

NATIONAL TRANSPORTATION SAFETY BOARD

FOR RELEASE:  
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# HIGHWAY ACCIDENT REPORT

CHARTERED BUS CRASH

ON

U.S. ROUTE 22 (INTERSTATE 78), NEAR

NEW SMITHVILLE, PENNSYLVANIA

JULY 15, 1970



NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C. 20591

REPORT NUMBER: NTSB-HAR-71-8

SS-H-10

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E R R A T A

Please substitute the following corrections in the subject report;

Page 51, Figure D, the caption should read:

Looking west along the eastbound median . . . .

November 22, 1971

**REPORT NUMBER: NTSB-HAR-71-8**

TECHNICAL REPORT STANDARD TITLE PAGE

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15. Supplementary Notes					
16. Abstract  About 1:55 p.m., July 15, 1970, a chartered tour bus carrying 53 school age children and their counselors on a sight-seeing trip into Pennsylvania was westbound on U.S. 22 (I-78) during a rainstorm. While traveling about 55 miles per hour on a slight curve to the right, the bus traversed a section of highway where excessive water flow was crossing the highway, producing "hydroplaning" and loss of control. The bus skidded clockwise 180° and into the cable-type guardrail, which failed to hold the bus, permitting it to roll (or vault) down a steep embankment with a 30-foot drop. In the crash, 18 occupants were ejected, resulting in death to seven students and varying injuries to some 47 other occupants.  The National Transportation Safety Board determines that the probable cause of this accident was either dynamic or viscous hydroplaning of the front wheels of the bus which initiated a skid from which the driver could not recover. Contributing factors included low basic skid resistance of the pavement in wet weather, and the probable presence of water draining across the pavement in an abnormal manner. The fatalities and injuries were caused by an ineffective highway guardrail which failed to prevent the bus from rolling down an embankment, by bus windows which failed to prevent ejection of some passengers, and in some cases, by the absence of occupant restraints.					
17. Key Words New Smithville, Pennsylvania, Chartered bus crash, Hydroplaning, Median drainage maintenance, Highway "skid numbers," Tedesco Bus Company, Highway water runoff, "woodruff key," Cable-type guardrail.				18. Distribution Statement Released to Public Unlimited Distribution	
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## FOREWORD

This accident was designated a "major accident," as defined in the regulations of the National Transportation Safety Board, on July 21, 1970. A public hearing was held in Allentown, Pennsylvania, November 3 to 6, 1970. Parties to the investigation were the Federal Highway Administration, the National Highway Traffic Safety Administration (then the National Highway Safety Bureau), the State of New Jersey (Division of Motor Vehicle and Public Utilities Commission), the State of Pennsylvania (Department of Transportation and State Police), and General Motors Corporation.

This report is based on facts obtained from official reports of the Pennsylvania State Police, the Pennsylvania Department of Public Health, the Pennsylvania Department of Transportation, the Bureau of Motor Carrier Safety of the Federal Highway Administration, the National Highway Traffic Safety Administration, the public hearing transcripts, on reports of the General Motors tests and examinations by the National Bureau of Standards, on Board observation of a test conducted by the Stevens Institute of Hoboken, N. J., and the Board's independent investigations. Determinations as to probable cause, and the conclusions and recommendations herein, are those of the Board.

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WASHINGTON, D. C. 20591  
HIGHWAY ACCIDENT REPORT

Adopted: September 8, 1971

CHARTERED BUS CRASH  
ON  
U.S. ROUTE 22 (INTERSTATE 78), NEAR  
NEW SMITHVILLE, PENNSYLVANIA  
JULY 15, 1970

### I. SYNOPSIS

About 1:55 p.m., July 15, 1970, a chartered tour bus carrying a group of young people, aged 10 to 17, and counselors on a sightseeing trip was westbound on U.S. 22 (Interstate 78, four lanes, limited access) about 12 miles west of Allentown, Pennsylvania, at a speed of (about) 55 miles per hour. A light rain was falling and had been preceded by a heavy shower.

