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Highway Accident Report
Intercity Bus Loss of Control and Collision with
Bridge Rail on Interstate 70 Near
Frederick, Maryland, August 25, 1985

(U.S.) National Transportation Safety Board
Washington, DC

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16. Abstract

On the afternoon of August 25, 1985, a westbound intercity bus with 17 occupants was traveling on Interstate 70, a four-lane divided highway near Frederick, Maryland. It was cloudy with light rain and the pavement was wet. About 12:40 p.m., as the bus descended a hill with a slight curve to the right, the rear tires of the bus lost traction. The bus moved side to side out of control, crossing both travel lanes and the right paved shoulder, and struck the left side of a reinforced concrete bridge rail over the Monocacy River before coming to rest. Of the 17 occupants onboard, 14 were ejected from the bus during the collision sequence. The busdriver and 5 passengers were fatally injured; 11 other passengers sustained minor to serious injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the bus during a braking maneuver on wet highway pavement with low and variant frictional qualities and at a speed too great for the existing weather conditions. Contributing to the accident were the lack of an operative speedometer and the lack of highway signs to warn the busdriver of the slippery road conditions.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: January 22, 1987

INTERCITY BUS LOSS OF CONTROL AND COLLISION WITH BRIDGE RAIL ON INTERSTATE 70 NEAR FREDERICK, MARYLAND AUGUST 25, 1985

SYNOPSIS

On the afternoon of August 25, 1985, a westbound intercity bus with 17 occupants was traveling on Interstate 70, a four-lane divided highway near Frederick, Maryland. It was cloudy with light rain and the pavement was wet. About 12:40 p.m., as the bus descended a hill with a slight curve to the right, the rear tires of the bus lost traction. The bus moved side to side out of control, crossing both travel lanes and the right paved shoulder, and struck the left side of a reinforced concrete bridge rail over the Monocacy River before coming to rest. Of the 17 occupants onboard, 14 were ejected from the bus during the collision sequence. The busdriver and 5 passengers were fatally injured; 11 other passengers sustained minor to serious injuries.

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INVESTIGATION

The Accident

About 10 a.m. on August 25, 1985, bus No. 633 departed the Baltimore Motor Coach Company (BMCC) terminal in Baltimore, Maryland, to make a scheduled trip to Charles Town, West Virginia, and return. Bus No. 633 stopped at several passenger pickup points before departing Baltimore about 11:45 a.m., proceeding west on U.S. 40 and then west on Interstate 70 (I-70) toward Frederick, Maryland. The bus was scheduled to arrive at the Charles Town race track between 1:15 and 1:30 p.m. It was raining lightly, the pavement was wet, and westbound traffic on I-70 was moderate.

Bus No. 633 traveled toward Charles Town in front of an intercity bus operated by the Carter Bus Service. About 1 mile from the Monocacy River Bridge, traffic slowed in the left westbound lane, and the Carter bus in the right westbound lane passed the slower moving bus No. 633. Shortly afterward, bus No.633 moved to the right westbound lane. Both buses continued westbound in the right lane and ascended a hill about 0.4 mile from the Monocacy River Bridge. Motorists stated that they had been traveling between 55 and 60 mph behind both buses when the Carter bus made a lane change (from the right to the

left lane) before cresting the hill and continued forward without experiencing any problems. Bus No. 633 began to move left in front of traffic in the left lane after cresting the hill; however, as the bus descended the right curve and crossed into the left lane, it began to skid out of control. A passenger in a van traveling in the right lane, about four car lengths behind bus No. 633, stated that he saw the brake lights activate on the bus as it began to go out of control just after it crested the hill. Another motorist, traveling in the left lane about 20 feet behind the bus, stated that the bus was fishtailing as it passed him on the right and continued down the hill. Motorists in cars following bus No. 633 indicated that it became unstable about 630 to 830 feet before the bridge and that it was completely out of control (swerving from side to side across each lane) within 500 feet of the bridge. Several passengers reported seeing the busdriver fighting the steering wheel to regain control as the bus swerved across the travel lanes. Each swerve of bus No. 633 became progressively worse with the driver overcompensating his steering actions. The bus was still out of control as it [illegible]ered the concrete bridge over the Monocacy River.

About 12:40 p.m., the left front corner of the bus struck the left side bridge rail, creating a large opening in the front of the bus. It then rotated counterclockwise, overturned onto its right side on the bridge pavement, and traveled westward another 267 feet before coming to rest against the left side bridge rail. (See figure 1.) The side windows on the bus were jarred open during the collision sequence. The driver and left front passenger seated directly behind the driver were ejected from the bus and fell about 70 feet to the river embankment. Twelve other passengers were ejected onto the bridge. No other vehicles were involved in the accident, and there was no fire.

Several motorists who had witnessed the accident stopped to assist injured passengers. Other motorists drove to a local residence and telephoned for assistance. An off-duty Maryland State Trooper, who was traveling westbound on I-70, arrived at the accident scene at 12:44 p.m. and radioed for assistance. The Frederick City Volunteer Fire Department received its first call about the accident at 12:46 p.m. Immediately after the call, a volunteer fire chief, who lived near the scene and had been notified of the accident, arrived onscene. At 12:48 p.m., the fire chief set up a command post and requested ambulance and medical assistance.

Approximately 77 persons manning 13 ambulances, 5 rescue squad units, 2 special disaster units, 3 medic units, 3 fire engines, 5 helicopters, and 2 boats responded to the accident to provide emergency assistance. A triage was established and all injured persons were evacuated from the scene within 48 minutes after the arrival of the first rescue unit. The surviving passengers were transported to four area hospitals; four bus passengers who had been declared "dead on-scene" were transported to the Baltimore Medical Examiner's office.

Injuries to Persons

Fatally Injured	Driver	Passengers	Totals
Maximum injury-			
Virtually Unsurvivable (AIS-6)*	0	0	0
Critical (AIS-5)	0	2	2
Severe (AIS-4)	0	1	1
Serious (AIS-3)	1	2	3
Subtotal	1	5	6

Figure 1.--Accident scene.

Nonfatally Injured	Driver	Passengers	Totals
Critical (AIS-5)	0	0	0
Severe (AIS-4)	0	0	0
Serious (AIS-3)	0	1	1
Moderate (AIS-2)	0	4	4
Minor (AIS-1)	0	6	6
Uninjured (AIS-0)	0	0	0
Subtotal	0	11	11
Total	1	16	17

* American Association for Automotive Medicine Abbreviation-Injury Scale (AIS). **Note:** Historically, the Safety Board has used the International Civil Aviation Organization (ICAO) criteria to classify severity of personal injury in most modes of transportation accidents. Based on these criteria, the bus driver and five passengers sustained fatal injuries, six passengers sustained serious injuries, and five passengers sustained minor injuries.

Vehicle Information

Bus No. 633, a 1963 General Motors Corporation (GMC) two-axle coach, model PD-4106, was purchased by the BMCC in 1970. The 41-passenger bus was equipped with an 8-cylinder diesel engine, air-mechanical service brakes, a 4-speed manual transmission, power steering, a restroom in the rear, a tachograph, and six radial tires. Only the driver's seat was equipped with a lap belt. The bus was 35 feet long, 8 feet wide, 10.1 feet high, and had a wheelbase of 21.75 feet. At the time of the accident, the odometer registered 316,187 miles, the hubometer reading was 114,409 miles, and the loaded weight of the bus was estimated at 24,036 pounds. The gross vehicle weight of the bus was 28,890 pounds.

The accident bus, which was engaged in interstate commerce, was registered in the State of Maryland. Consequently, the bus was subject to both State and Federal Motor Carrier Safety Regulations (FMCSR). In 1984, the State of Maryland adopted into its vehicle law 1/ Chapter 49 of the Code of Federal Regulations (CFR) Parts 390 to 398, which includes Part 393, Parts and Accessories Necessary for Safe Operation. Thus, failure to meet any of the adopted FMCSRs is a violation of State law.

A postaccident inspection of the bus revealed that impact damage was confined primarily to the front and right sides. The right front exterior panel and windshield had separated from the bus. Impact damage extended rearward about 42 inches on the right side and 24 inches on the left side. The front windshield, entrance door, steering wheel, column, and attaching linkage had separated from the bus during the crash. The entire bus body was skewed during the impact sequence causing all of the "push out" windows on both sides to jar open. (See figure 2.)

The right rear corner of the bus was pushed inward about 4 inches at the bottom. Exterior abrasion marks were found along the right side window frames, near the right rear tires, and on the top of the rear window sill on the right side. The distance between the abrasion marks was about 6 feet. The engine compartment access door had separated from its left hinge and had rotated upward around its right hinge.

1/ Maryland Vehicle Law Section 25-111, Motor Carrier Safety Inspections.

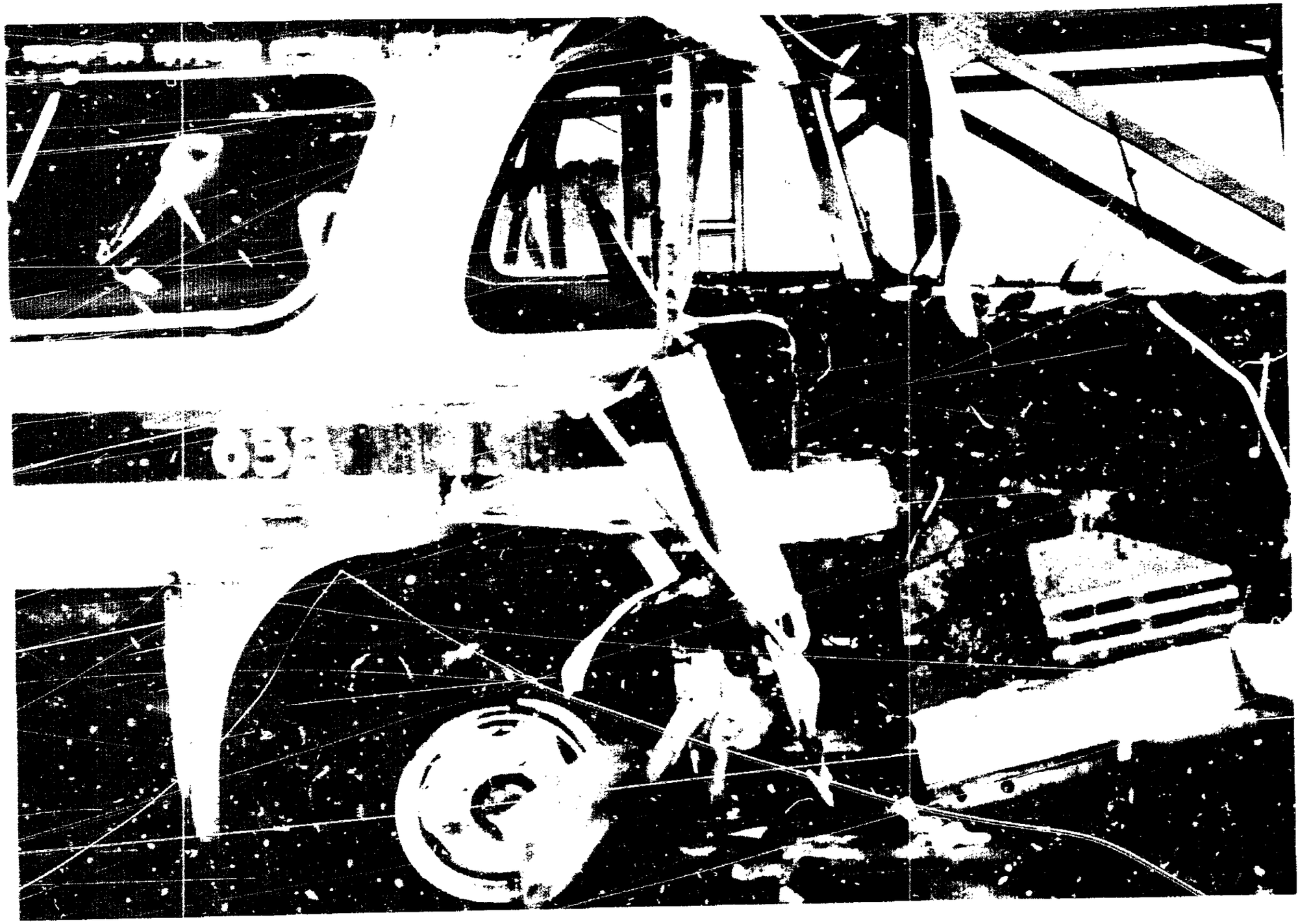

Figure 2.--Right front view of accident bus.

