident, its condition was indicative of an ineffective maintenance program. In fact, although the intent was to completely disconnect the anti-lock system, it had been only partially disconnected. The system was still functioning at the first bogie axle.

The anti-lock hardware was disconnected about 3 months before the accident. There was no record made of the disconnect; in fact, the tractor was subjected to a preventive maintenance inspection at least twice after the anti-lock hardware was disconnected. Those reports indicate that the brake anti-skid warning unit light was checked and found to be "OK." At the last two preventive maintenance inspections, the light was probably checked off as "OK" without actually being tested. If the light was not illuminating it would have been detected, and if the light was illuminating the disconnected anti-lock hardware would have caused the light to remain on, indicating a malfunction in the brake anti-lock system. In either case, the report would not have been marked "OK."

Interviews of the Kohler and Ryder employees revealed that neither the driver nor the mechanics had sufficient training to enable them to fully understand how the FMVSS-121 anti-lock brake system was supposed to operate. Disconnecting the anti-lock system appeared to be a cure-all for braking problems; this practice could prevent other braking discrepancies from being discovered.

Although some Kohler drivers' experiences may have been caused by problems other than a malfunction in the anti-lock system, as long as the malfunctions are not reported and fully documented and as long as such malfunctions are not completely examined by maintenance personnel

or referred to component manufecturers for correction, the informal indictments against anti-lock systems will continue. Other problems may, therefore, be camouflaged, and the advantages and disadvantages of the anti-lock devices impossible to evaluate.

CONCLUSIONS

Findings

1. Pre-trip brake tests were not sufficient to reveal the improper brake adjustments.

2. Because of improper brake adjustments, the truck lost all effective braking capability while descending the steep grade.

3. The truckdriver intentionally steered across the centerline at the curve and onto the northbound lanes.

4. Sight alignment was obstructed by the vertical bank at the curve and prevented the drivers from seeing each other in time to take any successful evasive action.

5. The tractor brakes should have been adjusted at the last preventive maintenance inspection, but were not.

6. The disconnected FMVSS-121 brake anti-lock hardware at the rear bogie axle had no causal relationship to this accident, but did indicate a laxity in maintenance procedures.

7. Although highway discrepancies were identified, they did not contribute to this accident.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was: (1) The loss of truck braking capability because the brakes were out of adjustment and (2) the southbound truckdriver's poor judgment in steering into the northbound lanes at a blind curve and into the path of the pickup truck. Contributing to the cause of the accident was an inadequate, preventive maintenance program by the carrier.

RECOMMENDATIONS

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

-- to the State of North Carolina:

"Upgrade State guardrail installations at this location to conform with current AASHTO and FHWA design and performance standards. (Class II, Priority Action) (H-78-67)

"Maintain edge line markings at this location by clearing debris from the pavement surface as recommended by Highway Safety Program Manual Standard No. 12, Chapter 4. (Class II, Priority Action) (H-78-68)"

-- to the Federal Highway Administration:

"Review North Carolina's barrier rail installation practices to assure that guardrails are upgraded when roadway resurfacing alters their relative height to the extent that they no longer conform to the AASHTO standards. (Class II, Priority Action) (H-78-69)

-- to Ryder Truck Rental:

"Amend its maintenance policy relative to brake adjustments by requiring an adjustment at least at each preventive maintenance inspection. (Class II, Priority Action) (H-78-70)"

As a result of this accident, the Safety Board reiterates its safety recommendation H-78-48, issued to the National Highway Traffic Safety Administration June 3, 1978:

"Develop a Federal Motor Vehicle Safety Standard stating a performance requirement for all newly manufactured commercial vehicles to have equipment that would insure brakes being in proper adjustment at all times."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

September 21, 1978