The postaccident inspection revealed that the dash-mounted speedometer/tachograph was inoperative at the time of the accident. The bus company's shop foreman stated that the speedometer/tachograph had been inoperative since June 1985 and that replacement parts had been ordered. State and Federal regulations do not require that buses be equipped with tachographs. However, Part 393.82 of the FMCSR states, "Every bus, truck, and truck-trailer shall be equipped with a speedometer indicating vehicle speed in miles per hour; which shall be operative with reasonable accuracy."

The service brakes were adjusted properly in accordance with the manufacturer's recommended specifications. Because the steering wheel, column, and attaching linkage were severely damaged during the collision, no determination of their operating capability could be made.

The bus was equipped with two 11.50 R20 radial tires on the front axle and four 12R22.5 radial tires on the rear axle. All tires, except the right front tire and the right rear outer tire, were inflated to a pressure between 92 and 105 psi and had an average tread depth of 10/32 inch 2/. The right front tire was damaged during the impact sequence. The right rear outside tire with a pressure of 30 psi was leaking near the tire rim.

The 4-speed manual transmission was intact and found in the neutral position. The maximum speed in fourth gear for the bus should be about 75 mph at a maximum engine speed of 2,100 rpm.

Driver Information

The 68-year-old driver was a resident of Baltimore, Maryland. He held a valid Maryland Class "A" license, dated March 1985; he was required to wear glasses while operating a commercial vehicle, and he held a current medical certificate, dated June 19, 1985. The busdriver's glasses were not recovered at the scene. Although his wife indicated that he normally wore his glasses while driving, the busdriver's medical certification vision test results indicated that he had 20/30 vision in both eyes without corrective lenses.

The busdriver had been off duty on August 23. He had driven a BMCC bus to Kings Dominion Park near Richmond, Virginia, and back on August 24, and he had gone off duty in the late afternoon. On August 25, he reported for duty about 10 a.m.

The busdriver had been employed as a substitute driver by the BMCC since June 1985. From June to September 1979, he had been employed by the BMCC as a mechanic's helper. Because of illness he had been assigned light vehicle maintenance work in the shop. Also, his BMCC employment application indicated that he had prior experience driving vans, flat trucks, tractor-semitrailers, and buses. Before June 1985, the busdriver had not driven commercial vehicles for about 6 years.

A review of the BMCC work records revealed that the busdriver had operated buses primarily on the weekends. Since June 1985, the busdriver had made a total of 15 trips which included several local trips to Memorial Stadium and Pimlico Raceway in Baltimore and several long distance trips to Kings Dominion Park. The busdriver had made one other trip to Charles Town, at which time the weather conditions were clear and dry.

2/ The Maryland Vehicle Inspection Code requires 4/32-inch tread depth on the front tires and 2/32-inch tread on the rear tires. The tire manufacturer's recommended maximum inflation pressure is 95 psi for the front and rear tires.

A review of records from the Maryland Department of Transportation (MDDOT) revealed that, from 1956 through 1978, the busdriver had received 22 moving violations, 3 license suspensions, and 3 license probations. (See appendix B.) From October 1978 to the date of the accident, there were no traffic violations, traffic accidents, or cited out-of-state traffic convictions. The busdriver did not report any of the license suspensions on his BMCC employment application.

According to his wife and available medical records, the busdriver became extremely ill in 1979, and it was determined that he was suffering from end stage renal disease (kidney failure). He was placed on hemodialysis treatment in 1980. His condition was considered suitable for transplant, and he received a kidney transplant in 1982. His body rejected the first transplant; after a period of hemodialysis, he received a second kidney transplant in February 1985. During the course of his illness, the busdriver had been a patient at the University of Maryland Hospital (UMH) Nephrology Department in Baltimore.

In addition, the busdriver was being treated for high blood pressure, a diabetes condition which predated his kidney failure, and a recent urinary tract infection. His hypertension and diabetes were, in part, related to the immunosuppressors he was taking to prevent rejection of the kidney transplant. The high dosage of immunosuppressors he was taking caused both elevated blood sugar and water retention. (When the busdriver was receiving hemodialysis treatment, insulin injections were not necessary and hypertension was not a problem.) According to his physician, the busdriver was taking the following medications daily:

- Cyclosporin, Imuran, and prednisone which are immunosuppressors to prevent rejection of the new kidney;
- A diuretic to relieve the high blood pressure condition;
- Insulin in the morning and evening for his diabetic condition; and
- An antibiotic for a urinary tract infection

Dr. M.R. Weir, the busdriver's primary physician at the UMH, indicated that the busdriver was highly motivated, that he was a careful patient, and that he was progressing extremely well. His new kidney was functioning properly and his hypertension and diabetes were under control. The physician also indicated that the hospital encourages all patients in the kidney transplant program to return to work if possible. He stated, however, that no one in his department had actually provided any written statements to the patient declaring that he was medically fit to work and that no one had spoken to any prospective employer about the busdriver's medical condition. The physician was aware that his patient had worked previously as a cab, bus, and truck driver. The UMH physician, however, was not aware of the medical qualifications required for commercial drivers who engage in interstate commerce, including the specific disqualification by the Federal Highway Administration (FHWA) of persons with diabetes mellitus requiring insulin for control. 3/

In a 1980 report, the FHWA discussed its position on the use of insulin. 4/ The report stated, in part:

3/ Title 49 CFR 391.41 (b) (3)
4/ Bureau of Motor Carrier Safety, FHWA. The Insulin-Dependent Driver, April, 1980, p. 35

> It is apparent that insulin-dependent diabetics, who are subject to sudden loss of consciousness or medical incapacitation, and whose occupation demands continual operation of a motor vehicle on the public highways present an increased danger to themselves and to the motoring public.

The loss of consciousness or medical incapacitation mentioned by the FHWA may result from too much sugar in the blood (hyperglycemia) or too little sugar in the blood (hypoglycemia). The busdriver in this accident was a noninsulin-dependent diabetic (NIDD). An NIDD produces some levels of insulin but may not produce an amount sufficient to maintain all of the body's needs. The accident busdriver did not produce sufficient insulin to counteract the effects of the immunosuppressive therapy he was receiving for his new kidney. When insulin-dependent diabetics (IDD) experience hyperglycemia from insufficient insulin, the most common immediate reaction is a diabetic coma. However, unlike IDDs, NIDDs may not notice elevated blood sugars until they become thirsty or fatigued, which may be several days after the blood sugar becomes elevated. 5/

Low blood sugar can affect both NIDDs and IDDs. If the amount of insulin is excessive, a hypoglycemic reaction may take place. A hypoglycemic reaction can be caused by too much insulin in the body as a result of too great an insulin dose, failure to eat sufficient carbohydrates and protein following an insulin injection, or exercise greater than normal. Symptoms of hypoglycemia may include the following: nausea, hunger, headache, irritability, lethargy, sweating, dizziness, loss of muscle coordination, and mental confusion. Severe hypoglycemia may result in convulsions and coma. Treatment for this condition is the ingestion of glucose products.

The busdriver maintained a logbook of his blood sugar readings and insulin injections which showed that his blood sugar readings were within his normal limits 80-180 milligrams per deciliter (mg/dl) for the 3 days preceding the accident. His wife stated that he ate regular meals and snacked between meals as well. He customarily took along a cooler filled with drinks and food when he drove for the BMCC. A cooler was discovered in the wreckage following the accident.

On June 19, 1985, the busdriver received his physical examination for his U.S. Department of Transportation medical certificate from Dr. deBorja in Baltimore. The examination form (see appendix C) contains a health history section and physical examination section. The health history question "Kidney disease" was checked yes, with the explanation "left kidney transplant, Sept 1982." The health history questions, "Diabetes" and "Extensive confinement by illness or injury," were checked no.

The physical examination described the busdriver's visual acuity as 20/30 in each eye without corrective lenses. There was no evidence of disease or injury to his eyes. The physical continued with normal findings except for a "reported slightly elevated" blood pressure of 165/90. Dr. deBorja explained in an interview with Safety Board investigators that he felt a 68-year-old man could have a normal systolic pressure as high as 170, despite the Federal guidelines of a maximum of 160/90.

The busdriver's urinalysis was normal, with no sugar reported. Two additional notations were made on the physical examination form: "Vericose veins from dialysis" were noted in his upper extremities and "Had his doctor's okay for work 6-18-85. Dr. M. Weir."

5/ Wyngarin, D.B., Smith Jr., Little, and Saunders, W. B., Cecil Textbook of Medicine, 15th Edition, Philadelphia, Pennsylvania, 1985

Dr. deBorja stated that the busdriver had shown him a letter from Dr. Weir stating that it was okay for him to return to work, but that he did not keep a copy of the letter on file. Dr. DeBorja stated that he was unaware that the busdriver was injecting insulin daily to control his diabetes condition, that the busdriver was undergoing drug therapy, and that he had received a second kidney transplant in February 1985.

Motor Carrier Information

The BMCC, a small company located in Baltimore, is a common carrier of passengers with operating authority that extends throughout the continental United States. The company has been operating since 1918 and, at the time of the accident, employed 15 drivers (8 full time and 7 part-time). The BMCC operated seven buses; bus maintenance was performed by a staff of three full-time and one part-time mechanic/helper.

Since 1939, the FHWA has conducted 11 safety audits of the BMCC. In 1974, BMCC paid a civil forfeiture penalty of $2,600 for driver qualification file and accident reporting violations. The last safety audit before the accident was conducted in 1982, and the last safety audit after the accident was conducted in November 1985. An FHWA investigator stated that the last audit revealed the BMCC failed to check the busdriver's background and driving records of two of the seven drivers whose records were reviewed, and that the BMCC failed to report four traffic accidents which met the reportable criteria of the FHWA. As a result of the audit, the carrier was rated "conditional" (marginal). A followup safety audit was performed in September 1986. The audit revealed that the motor carrier had corrected all previously noted deficiences and was in compliance with the FMCSR. As a result of the audit, the FHWA investigator recommended that the carrier be rated satisfactory.

Records show that BMCC officials administered a road test and a written examination to the accident busdriver in June 1985, but officials stated that they did not provide any formal training to the driver. BMCC officials also stated they were aware of the busdriver's kidney ailment, but that they did not know of his diabetes condition. The BMCC officials also stated that the busdriver had shown them a letter signed by Dr. Weir of the UMH, stating that it was okay for him to work. However, they did not keep a copy of the letter on file. The busdriver's qualification file maintained by BMCC contained a copy of his Maryland driving record, dated June 19, 1985, which indicated his previous violations and that his license had been previously suspended.

Highway Information

The bus collided with the Monocacy River Bridge about 4 miles east of Frederick in hilly terrain. The highway at the accident site is designated as I-70/US 40. It generally runs east-west and is not a limited access road. At least seven at-grade crossovers in the median are within 3 miles of the accident site and are used regularly for business and private access.

On the westbound approach, the highway has a 2 to 4 percent positive grade for about 2,178 feet and then descends for 1,250 feet on a 2° right curve before reaching the bridge. The maximum downhill grade on the approach to the bridge is about 7 percent. The 11.5-foot-wide travel lanes on I-70/US 40 are constructed of a concrete subbase with an asphalt overlay, and the north and south shoulders are paved with asphalt. The 2° curve is designed with a superelevation which ranges from 4.5 to 7 percent. Visibility on the westbound approach to the bridge is about 700 feet and the posted speed limit is 55 mph.

The 466-foot-long bridge is 28 feet wide. It has a 7 percent downgrade and a 7-inch-high barrier curb, which is used as a walkway on both the north and south sides of the bridge. The bridge deck is constructed of concrete, and it has an asphalt overlay. The bridge rail, which varies from 39 to 54 inches high, was constructed with reinforced concrete.

The postaccident inspection revealed scrapes, gouges, and impact damage to the bridge rails on both sides of the bridge and on the pavement surface. Tire marks were found in both the right and left travel lanes of the bridge.

At the time of the accident, from 588 to 200 feet east of the bridge, the pavement surface of the right westbound lane was rough, especially in the wheel paths. Bumps ranging from 0.25 to 1.0 inch high were found in both wheel paths. The MDDOT advised Safety Board investigators that the right lane had been milled about 4 years before the accident to remove bumps and to restore the pavement profile.

From June 1984 through May 1985, the MDDOT conducted several skid inventory and pavement roughness tests to monitor the pavement performance on I-70. These tests indicated that at the accident site the pavement on the westbound approach to the bridge was becoming rough (test results were 185 inches/mile; above 200 inches/mile is considered rough). The skid numbers 6/ measured in the left wheel path of the right westbound lane were 26 to 30. The MDDOT had determined that the pavement on this section of I-70 was marginal before the accident and had contracted it for resurfacing. In September 1985, the MDDOT repaved the westbound approach to the bridge to eliminate the rough pavement conditions.

As a result of a Safety Board special study on skid resistance 7/ and its investigation of several highway accidents involving commercial vehicles on wet pavement, the Safety Board recommended that the FHWA:

> H-32-34
>
> Conduct and publish a comprehensive review of each State's skid accident reduction program to identify problem areas, to develop corrective recommendations where necessary, and to disseminate more widely innovative local practices of proven value and general applicability.

In its response dated September 13, 1985, the FHWA indicated that it had increased its emphasis in the skid program area and had "issued a memorandum directing our region and division offices to conduct reviews of their State's skid accident reduction programs using the guidelines and findings from the headquarters review."

6/ Skid number: the tire to pavement friction coefficient X100 for a specified set of test conditions. Although there is no consensus of opinion on appropriate skid numbers for wet pavement surface, the State of Kentucky, a leader in skid resistance research, has developed the following criteria:

Above 39	-	(Good) Skid Resistant
33 to 39	-	Marginal
26 to 32	-	Slippery
Below 26	-	Very Slippery

7/ Safety Effectiveness Evaluation—"Fatal Highway Accident on Wet Pavement—The Magnitude Location, and Characteristics" (NTSB-HSS-80-1).

As of April 1986, the FHWA has conducted 21 individual reviews of State programs on skid accident reduction. Currently, most of the State programs have been reviewed. The program for the State of Maryland was reviewed on March 17-21, 1986. The review contained 11 recommendations which dealt with signing, policies on skid numbers, histories of pavements, tests at speeds other than 40 mph, further testing on aggregates, prohibition of the use of some aggregates, prohibition of partial width paving, and problems for testing and construction on bridges. The review stated, in part:

> The State has a comprehensive skid accident reduction program as required by FHWA policy. The Maryland skid accident reduction program has a number of excellent components and there have been a number of State efforts in the past to assure adequate skid resistance is being provided. However, there is concern at this time that there are some weaknesses in the overall system which may be resulting in some undesirable levels of pavement friction on certain highway facilities.

The FHWA review recommended, in part:

> Policies or guidelines should be developed on what action should be taken to address lower skid number road sections identified through the State's annual skid testing inventory
>
> Guidelines should be developed for installation of appropriate warning signs as an interim measure where skid resistant characteristics are found to be questionable or inadequate.

On September 8, 1986, the State of Maryland responded to the FHWA recommendations. The response stated, in part:

> The Office of Traffic is developing guidelines for signing low friction locations. As soon as appropriate threshold values for signing are determined the guidelines will be distributed to the district offices.

Meteorological Information

At the time of the collision, the sky was cloudy, the temperature was about 70° F, and a light, steady rain was falling. Based on the available data, the Safety Board determined that at 12:40 p.m. on the day of the accident, the rainfall rate was about 0.06 inch per hour.

Medical and Pathological Information

Four persons were pronounced dead at the scene. The busdriver and one passenger died at the hospital.

The busdriver's death was attributed to multiple injuries to the head and the lower torso area. A toxicological analysis of the busdriver's blood sample was negative for alcohol, opiates, and other illicit drugs; however, it did reveal the presence of lidocane which was administered by emergency room personnel in an attempt to revive the busdriver at the hospital. Blood taken in the emergency room was tested, and the glucose level was measured at 166 mg/dl; it is unclear whether the busdriver was administered a glucose solution by emergency personnel at the scene. Therapeutic levels of prescription drugs normally would not be discovered in a standard toxicological analysis and were not tested for this investigation.

Autopsies revealed that the fatal injuries of four of the five passengers were the result of massive head trauma. The fifth fatally injured passenger sustained a transection of the spinal cord.

Six of the eleven surviving bus passengers sustained minor injuries (AIS-1) consisting of abrasions, contusions, lacerations of the extremities, and fractured ribs. The remaining five passengers sustained moderate to serious injuries (AIS-2 to AIS-3) consisting of cerebral contusions and concussions and fractured clavicles, fibulas, humeri, and pelvises.

Survivability

At the time of the accident, most of the passengers aboard bus No. 633 were either asleep or reading. The passenger in seat 10B stated that the rear of the bus swerved to the right and then to the left, and swerved right again causing the front of the bus to then strike the left side bridge rail. He stated that during the accident sequence, he felt pinned inside the bus and [illegible]it that the back of the bus was moving faster than the front. He said that "every[illegible]e was upside down" after impact. The passenger in a seat near the front of the bus stated that several passengers started screaming as the bus swerved from side to side.

The busdriver and 13 passengers were ejected from the bus. Only the driver's seat was equipped with an occupant restraint. However, the driver was not wearing the lap belt at the time of the accident.

Three passengers remained inside the bus during the accident sequence. The passenger in seat 2B was pinned inside the bus because the seatback of seat 1A had fallen rearward on top of his legs. The passenger in seat 5A stated that he held onto the back of seat 4A with both arms as hard as he could to brace himself for the crash, and that when the sequence ended, he was on the floor. The passenger in seat 9B stated that she felt her body being directed by the crash forces toward the windows, but that a seat cushion flew up and kept her from being ejected through the window. (See figure 3.)

Tests and Research

Several highway and vehicle handling tests were conducted at the accident site to determine the tire-to-pavement friction coefficient under wet pavement conditions and to determine the lateral stability of the bus at various speeds.

Friction Tests.--At the request of the Safety Board, on August 27, 1985, standard lock-wheel-skid tests 8/ were performed by the MDDOT at 40 mph in both westbound lanes of I-70 from the crest of the hill to the bridge over the river. The tests were performed to determine the tire-to-pavement friction coefficient at various locations in both wheel paths of the right lane and the left wheel path of the left lane. 9/ All tests were performed on wet pavement.

Nonstandard lock-wheel-skid tests 10/ were performed on August 27, 1985, in the right lane at 50 mph. These tests also were performed on wet pavement. The Safety Board requested the tests because previous investigations have indicated that the

8/ Skid tests performed at 40 mph in accordance with the procedures outlined in the American Society of Testing Materials (ASTM-E 274).
9/ There was as blockage in the roadway which prevented the Safety Board from testing the right wheel path of the left lane.
10/ Skid tests performed at speeds other than 40 mph.

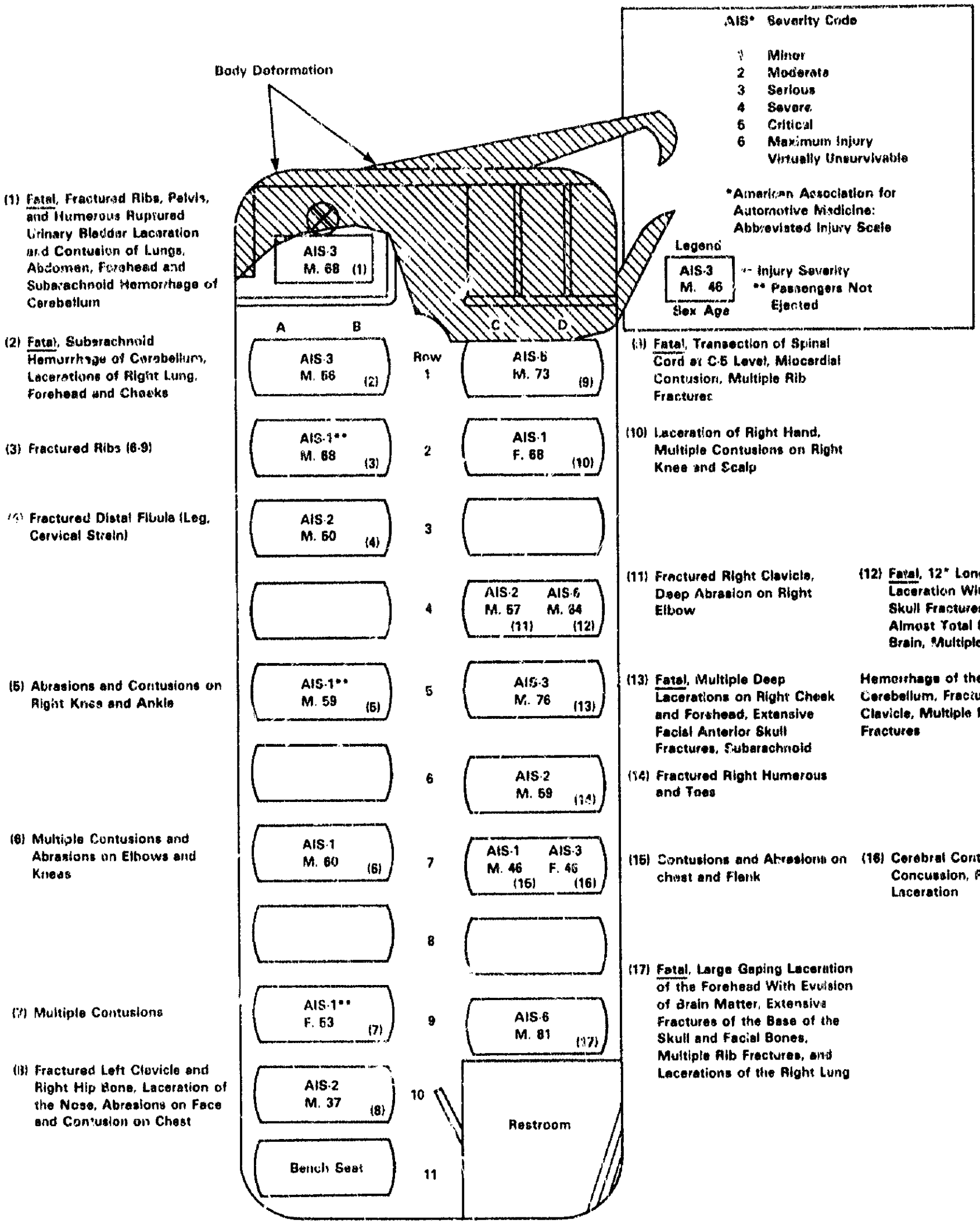

Figure 3.—Bus seating chart noting occupant age, sex, AIS injury severity, and seat location.

significant loss of tire-to-pavement friction quality, which can accompany speed, increases on some wet pavement surfaces. The results of the lock-wheel-skid tests are shown in table 1.

Table 1.--Skid test results for I-70 westbound lanes.

	Right Westbound Lane			Left Westbound Lane
Milepost	Right Wheel Path 40 mph (Skid No.)	Left Wheel Path 40 mph (Skid No.)	Left Wheel Path 50 mph (Skid No.)	Left Wheel Path 40 mph (Skid No.)
18.1 --	28	24	36	
13.13	30	29	25	34
18.09	27	27	23	35
17.94 (Bridge)	--	34	28	38

The MDDOT does not have a specific policy on pavement friction improvement; however, it provided the Safety Board with skid test data for new construction and resurfacing jobs performed on highways maintained by the department since 1972.

Table 2.--Distribution of skid numbers for Maryland highways tested at 40 mph.

	Skid Number	
	Bituminous Concrete	Portland Cement Concrete
Number of tests performed	6448	767
Distribution for 67% of all tests	41-59	49-59
Distribution for 95% of all tests	32-68	43-65
Average skid number for tested surface	50	54

A 1979 study performed by the State of Kentucky 11/ evaluated several factors which could be used to identify slippery wet roads. The study concluded that:

> A minimum skid number should be set to safeguard the public from slipperiness regardless of the accident history or pavement conditions of the highway.
>
> Any highway section with a daily traffic count above 1,000 should be deslicked if the skid number of the pavement is 28 or less. Signs should be posted to warn the public of road hazards and to reduce vehicle speeds under wet pavement conditions until the slippery conditions have been corrected.

The study suggested the following guidelines: slippery wet paved highways should be considered "skid resistant" if the skid numbers are 39 and above, "marginal to slippery" if the skid numbers are between 39 to 26, and "very slippery" if the skid numbers are below 26.

11/ Rizerburg, Roland L. and Burchett, James L., "Statewide Survey of Skid Resistances of Pavements (1979)," Kentucky Department of Transportation Research 552, September 1980.

Vehicle Handling.--On September 8, 1985, Safety Board investigators, in cooperation with the Maryland State Police, the MDDOT, and the BMCC performed vehicle handling tests at the accident site to determine the performance capabilities of a similar bus under similar wet pavement conditions. 12/ The rear tire and wheel assemblies with the tire pressures unchanged 13/ from the accident bus were mounted on the test bus, a GMC model 4106 coach, and the bus was loaded with sandbags to simulate the occupant weight and distribution at the time of the accident. To ensure the safety of the tests, panic stops and erratic steering maneuvers were not performed. Nine tests were conducted at speeds varying between 40 and 62 mph with the bus traveling in the right lane, left lane, and straddling both westbound lanes, and with the bus performing lane change maneuvers with and without braking.

Three video cameras were used to record and document all tests. Observers were placed at 100-foot intervals to detect any vehicle handling irregularities which might have influenced the bus dynamics. Speed was measured by radar at the top of the hill and by Visual Average Speed Computer and Recorder for the last 500 feet of the hill approaching the bridge. The bus handled normally in the vehicle tests performed in the left westbound lane at speeds up to 61 mph. Several irregularities were noted during the vehicle tests performed in the right westbound lane and during lane change maneuvers from the right lane to the left lane. (See table 3.) The bus began to fishtail, displaying early signs of instability during a lane change maneuver just before 63 mph.

Accident Data

According to MDDOT's accident data base, there were 19 accidents from 1982 through 1984 within 1 mile of the accident site on westbound I-70. Six of the accidents involved collisions with a fixed object, two occurred on wet pavements, and two involved heavy trucks. (See appendix D.)

The accident rate for this section of westbound I-70 was 57 accidents per 100 million vehicles miles (MVM). The State accident rate for a similar type of road was 96 accidents per 100 MVM.

Data for 1985 from the Maryland State Police indicated that three accidents involving commercial vehicles had been reported on westbound I-70/US-40 from the hill to the Monocacy Bridge. One accident involved a loss of control of a heavy truck during heavy rain conditions on wet pavement, and one occurred on icy pavement.

The Safety Board has been concerned about the stability of the GMC Model PD-4106 bus because of three previous accidents it investigated in which control of the buses was lost on wet pavement. These accidents involved the following conditions: a single bus traveling between 50 and 62 mph in light to heavy rain on wet pavement with a low and variant friction. The accident drivers had varying levels of experience with intercity buses and, in two cases, were driving the buses through shallow curves when the loss of control occurred. Collectively, the accidents resulted in 6 fatalities and 65 injuries.

12/ Water was evenly sprayed on the pavement surface by a 5,000-gallon tank truck. The water depth was measured before each test to simulate the rain conditions at the time of the accident.

13/ The leaking right rear outer tire was repaired and inflated to 95 psi.

Table 3.--Bus test runs.

Test No.	Speed Range (mph)	Lane	Water depth (inch)	Observations
1	50.8 (no braking)	Right	0.01	Front tires bounced slightly
2	40.9 (no braking)	Left	0.01 or less	Smooth ride
3	50.0 to 51.4 (light braking)	Left	0.01 or less	Smooth ride
4	52.0 to 55.5 (light braking)	Left	0.01 or less	Sway by bridge from station * 100 to station +80
5	55.0 to 61.2 (light braking)	Left	0.02 to 0.01	Smooth ride
6	59.0 to 59.2 (no braking)	Straddle both lanes	0.02 or less	Based on inside from station camera, rougher ride than test No. 5 but smoother than test No. 4.
7	47.0 to 58.0 (no braking)	Lane change right to left	0.01 or less	Hit small bump near station 600 and bounced
8	54.0 to 58.8 (light braking)	Straddle	0.01 or less	Fairly smooth of right ride edgeline
9	52.0 to 62.9 (heavy braking)	Lane change right to left	0.01 or less	Fishtailed around station-200 after hitting bump near station -530

* Station: Distance in feet from the designated reference point which was the east side of the Monocacy Bridge

One accident on October 11, 1975, on I-495 in Bethesda, Maryland, 14/involved a GMC Model PD-4106 bus driven by a professional driver who was negotiating a 5° right curve at 50 mph when the rear wheels of the bus lost traction and began to slide from side

14/ Special Investigation--"Metropolitan Coach Corporation Charter Bus Accident, Bethesda, Maryland, October 11, 1975" (NTSB-HAR-76-6).

to side. In the final slide, the bus rotated 160°, contacted the guardrail, and rolled onto its side. The pavement surface was marginal (SN 36). In 1980 in Luling, Texas, 15/ a bus with a maximum tire tread of 4/32 inch on the rear tires and being driven by a 30-year-old occasional bus driver, was beginning to negotiate a 2° left turn at 55 mph on a slippery split coefficient surface (SN 26 to 38) when he lost rear traction. The bus crossed into the left lane and slid side to side across both travel lanes before overturning onto its side on the right shoulder. On July 20, 1985, near Acklery, Texas, 16/ a bus traveling between 60 and 62 mph and driven by a 48-year-old occassional bus driver, lost control on a straight section of roadway, where there was a split coefficient of friction in the same lane (SN 0.48 and 0.16).

Following the accident near Frederick, the Safety Board requested accident data from the FHWA and the National Highway Traffic Safety Administration (NHTSA) on the GMC Model PD-4106 bus. The Board also mailed a survey to 50 States and the District of Columbia to determine statistically if GMC Model PD-4106 buses were involved in a greater than expected (based on vehicles miles traveled) number of wet pavement accidents when compared with other models of intercity buses.

The FHWA and the NHTSA were able to provide only limited data to the Safety Board. The FHWA provided five in-depth investigations of similar accidents involving GMC Model PD-4106 buses that occurred between 1963 and 1969. The NHTSA data did not provide data on any accidents involving GMC Model PD-4106 buses primary because the vehicle identification numbers of buses involved in accidents was not available and therefore, not all buses in the accident data base could be identified by make and model.

Also, letters were sent to all 50 States and the District of Columbia requesting vehicle registration and accident data on GMC Model PD-4106 buses. Of the 32 States that responded to the letter, 19 States identified a total of 649 registered GMC Model PD-4106 buses. (See appendix E.) Nine States, which were able to identify accidents involving GMC Model PD-4106 buses by vehicle identification numbers (VIN), reported 59 accidents involving GMC Model PD-4106 buses between 1982 and 1985; 15 of the accidents occurred on wet, snowy, or icy pavement. (See appendix F.) Two States that responded to the Safety Board's survey indicated that they would have to manually search their accident files to provide accident data by VIN.

The Safety Board reviewed the NHTSA's State Accident Report Forms Catalogue for 1985. 17/ It disclosed that 16 States and the District of Columbia do not collect the VIN on their accident report forms, especially for commercial vehicle accidents. 18/ However, as of 1985, 34 States had made provisions to record the VIN data on their form.

New Investigative Techniques

At the time of the accident in the immediate vicinity of the bus No. 633, there were eight other vehicles westbound within a space of about 800 feet. To determine the

15/ Highway Accident Report—"East Side Church of Christ Bus Skid and Overturn, U.S. Route 183, Near Luling, Texas, November 16, 1980" (NTSB-HAR-81-4).

16/ Highway Summary Accident/Incident Reports—"Near Ackerly, Texas, July 20, 1985; Eureka Springs, Arkansas, September 13, 1985; and Bramwell, West Virginia, October 13, 1985" (NTSB/HAR-87/01/SUM).

17/ DOT HS 806 884, February 1986

18/ California, Hawaii, Idaho, Indiana, Kentucky, Massachusetts, Minnesota, Mississippi, New York, North Dakota, Ohio, Oregon, Pennsylvania, Tennessee, Virginia, and Wyoming.

interrelationships of these vehicles and the effects of grade on the speed of the two buses while the other vehicles were going at fairly constant speeds, the Safety Board developed a computer animation of the accident sequence.

In general, the Safety Board's computer animation provides a computer drawing which depicts the positions of vehicles relative to each other and the highway at a given time. By providing drawings at various chronological time intervals, a picture emerges with changes in the position of vehicles relative to each other and the highway. This enables the viewer to gain a pictorial perspective of the accident dynamics.

The drawings generated in a computerized animation are based on mathematical models (equations) which represent the dynamics of the accident, the highway, and the vehicles. The computer solves these equations in accordance with certain required input and assumptions, based on data about accident. The accuracy of the computerized drawings are dependent on the degree of sophistication of the mathematical models representing the accident dynamics, highway conditions, vehicle conditions, and the accuracy of the input data concerning vehicle placement, vehicle speeds, and actions of drivers during the accident sequence.

Equations in terms of X, Y, Z, heading, roll, and pitch must be solved for each small time segment. Often three-dimensional vehicle models with numerous points are used. Animation is generated by filming computer drawings frame by frame. Each frame is photographed with a 16 mm film camera. The Safety Board believes that accident reconstruction animations in the future will be developed more frequently, will involve more complex models and more use of color, and should help to improve the understanding of accident dynamics. Figures 4 and 5 are computer drawings produced to show the various dynamics and vehicle relationships, during the accident.

ANALYSIS

Accident Dynamics

Witness statements indicate that on the approach to the accident site, bus No. 633 was following the Carter bus in the right lane. Both buses passed several motorist in the left lane traveling between 55 and 60 mph. After passing slower moving traffic, the Carter bus moved to the left lane before cresting the hill. The BMCC bus began moving into the left lane after cresting the hill and starting the downgrade toward the bridge. A passenger in a van behind the bus noticed activation of the bus brake lights at the time the bus began to go out of control.

Based on the impact damage to the front of the accident bus, the Safety Board believes the bus initially struck the bridge rail at an angle of about 67° from its normal direction of travel. The bus penetrated the bridge rail, but it did not vault the bridge because its center of mass continued to move counterclockwise which pulled the bus in a westward direction down the bridge. The rear of the bus continued to rotate forward causing the front end of the bus, which was trapped in the bridge rail, to rip open. Based on the impact damage on the right side, the bus also rolled over about 90° on to its right side, rotated almost 360° counterclockwise while traveling west on top of the bridge deck, uprighted itself along the right side bridge rail by rolling to the left, and slid to rest in the upright position along the left bridge rail. The height of the bridge rail helped to upright the bus as the front of the bus slid along the right side bridge rail. During the

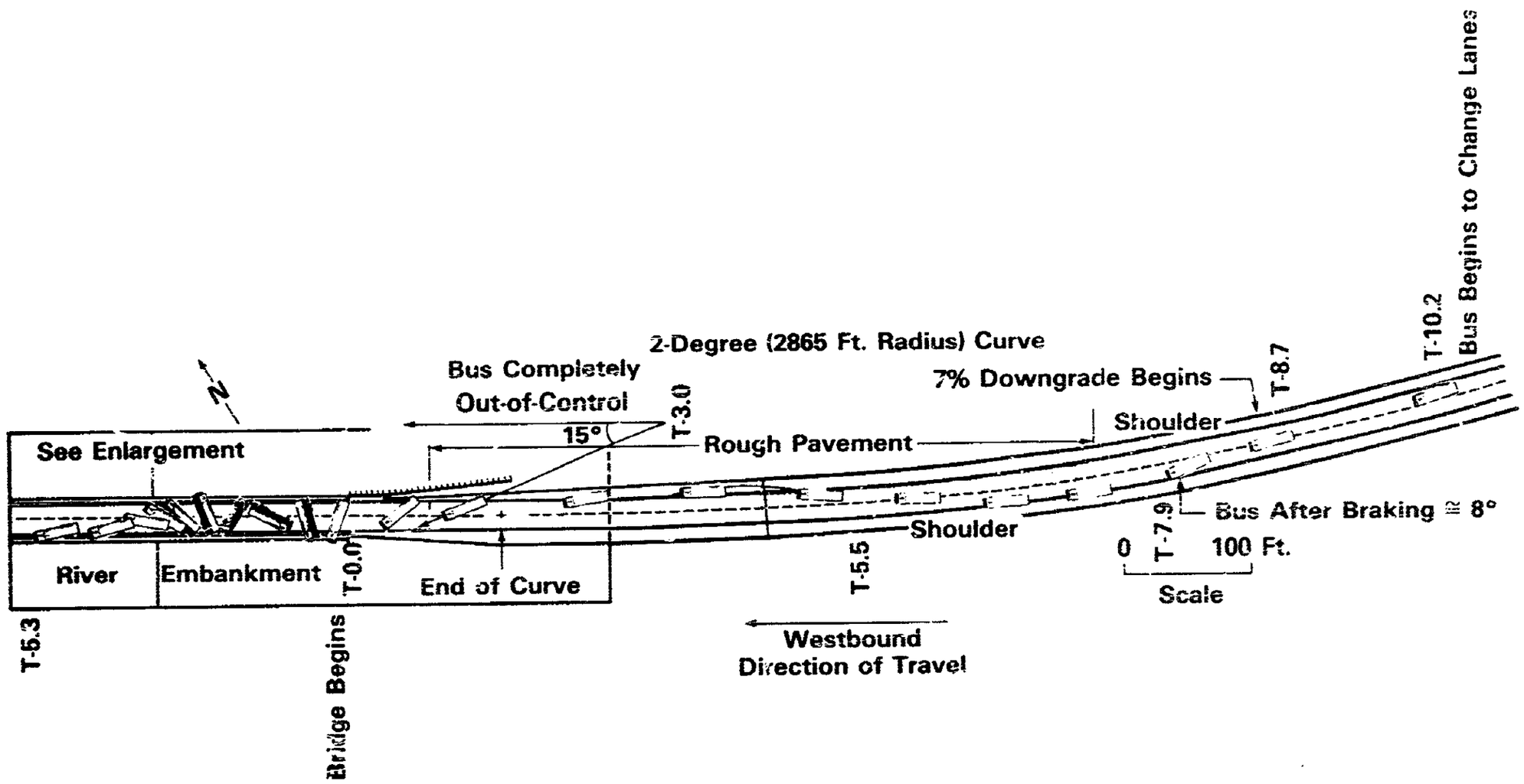

Figure 4.—Accident site on I-70 westbound lanes near Frederick, Maryland.

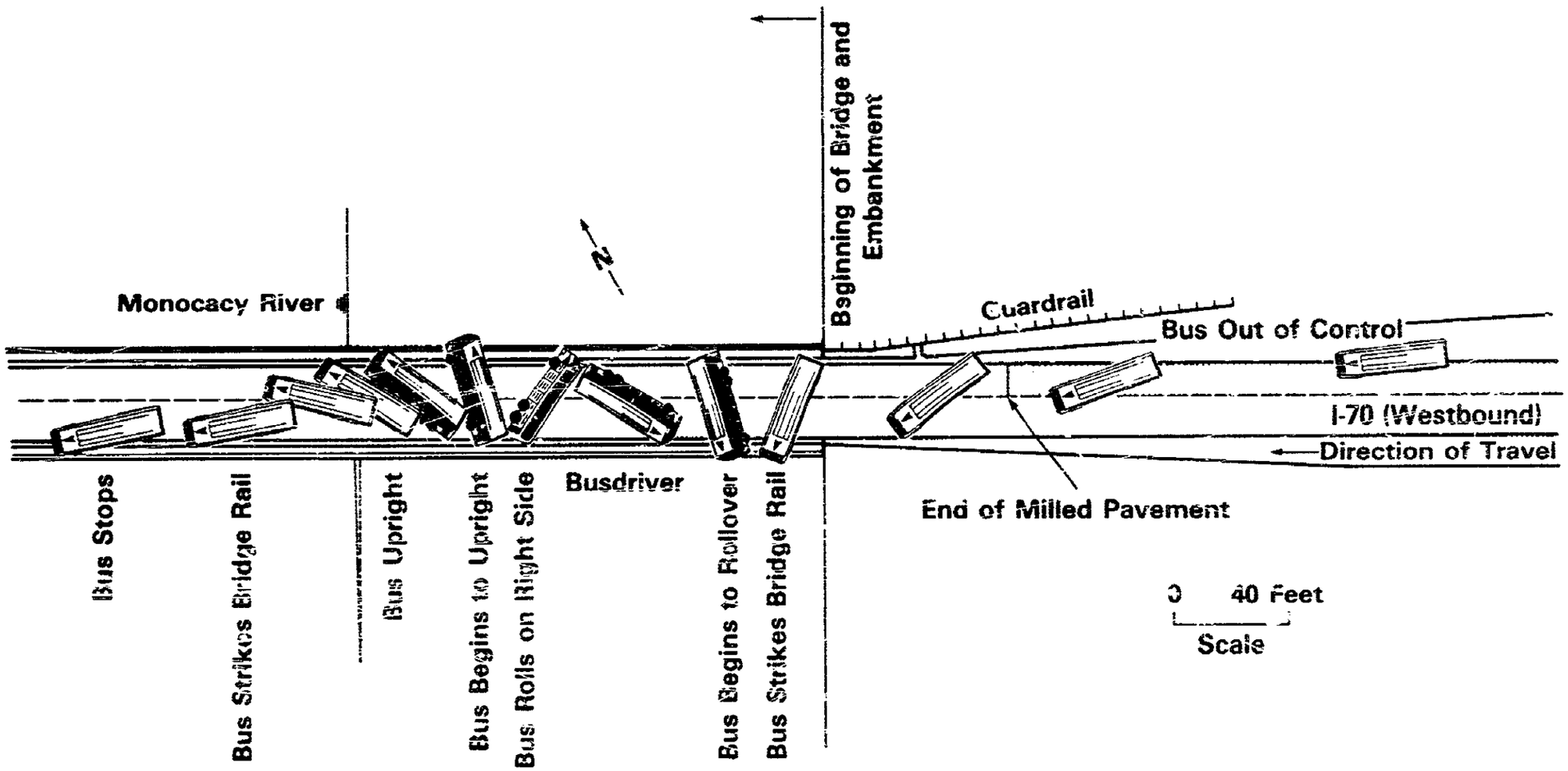

Figure 5.—Enlargement of bus dynamics.

entire dynamic sequence, the bus traveled between 900 and 1,100 feet from the point where the initial loss of control occurred to its final resting position on the bridge. (See figures 4 and 5.)

Based on the analysis of the accident dynamics, and the distance the bus slid to rest, the busdriver probably lost control of the bus initially while traveling between 58 and 63 mph, and the bus probably struck the bridge rail between 48 and 53 mph. The speed at which the bus in the postaccident vehicle handling tests appeared to be on the verge of instability tends to corroborate these estimated speeds. Near loss of control of the test bus began just before 62.9 mph during the change in lanes from right to left while the driver was braking the vehicle.

Vehicle Inspection

The postaccident inspection did not reveal any evidence of mechanical problems with the service brakes, tires, or transmission that were causal to the accident. Although the steering wheel column and attaching linkage were severely damaged in the accident, witness statements indicate that the busdriver was actively steering the bus until it struck the bridge. Thus, it is unlikely that a steering problem precipitated the accident.

The BMCC shop foreman stated that the speedometer/tachograph on the accident bus had been inoperative for almost 2 months before the accident. Although replacement parts had been ordered, the BMCC continued to operate the accident bus in violation of 49 CFR Part 393.82 and Maryland Vehicle Law, Section 25-111. Busdrivers need a speedometer to be aware of vehicle speed on a continuous basis, to assure obeyance with all local and State speed ordinances, and to assure that the speed of the bus is commensurate with known weather and road conditions. Although commercial drivers probably can estimate the speed of the vehicle with considerable accuracy without reference to a speedometer, the instrument is essential to safe operation of large vehicles during inclement weather conditions particularly for a part-time driver. Therefore, the Safety Board concludes that the lack of an operative speedometer contributed to the cause of the accident.

Vehicle Stability

A loss of rear tire traction probably initiated the accident sequence. The loss of traction most likely resulted from a combination of conditions, which included the weather, pavement friction, vehicle handling, and speed.

Weather.--At the time of the accident, the temperature was about 70° F. Light, steady rain had been falling for about 1/2 hour. The rain intensity at that time was only 0.06 inch per hour--not enough to cause flooding of the road surface. Generally, commercial vehicle tires will produce two to three times more lateral traction on dry surface than on the same surface under wet pavement conditions. If the road surface has poor drainage qualities, water can remain in the traffic lanes during light rainfall and can cause the tires to hydroplane. 19/

The grade and the superelevation on the approach to the bridge were sufficient to promote good drainage under light rainfall. Using the air pressure and tire foot print (aspect ratio) generated from the tires on the test bus, the hydroplaning speed was

19/ Hydroplaning: a condition which occurs when the tire is fully separated from contact with the road surface by a film of water.

calculated to have been about 83 mph. This speed exceeded the maximum speed capabilities of the accident bus (75 mph) by 8 mph and exceeded the estimated maximum speed of the bus at the time of the accident by at least 20 mph.

Vehicle Speed.--The skid numbers measured at 40 mph on the approach to the accident site ranged from 27 to 34 in the right lane and from 34 to 38 in the left lane. Under the criteria established by the State of Kentucky, 20/ the pavement at the accident site would be considered "marginal to slippery." However, the wet pavement tire-to-pavement friction capability of the "marginal to slippery" pavement is further reduced as speed increases. Skid numbers can be reduced by as much as 25 percent (eight skid numbers) when the vehicle speed is increased by 50 percent (e.g., from 40 to 60 mph). Thus, if loss of control occurred at a speed between 58 and 63 mph, the skid numbers could have been reduced by as much as 25 percent, and the pavement would have been considered "very slippery." Any reduction in traveling speed or increase in pavement friction would have improved the stability of the bus, particularly while the bus was being braked during a lane change maneuver.

Vehicle Handling.--For a bus to negotiate a curve at high speed, the front and rear tires must side slip (slip laterally) to maintain the bus in the curve. The front and rear tires must generate cornering forces to counter the centrifugal forces that pull the bus out of the curve. Under wet pavement conditions, any phenomenon which reduces the ability of the tire to generate cornering forces will adversely influence vehicle handling.

Witnesses indicated that the busdriver applied his service brakes during the lane change maneuver. As the brakes were applied to reduce the vehicle's forward speed, the cornering forces generated by the front and rear tires to counter the centrifugal forces also were reduced. Further, the lane transition occurred on pavement which had marginal frictional qualities. Because the majority of the weight of the bus was supported by the rear axle, and the rear tires could not be steered to generate more cornering forces, the loss of rear traction occurred first which caused the rear of the bus to slide sideways. In postaccident tests with a similar bus, the bus was stable while straddling both lanes with light braking up to 59 mph; at higher speeds, instability was initiated.

Pavement Friction.--Based on witness statements, the accident bus most likely was straddling both lanes when the busdriver applied the service brakes and thus was subjected to differential friction 21/ between the right and left lanes. Tests performed on wet pavement at milepost 18.13 (about 800 feet east of the bridge) at 40 mph indicated skid numbers of 29 and 34 for the right and left lanes, respectively. Consequently, when the service brakes were applied, the bus was subjected to a counterclockwise turning moment which rotated the bus about 6° to 10° initially toward the lane with the higher skid numbers. In 1976, the Arizona Department of Transportation conducted vehicle control tests to evaluate maneuvering problems associated with a differential friction surface. The first phase of the tests attempted to determine how many degrees a braked vehicle would rotate before it could not be safely corrected by the driver. In tests conducted at 50 mph, the driver was unable to control the braked vehicle after 10° of rotation.

20/ Statewide Survey of Skid Resistances of Pavement (1979).

21/ Differential friction: a condition where different or unequal coefficient of friction exists for individual wheel paths. Although the coefficient of friction may be good in both lanes, the difference during a lane change maneuver might cause a vehicle to spin out of control when braking. J.C. Burnes, "Differential Friction: A Potential Skid Hazard," Transportation Research Record No. 602, 1976.

In this accident, because the bus initially rotated less than 10°, control probably was not lost completely during the first lane change. However, at speeds between 58 and 63 mph, the busdriver would have had little time to react, steer, and straighten the path of the bus in its travel lane. Consequently, the busdriver apparently over corrected which led to the ultimate loss of control. The initial loss of control also occurred well before the area of rough pavement where the coefficient of friction was reduced even further. Therefore, the Safety Board concludes that the differential coefficient of friction between the right and left lanes contributed to the loss of control.

Highway

The State of Maryland recognized that the pavement near the accident site was too rough before the accident and had scheduled it for improvement. It also had instituted policies to prohibit long sections of milling without immediate surface overlays. This surface was overlayed after the accident during the fall of 1985. The accident data on this stretch of road indicated a relatively few number of accidents despite the low skid numbers and rough pavement; thus, the State opted not to post warning signs before surface treatment. The Safety Board believes that warning signs should be posted on roads with poor frictional qualities and rough pavement when work to improve the surface is not immediately scheduled. Therefore, we conclude that the failure to post signs to warn drivers of the slippery road condition contributed to the cause of the accident.

According to the response to the FHWA review, the State of Maryland will develop guidelines for signing low friction locations. These guidelines, hopefully, will establish policy for posting slippery wet roads with inadequate skid resistance until permanent corrective action can be implemented. The Safety Board believes that the FHWA should complete its review of the State programs on skid accident reduction and publish the results of its findings to encourage other States to improve their prospective programs.

Medical Condition of Driver

At the time of the accident, the busdriver was an outpatient at the University of Maryland Hospital (UMH). To prevent the rejection of the kidney transplant, he was being treated with immunosuppressors. This exacerbated his existing diabetes condition, and the resulting elevated blood sugar levels could only be controlled by daily insulin injections. In addition, the busdriver was using prescribed medication to treat hypertension and a urinary tract infection.

The busdriver's primary physician, Dr. Weir, stated that the busdriver was experiencing no ill effects from the multiple medications and that these levels of prescription drugs would not have impaired his ability to drive. The busdriver's medical record did not reflect any episodes of dizziness or mental confusion which would have indicated a tendency toward hypoglycemic events.

Safety Board investigators also discussed the potential effects of the busdriver's medication with physicians from the Federal Aviation Administration's (FAA) Office of Aviation Medicine. They stated that the FAA has certified many pilots with transplanted kidneys who were taking antirejection medications similar to those used by the busdriver involved in this accident. However, insulin use is specifically prohibited by the FAA because of the unpredictability of the occurrence of a hypoglycemic event.

The toxicologist who performed blood tests for the Safety Board in this accident stated that immunosuppressive, diuretic, and antibiotic drugs are not psychoactive and that he did not consider them to be a threat to the busdriver's ability to perform his duties. However, he agreed that the use of insulin posed the most serious threat to the driver's performance.

The blood drawn from the busdriver while he was in the hospital revealed a glucose level (blood sugar) of 166 mg/dl which is considered higher than normal (110 mg/dl) by most diabetes experts. However, it was within the customary range (80-180 mg/dl) for the busdriver. Furthermore, his blood sugar logbook indicated that his blood sugar was in control for each of the last 3 days before the accident. Consequently, it is highly unlikely that the bus driver experienced an incapacitating hyperglycemic event in this accident.

Because the busdriver had received extensive emergency care before his blood was drawn, it is possible that the measured glucose level of 166 mg/dl was artificially elevated. His body's reaction to the accident trauma also may have elevated the glucose level. It is unlikely, however, that these two factors would have raised the glucose from a hypoglycemic level of below 60 mg/dl to the emergency room finding of 166 mg/dl.

Also, it is unlikely that the busdriver had experienced a hypoglycemic reaction from failure to eat breakfast. Such a failure would have resulted in a reaction within 1 to 2 hours after the insulin injection. Further, witnesses on the accident bus stated that the busdriver attempted to regain control of the bus before impact. This behavior is not consistent with a hypoglycemic episode. Consequently, although the potential existed, there is no evidence to suggest that the busdriver was impaired by a hypoglycemic event.

The Safety Board is concerned about the thoroughness of the busdriver's DOT physical examination. The examination failed to detect that the busdriver was suffering from end stage renal disease and that he was being treated for hypertension, diabetes, and a urinary tract infection even though the examining physician knew that the busdriver had undergone a kidney transplant operation. In addition, the examination also failed to detect that the busdriver was injecting insulin daily and taking medication for his other ailments.

Also, the Safety Board is concerned that the examining physician accepted the busdriver's note concerning his recovery from the kidney transplant operation and that he did not make any attempt to contact the busdriver's primary physician at the University of Maryland Hospital to further satisfy himself that the patient was medically fit to drive commercial vehicles. When commercial drivers make voluntary declarations about their medical histories, it is incumbent on the examining physician to ensure that any previous or existing medical problems do not adversely influence the performance of the driver. Examinations performed to meet the minimum medical requirements of the FMCSR should be expanded to be commensurate with the seriousness of the identified medical ailments.

Driver Qualifications

The Safety Board believes that the busdriver was alert at the time of the accident; however, he should not have been driving the bus. He was in violation of 49 CFR 39.14(b)(3) which prohibits the use of insulin by drivers engage in interstate commerce. As a motor carrier operating in interstate commerce, the BMCC is subject to the requirements of the FMCSR contained in 49 CFR. Title 49 CFR 391.41(b)(3) states that a person is physically qualified if he "has no established medical history or clinical diagnosis of diabetes mellitus currently requiring insulin for control." Consequently, the Safety Board concludes that the busdriver was not in compliance with all the requirements of Part 391 and, therefore, was not qualified to drive.

It appears that the BMCC management did not adequately evaluate the busdriver's qualifications during the hiring process. The BMCC was aware of the driver's long-term kidney ailment, his limited experience in driving commercial buses and his driving record

associated with his previous driving experience. Although the busdriver had passed his recent DOT physical examination, his long hiatus from work meant he had not driven commercial vehicles for quite a while. The BMCC should have performed more thorough checks to ensure that the busdriver was medically able to drive and that he was properly trained to handle a passenger bus under critical driving situations. Thus, it appears that the BMCC management did not exercise good judgment in hiring the accident busdriver.

Since 1980, the Safety Board has investigated five major highway accidents including this accident, 22/ in which commercial vehicle operators had falsified or omitted pertinent data on their medical certification forms or on their driver license applications during their preemployment evaluation process. Collectively, these accidents resulted in 56 fatalities and 102 injuries.

On February 24, 1983, near Willow Creek, California, a dump truck crossed the highway centerline and collided with a schoolbus. Two persons were killed and 30 persons were injured. The investigation disclosed that the truck driver had several medical problems, including loss of memory, dizziness, and loss of vision due to renal glycosuria (an abnormally large amount of sugar in the urine.) As result of that accident, the Safety Board urged the FHWA to:

> H-83-68
>
> Revise Federal Motor Carrier Safety Regulation 49 CFR 391.43 to incorporate a provision, similar to that specified in 14 CFR 65.20(a) for airmen medical certification, which will prohibit the falsification or omission of medical information in connection with a medical certification physical examination.

On May 24, 1985, the FHWA responded that an advance notice of proposed rulemaking (ANPRM) had been published in the Federal Register on January 23, 1985, prohibiting the falsification of information related to the medical certification of commercial drivers. As a result of this response, Safety Recommendation H-83-68 was classified as "Open--Acceptable Action" pending adoption by the FHWA of an acceptable final rule. The final NPRM, "Qualifications of Drivers," dated May 13, 1986, did not contain wording that would prohibit falsification of medical records. Based on this omission, the Safety Board has reclassified Safety Recommendation H-83-68 as "Closed--Unacceptable Action."

The busdriver's primary physician at the UMH was aware that his patient had previously worked as a bus and truck driver, but he was not aware that his patient, while employed in these occupations, was subject to certain State and Federal medical requirements. Generally, physicians want to help impaired persons participate fully in occupational activities and do not recommend depriving any impaired patient of the privilege to drive without good reason. Although Dr. Weir did not specifically address the issue of the driver returning to his position of operating commercial vehicles, it is possible that the driver could have misinterpreted this as an approval to return to any line of work.

22/ Highway Accident Reports--"Central Texas Bus Lines, Inc., Charter Bus, State Route 7, near Jasper, Arkansas, June 5, 1980" (NTSB-HAR-81-1); "Collision of Humboldt County Dump Truck and Klamath-Trinity Unified District Schoolbus, State Route 96, near Willow Creek, California, February 23, 1983" (NTSB/HAR-83/5); "Multiple Vehicle Collision and Fire, U.S. 13 near Snow Hill, North Carolina, May 31, 1985" (NTSB/HAR-86/02); and Intercity Bus Charter Bus Loss of Control and Rollover into River near Walker, California, May 30, 1986" (currently under investigation).

The Safety Board believes that physicians must be careful not to recommend the return of patients, whose medical impairments are such that they cannot function properly if they fail to take prescribed medication, to occupations such as driving commercial vehicles which could endanger themselves or others.

In a recent publication entitled "Medical Conditions Affecting Drivers," 23/ the American Medical Association (AMA) suggests that practicing physicians, who examine or provide care for drivers of commercial vehicles, should become familiar with those medical regulations applicable to these drivers. The AMA states:

> The physician should become familiar with the driver license classifications of the states where his or her patient resides, as well as with special regulations concerning individuals with certain conditions or undergoing certain treatments because the regulations may affect various aspects of patients' lives, including their occupations. Also, the physician's recommendations and actions should be consistent with those regulations.

The Safety Board believes that this is a worthy objective. However, according to the AMA, there is no plan for widespread distribution of this publication. Dissemination by the AMA of pertinent information on medical qualifications applicable to commercial vehicle drivers to practicing physicians within each State would help to achieve this objective.

The busdriver also failed to disclose three license suspensions on his employment application, and he failed to provide the facts and circumstances surrounding the license suspensions. A copy of the busdriver's Maryland driving record, which noted that the busdriver had received a previous license suspension, was on file with the BMCC. Although the BMCC was cited in the November 1985 BMCS audit for failing to check the busdriver's background and DMV records, at the time of the accident, the busdriver held a vaild license free and clear of any current suspension.

Results of Safety Board Survey, GMC Model PD-4106 Buses

The Safety Board has investigated four accidents (including this one) in which GMC Model PD-4106 buses have gone out of control on wet pavement. 24/ Although the four bus accidents do not represent the general population of bus accidents, the Board was concerned that these buses appear to have lost rear wheel traction while negotiating shallow curves at highway speeds on marginal to slippery wet surfaces. None of the busdrivers regained control after the initial loss of control. Two of the bus drivers had limited driving experience and operated their buses at speeds too great for the weather conditions.

The Safety Board attempted to obtain data to determine if the GMC Model PD-4106 buses were overrepresented in accidents involving a loss of control on wet pavement. However, we were unable to evaluate this issue because of insufficient data. Only limited accident data was available by VIN. Further, data on vehicle miles traveled, as well as the number of various bus models, were not available to provide a measure of exposure to accidents. Thus, insufficent data precluded the Safety Board from determining whether the GMC Model PD-4106 bus is involved at a greater than expected frequency in loss of control accidents on wet pavement.

23/ Doege, T.C. and Engelberg, A.C. Eds., "Medical Conditions Affecting Drivers," American Medical Association.
24/ Bethesda, Maryland (NTSB-HAR-76-6); Luling, Texas (NTSB-HAR-4); and Ackerly, Texas (NTSB/HAR-87/01/SUM).

Although no conclusions could be reached concerning the representation of GMC Model PD-4106 buses in bus accidents, the survey revealed an important deficiency in the accident reporting system of some States. Sixteen States and the District of Columbia do not collect VIN or enter the VIN data into their accident reporting systems, especially for commercial vehicle accidents.

Highway Safety Program Standards (HSPS) No. 10, Traffic Records, and No. 18, Accident Investigation and Reporting, recommend that the State accident record agencies notify State motor vehicle agencies of accidents to update motor vehicle history and driver record files. Minimum information suggested by HSPS No. 18 for a driver-reported motor vehicle accident includes vehicle make, model, year, body type, model name, and VIN for all vehicles.

The Highway Safety Act of 1966 established the framework for the present motor vehicle registration safety program. Two of the specific objectives of the program are to:

(1) Provide a system for cross-referencing and linking vehicle and ownership information for highway traffic safety studies to research highway accidents and injury causation investigations.

(2) Develop and maintain registration data bases to assist the vehicle inspection program and the manufacturer's recall campaigns for defective vehicles.

The Safety Board believes that each State should collect and enter VIN data in its accident reporting systems to enable accident studies to be performed by vehicle type. This will allow commercial and out-of-State vehicles to be included in accident data analyses and, in some cases, eliminate the costly cross-referencing to the vehicle registration file. Thus, the 16 States previously referenced and the District of Columbia should revise their existing motor vehicle accident reporting systems to include the VIN as a data element on their accident report forms and the computer data base.

In addition, the Safety Board believes that VIN data should be a required data element for all accidents in the NHTSA Fatal Accident Reporting System (FARS) file. The collection of VIN data is consistent with the objectives of HSPS Nos. 10 and 18.

Survival Aspects

The 17 occupants aboard the bus were evenly dispersed throughout the bus. Fourteen occupants were ejected during various stages of the accident sequence, either through the large opening in the front of the bus or through the side emergency exit windows.

The three passengers who were not ejected sustained only minor injuries in the accident and were seated in the second, fifth, and ninth rows on the left side of the bus. One passenger remained inside the bus because he was pinned in his seat, another passenger anticipated the collision and braced himself appropriately, and the third passenger's ejection path was blocked by a loose seat cushion.

Of the eight ejected passengers who survived the collision, three sustained minor injuries, four received moderate injuries, and one was seriously injured. Two of the eight passengers reported that they were ejected through the opening in the front of the bus; four other passengers reported that they were ejected through the right side windows; and the remaining two did not know their path of ejection.

The busdriver and two fatally injured passengers probably were ejected through the large opening in the front of the bus which developed when it initially struck the bridge and while the bus was facing the river bank where their bodies came to rest. The three remaining fatally injured passengers were seated near windows on the right side and probably were ejected through the windows during the overturn sequence. Most of the fatally injured passengers sustained their injuries from contact with fixed objects outside the bus.

There was no evidence of any blood, tissue, or hair on the frame around the windshield or opening in the front. Only four seats in the bus showed small deposits of blood. Thus, it is not likely that any of the occupants sustained anything greater than moderate injuries from contact with structures inside the bus.

Bus Crashworthiness

The bus sustained very little crush damage during the accident sequence. The front steering wheel and instrument panel were torn away during the impact with the bridge rail. All other bus body components rearward of the driver's seat were intact. The passenger compartment was not penetrated, and the passenger's survival space was maintained.

Seatbelts.--Occupants inside the bus were subjected to forward accelerations during the initial impact with the bridge rail and lateral and vertical accelerations during the overturn sequence. Except for the passengers in seat 2B, all other bus occupants were thrown from their seats at some point during the accident sequence. Had lap belts been installed and used by the bus occupants, it is unlikely that they would have been ejected from the bus during the initial frontal impact. However, it should be noted that the floor and seats in this bus would have to be substantially upgraded to retrofit it with lap belts.

Lap belts were designed primarily to prevent ejection of the occupants and keep them in place in rollover accidents. 25/ If lap belts had been used, the restrained passengers probably would have hit the unpadded seatbacks, sidewall and interior surfaces of the modesty panel during the initial impact with the bridge and during the lateral movement of the bus.

The installation and use of lap belts is not likely to have lessened the outcome of the six passengers who sustained minor injuries. They would have been subjected to contact with seatbacks and other sharp objects inside the bus which could easily produce similar injuries. The injury outcome for the five surviving bus passengers who sustained moderate to serious injuries is less predictable. Many of these passengers were seated near windows which opened on the right side, and they might have made violent contact with the window or the ground during the overturn sequence. Although their injuries could have been different, it is not known if their injuries would have been less severe had they worn a lap belt.

The five fatally injured passengers sustained fatal injuries from collisions with a fixed object outside the bus. Since the passenger compartment rearward of the driver's seat remained intact, it is believed that the fatally injured passengers would have had a better chance to survive the accident had they remained inside the bus during the accident sequence. However, due to the dynamics of this accident, it is difficult to

25/ Statistical Evaluation of the Effectiveness of Federal Motor Vehicle Safety Standard (FMVSS) 222: School Bus Seating and Crash Protection, Center for the Environment and Man, Inc., October 1980.

determine if lap belts would have reduced the overall severity of injuries sustained by these passengers in this accident. Furthermore, in a severe accident of this type, lap belt-induced severe or fatal injury cannot be eliminated as a possibility.

The accident bus was manufactured in 1963 and had been retrofitted with a lap belt for the driver. If the driver had been wearing his lap belt, he probably would not have been ejected. However, the driver was seated in the direct impact area and the survivable space was reduced significantly. The body structure in this area initially was pushed inward and then was pulled away during the accident sequence. Therefore, it is likely that the injuries received by the driver would have been severe, perhaps also fatal, if he had been restrained by his lap belt.

Windows.--The bus was slightly skewed during the initial impact with the bridge, causing the emergency exit windows to open. The permanently fixed windows (i.e., driver side window and rear windows) remained intact during the collision sequence. If the emergency exit windows had not been jarred opened, it is likely that the eight passengers who were ejected through these windows would have remained inside the bus and most would have been less seriously injured.

Bus No. 633 was built before the enactment of FMVSS No. 217, "Bus Window Retention and Release," which requires bus windows to retain a certain rigidity to prevent unwarranted opening. The standard also specifies requirements for the percentage of emergency exit space for and the location of those exits in buses. If the bus had been designed to comply with FMVSS No. 217, the windows would have withstood greater impact loading, and there may have been fewer emergency exit windows in the bus. Consequently, if the bus had been built to current standards, passenger injuries probably would have been reduced since more passengers would have remained inside the bus.

Emergency Response

The emergency response was executed in a timely, orderly, and efficient manner. Emergency response personnel arrived about 4 minutes after the accident and established a command center and triage onscene. All injured persons received prompt medical attention and were evacuated from the scene within 48 minutes of the arrival of the first rescue unit.

CONCLUSIONS

Findings

1. Although the potential existed, there was insufficient evidence to suggest that the busdriver was medically impaired at the time of the accident.

2. The accident sequence began with the application of the brakes at the time the bus began to move into the left lane, resulting in a loss of rear tire traction.

3. The busdriver initially lost control of the bus between 58 and 63 mph and struck the bridge between 48 and 53 mph. The initial loss of control occurred at a speed too great for the weather conditions.

4. The differential coefficient in pavement friction between the two westbound lanes contributed to the loss of control.

5. The State of Maryland failed to post signs to warn the busdriver of the known slippery road condition during wet pavement conditions

6. Hydroplaning did not occur.

7. The postaccident investigation did not reveal any mechanical discrepancies with the service brakes, tires, or steering system on the bus which were causal. However, the inspection did reveal that the speedometer on the accident bus had been inoperative for almost 2 months.

8. The BMCC continued to operate the accident bus with an inoperative speedometer in violation of Maryland Vehicle Law, Section 25-111.

9. The busdriver failed to disclose pertinent medical information to his employer and the examining physician who performed his medical certification.

10. Although the busdriver also failed to disclose to his employer information on his previous license supensions, since his driving record was on file, the employer should have been aware of some of these suspensions.

11. At the time of the accident, the busdriver had a valid license free and clear of any current suspension.

12. Based on the length of time he was out of work and the seriousness of his medical problems, the BMCC did not adequately evaluate the busdriver's qualifications at the time it rehired him.

13. Based on the medical requirements specified in Part 391 of the FMCSR, the busdriver was not qualified to operate an interstate commerce vehicle because it was necessary for him to use insulin.

14. The physical examination for the busdriver's DOT medical certification was insufficient to detect the fact that the busdriver was taking insulin to control an elevated blood sugar level.

15. Because of insufficient data and the inability to determine vehicle exposure, no conclusions could be made concerning the vehicle stability of the GMC Model PD-4106 bus.

16. Several States currently do not collect and/or enter the VIN data in their motor vehicle accident files.

17. The five fatally injured passengers who sustained injuries from fixed object collisions after being ejected from the bus would have had a better chance to survive the accident had they remained inside the bus.

18. Lap belts probably would not have lessened the injury outcome for the passengers who sustained minor injuries.

19. If the busdriver had been wearing his lap belt, he probably would not have been ejected. However, it is not likely that his injuries would have been less severe had he used the available lap belt due to his location in the bus.

20. If the emergency exit windows had not opened, most of the eight passengers who sustained moderate to fatal injuries would have remained inside the bus and may have received lesser injuries.

21. The emergency response was executed in a timely, orderly, and efficient manner.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the loss of control of the bus during a braking maneuver on wet highway pavement with low and variant frictional qualities and at a speed too great for the existing weather conditions. Contributing to the accident were the lack of an operative speedometer and the lack of highway signs to warn the busdriver of the slippery road conditions.

RECOMMENDATIONS

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

--to the States of California, Hawaii, Idaho, Indiana, Kentucky, Massachusetts, Minnessota, Mississippi, New York, North Dakota, Ohio, Oregon, Pennsylvania, Tennessee, Virginia, and Wyoming, and the District of Columbia:

> Revise the existing motor vehicle accident reporting system to include the vehicle identification number as a data element on the accident report forms and in the computerized accident data base. (Class II, Priority Action) (H-87-6)

--to the National Highway Traffic Safety Administration:

> Require that vehicle identification number data be collected and reported for all accidents in the Fatal Accident Reporting System data files. (Class II, Priority, Action) (H-87-7)

--to the American Medical Association (AMA):

> Urge local chapters in each State and the District of Columbia to disseminate information on State and Federal medical qualifications for commercial vehicle drivers to practicing physicians who examine or provide care for commercial vehicle operators. (Class II, Priority Action) (H-87-8)

> Encourage practicing physicians to use Federal and State medical quaification information when counseling patients on their medical fitness to drive. (Class II, Priority Action) (H-87-9)

Also, the Safety Board reiterates Safety Recommendation H-82-34 to the Federal Highway Administration:

> Conduct and publish a comprehensive review of each State's skid accident reduction program to identify problem areas, to develop corrective recommendations where necessary, and to disseminate more widely innovative local practices of proven value and general applicability.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

January 22, 1987

APPENDIXES

APPENDIX A
INVESTIGATION

Investigation

The National Transportation Safety Board was notified of the accident at 3 p.m. on August 25, 1985, by the Maryland State Police. Highway Accident Investigators were dispatched from the Safety Board's Headquarters Office in Washington, D.C. The first investigator arrived onscene about 4:30 p.m. Participating in the investigation were representatives of the Maryland State Police, the Maryland Department of Transportation, the Baltimore Motor Coach Company, the Federal Highway Administration, and the General Motors Corporation.

Deposition

There were no depositions taken, and no public hearing was held in conjunction with the investigation.

APPENDIX B

BUSDRIVER LICENSE AND VIOLATION RECORD FROM THE DEPARTMENT OF TRANSPORTATION

09-04-56	Speeding
09-04-56	Reckless driving
09-04-56	Fail to stop for emergency vehicle
09-26-56	Hearing - 60 day suspension
09-26-56	Hearing - 1 year probation
12-04-56	Suspension withdrawn
07-22-58	Speeding
09-11-58	Improper passing
10-14-58	Speeding
12-10-58	Hearing - 2 years probation
09-22-59	Automatic signal
03-02-60	Speeding
04-18-60	Hearing - Reprimand
07-14-60	Speeding - Suspended sentence
10-08-62	Automatic signal
01-23-63	Exceeding speed limit by 10 m.p.h.
07-27-62	No registration card in possession
07-27-62	Speeding
05-07-64	Hearing - suspended 15 days
05-07-64	Signed statement - no license in possession
05-22-64	Suspension withdrawn
07-17-64	Exceeding speed limit by 10 m.p.h.
09-23-64	Suspension - 30 days
10-09-64	License received at MVA.
11-08-64	Suspension withdrawn
05-28-65	Speeding
09-08-65	Hearing - 1 year probation
04-16-68	Failing to obey traffic device
06-24-69	Speeding - Suspended sentence
12-29-72	Automatic signal
03-22-74	Exceeding speed limit by 10 m.p.h.
05-08-74	Point system - Warning letter mailed
06-10-75	Automatic signal
08-01-75	Failing to obey traffic device
08-07-75	Point system - Warning letter mailed
12-11-75	Speeding
10-20-78	Improper tags

APPENDIX C

PHYSICAL EXAMINATION FOR BUSDRIVER

Name: GEORGE W. BROWN
Address: 903 PENNSYLVANIA AVE 21204
Social Security No. 214-10-0204 Date of Birth: 3-31-17 Age: 68

☐ New Certification ☐ Recertification

HEALTH HISTORY

Yes	No		Yes	No	
☐	✓	Head or spinal injuries.	☐	✓	Nervous stomach
☐	✓	Seizures, fits, convulsions, or fainting.	☐	✓	Rheumatic fever.
☐	✓	Extensive confinement by illness or injury.	☐	✓	Asthma.
☐	✓	Cardiovascular disease.	☐	✓	Kidney disease.
☐	✓	Tuberculosis.	☐	✓	Muscular disease.
☐	✓	Syphilis.	☐	✓	Suffering from any other disease.
☐	✓	Gonorrhea.	☐	✓	Permanent defect from illness, disease or injury.
☐	✓	Diabetes.	☐	✓	Psychiatric disorder.
☐	✓	Gastrointestinal ulcer.	☐	✓	Any other nervous disorder.

If answer to any of the above is yes, explain: (1) Kidney transplant Sept 1982

PHYSICAL EXAMINATION

General appearance and development: Good: ____ Fair: ____ Poor: ____

Vision: For distance: Right 20/ 20 Left 20/ 20 without corrective lenses ☐ With corrective lenses if worn

Evidence of disease of injury: Right: None Left: None Color Test: Normal

Horizontal field of vision: Right 90° Left 90°

Hearing: Right ear 30/30 Left ear 30/30 Disease or injury None

Audiometric Test (complete only if audiometer is used to test hearing) decibel loss at 500 Hz ____, at 1,000 Hz ____, at 2,000 Hz ____

Throat: Normal

Thorax: Heart Normal If organic disease is present, is it fully compensated? ____

Blood pressure: Systolic 150 Diastolic 90

Pulse: Before exercise Normal Immediately after exercise 90 / Normal Lungs ____

Abdomen: Scars Operative Abnormal masses No Tenderness ____

Hernia: Yes ____ No ✓ If so, where? ____ Is truss worn? ____

Gastrointestinal: Ulceration or other disease: Yes ____ No ✓

Genito-Urinary: Scars ____ Urethral discharge None

Reflexes: Romberg Negative Pupillary Normal Light R Normal L ____

Accommodation Right Normal Left Normal

Knee Jerks: Right: Normal ✓ Increased ____ Absent ____

Left: Normal ✓ Increased ____ Absent ____

Remarks: Frequent urination

Extremities: Upper Deformities Lower Normal Spine Normal

Laboratory and other Special Findings: Urine: Spec. Gr. 1016 Alb. Negative Sugar Negative

Other laboratory data (serology, etc) ____

Radiological data ____ Electrocardiograph ____

General comments No this Bus Dr. Dr. Wise

6-18-85 1501 Ridgely St 21230 Pedro S. DeBoria MD
(Date of examination) (Address of examining doctor) (Name of examining doctor)(Print)

(Signature of examining doctor)

NOTE: This section to be completed only when visual test is conducted by a licensed optometrist.

(Date of examination) (Address of optometrist) (Name of optometrist)(Print)

(Signature of optometrist)

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined GEORGE BROWN in accordance with the Federal Motor Carrier Safety Regulations
(Driver's name)(Print)
(49 CFR 391.41-391.49) and with knowledge of his duties, I find him qualified under the regulations.

☐ Qualified only when wearing corrective lenses.
☐ Qualified only when wearing a hearing aid.

A completed examination form for this person is on file in my office at 1501 Ridgely St. 21230
(Address)

6-19-85 PEDRO S. DE BORIA, MD
(Date of examination) (Name of examining doctor)(Print) (Signature of examining doctor)

903 Penna. Ave. 21204
(Address of driver) (Signature of driver)

Form No. 88

APPENDIX D

ACCIDENT DATA FOR WESTBOUND I-70 FROM 1982 THROUGH 1984

	Fatal Accidents	Injury Accidents	Property Damage Accidents	Total Accidents
1982	0	0	3	3
1983	0	5	5	10
1984	1	2	3	6
Totals	1	7	11	19

APPENDIX E

SURVEY OF STATE VEHICLE REGISTRATION AND ACCIDENT FILES FOR GMC-4106 BUSES

STATE	Responded	Could define registration of PD 4106	Collect vehicle identification number on accident report	Could define accidents with PD 4106	Number of registered PD4106	Number of accidents PD4106 1982 - 1985	Accidents involving PD4106 on wet slippery, snowy or icy roads	Provided bus accident data but could not determine PD4106 involvement	Accident data not available by VIN
Alabama			X						
Alaska	X		X						2/
Arizona	X	X	X		7	0			
Arkansas	X	X	X	X	0				
California									
Colorado	X	X	X		0				X
Connecticut			X						
Delaware	X		X						
District of Columbia									
Florida			X						
Georgia	X		X						
Hawaii	X								
Idaho	X	X			38				X
Illinois	X	X	X		50 3/				
Indiana									
Iowa	X		X						
Kansas	X	X	X	X	1	1	1	X	X
Kentucky	X								X
Louisiana	X	X	X		4				
Maine	X	X	X		11				
Maryland	X	X	X	X	41	15	3		
Massachusetts									
Michigan	X	X	X		56			X	
Minnesota									
Mississippi									
Missouri	X		X						
Montana			X						
Nebraska	X	X	X	X	0	0			
Nevada			X						
New Hampshire	X	X	X		13				X
New Jersey			X						
New Mexico	X	X	X	X	12				
New York	X	X		X	107	31	9		
North Carolina	X	X	X	X	84	4			
North Dakota	X	X			0				
Ohio	X							X	X
Oklahoma			X						
Oregon	X	X			65				
Pennsylvania	X	X			79				2/
Rhode Island			X						
South Carolina			X						
South Dakota	X		X	X		2			
Tennessee									
Texas	X		X						X
Utah	X	2/	X						
Vermont			X						
Virginia	X	X			75				
Washington			X						
West Virginia	X		X						X
Wisconsin			X						
Wyoming	X			X		6	2		
TOTAL	32	19	34	9	549	59	15		

1/ Based on 1985 NHTSA Survey

2/ Future Capability

3/ Includes PD 4107

APPENDIX F

ACCIDENTS WHICH INVOLVED GMC MODEL PD-4106 BUSES ON WET, SNOWY, OR SLIPPERY SURFACES

1. March 6, 1982
   Garrett County, Maryland
   The rear of a GMC Model PD-4106 bus that was slowing struck the side of a parked jeep. The road was straight and level, it was raining, and there was ice on the road. No one was injured.

2. March 7, 1982
   Marshall, New York
   During snow, the right front fender of a GMC Model PD-4106 bus struck the left front fender of a passenger car while the bus was overtaking the passenger car on a level curve. The bus then collided with a guard rail. No one was injured.

3. March 17, 1982
   Albany, New York
   During rain, a GMC Model PD-4106 bus struck a curb as it was coming off the interstate onto a curved ramp on a grade. The front under carriage of the bus was broken. The bus driver experienced chest pains and was taken to the hospital.

4. April 14, 1982
   Batavia, New York
   During snow a GMC Model PD-4106 bus was following three other automobiles on a straight, level road. The bus apparently struck one or two of the vehicles as they slowed and changed lanes. Two car occupants were injured.

5. August 18, 1982
   Campbell, Wyoming
   During sleet and hail, on a wet pavement on a straight downgrade a GMC 4106 bus tried to stop on wet pavement on a straight downgrade, but slid into the rear of an automobile. One person in the automobile obtained a nonincapacitating injury and was treated and released.

6. January 5, 1983
   Queens, New York
   During rain, a GMC Model PD-4106 bus and a passenger vehicle collided with each other. Three occupants in the automobile were injured.

7. January 24, 1983
   Campbell, Wyoming
   During fog, three vehicles were stopped behind a school bus when a GMC PD-4106 bus approached from the rear and was unable to stop on a icy road that was straight and level. The bus pushed the three stopped vehicles into each other. No one was injured.

8. January 25, 1983
Kansas
A GMC Model PD-4106 bus was passing a truck and was returning to his lane when an oncoming vehicle braked on a snowy surface and slid into the bus or truck striking the bus or truck near the left rear. The bus was still in the car's lane at impact. Two people in the car received nonincapacitating injuries.

9. February 7, 1983
Lockport, New York
At an intersection controlled by a traffic signal during snow, a southbound Suburban struck an eastbound sedan and a northbound GMC Model PD-4106 bus on slippery pavement.

10. February 14, 1983
Kings County, New York
On a slippery pavement, a police vehicle struck a GMC Model PD-4106 bus that was stopped in traffic. Two occupants in the police vehicle were injured.

11. February 18, 1983
Amsterdam, New York
On a slippery pavement at an intersection controlled by a traffic signal, a pickup truck struck a GMC Model PD-4106 bus stopped in traffic. There were no injuries.

12. April 2, 1983
Baltimore County, Maryland
A slow-moving GMC Model PD-4106 bus ran into the rear of a vehicle, pushing it into two other vehicles which were waiting for the first car to make a left turn. The roadway was straight, level, and wet with a 40-mph speed limit. It was raining at the time. Two people in the slowing passenger vehicles were injured.

13. April 16, 1983
Bronx County, New York
During rain on an interstate segment that was curved and level, a car struck a median barrier and then a GMC Model PD-4106. No one was injured.

14. September 30, 1983
Baltimore, Maryland
On a wet pavement during rain, a GMC Model PD-4106 bus struck a light support pole and then a guard rail. The road was level and curved, and the speed limit was 50 mph. The driver was injured.

15. August 16, 1985
Monroe, New York
A parked GMC Model PD-4106 bus was struck by one or two automobiles on wet pavement. The driver of the second vehicle was injured.

☆U.S. GOVERNMENT PRINTING OFFICE:1987-181-131:40188