While it was on a 2° curve to the right, just east of the Berks-Lehigh County line, the bus started to slide on the wet highway, then rotated 180° clockwise through the guardrail and off the northern embankment. It overturned at the bottom of the embankment, ejecting 18 persons and pinning six of them under the left side of the bus. Seven children were fatally injured. No fire ensued.

The highway at the accident site when wet was found to have a skid number lower than the minimum recommended by Federal Highway Administration, and improper drainage resulting from inadequate maintenance of the median. It had a significantly high accident record involving skidding and loss of vehicle control. After the crash, a dramatic reduction in accidents resulted from the surface grooving, grading and paving of the median and shoulders, and replacement of the cable-type guardrail with a W-beam type.

The two left-rear tires of the bus were smooth; all others had adequate tread. Steering-system damage, found after the crash, could not be positively established as being pre-crash, in-crash, or post-crash induced.

The driver, a 45-year-old male, had a poor health history and a substantial record of traffic violations and accidents, but no specific health factor or driving error was involved in this crash.

The National Transportation Safety Board determines that the probable cause of this accident was either dynamic or viscous hydroplaning of the front wheels of the bus which initiated a skid from which the driver could not recover. Contributing factors included low basic skid resistance of the pavement in wet weather, and the probable presence of water draining across the pavement in an abnormal manner. The fatalities and injuries were caused by an ineffective highway guardrail which failed to prevent the bus from rolling down an embankment, by bus windows which failed to prevent ejection of some passengers, and in some cases, by the absence of occupant restraints.

### II. FACTS

#### 1. History of the Trip

The tour group consisted of students and staff of the Hillel Country Day School, at

Lawrence (L.I.), New York. The tour, planned as a 2-day sightseeing and educational trip through the Pennsylvania Dutch country, was scheduled to leave Lawrence at 10 a.m., July 15, 1970.

When he was en route to Lawrence, after picking up the broker, the busdriver made a wrong turn. As the bus was negotiating a narrow street to get back on course, the right rear tire struck and damaged a fire hydrant, and the tire. While the tire was being changed at a nearby garage, the mechanic noted that tire air pressure was not uniform, and he said he would even them all at 100 pounds per square inch. Meanwhile the busdriver made a visual inspection of the bus and looked at all tires. The damaged tire, unrepaired, was mounted as the spare. This incident made the bus some 20 minutes later than scheduled.

All charter arrangements and trip details had been handled through a broker who accompanied the group, which consisted of 52 school children (aged 10 to 17) and six counselors and supervisors. These 58 persons crowded into 53 seats. The broker sat on a stool next to the driver, who made no comments about the apparent overload.

En route there was intermittent rain, heavy at times. Rest and refreshment stops were made. At Easton, Pennsylvania, while it was westbound on U.S. 22, some 30 miles east of the accident site, the bus skidded on the wet highway, but the driver regained control. He commented that it was a "dangerous, slippery highway," and that he was going to slow down and "take no chances." Passengers said he appeared unfamiliar with the bus and the route.

The bus skidded again, precipitating the fatal crash, just before 2 p.m., about 12 miles west of Allentown.

## 2. Kinematics of the Bus

The busdriver has made no detailed statement as to kinematics of the bus before or

during the crash.<sup>1</sup> He said only that while going "about 40" (based on an estimate, as the speedometer was inoperative), the bus hit a "slick spot," after which the rear slid to the right, then to the left, and then he just "lost it." A driver of a following car clocked the bus speed at 55 m.p.h., based on his own known speed. A passenger on the bus said the front of the bus skidded to the left; that he heard gravel thrown about and the driver then steered hand-over-hand to the right. Gravel was later found on the roadway, just west of the paved median crossover point. The bus front swung to the right and headed for the north guardrail, at which time the driver turned hard to the left. The bus front, this witness said, hit the north guardrail, after which he remembered only a rolling sensation before losing consciousness. Another passenger recalled the driver steering hard to the left, but said that the driver had waited too long to do any good in correcting the spin.

Once it crossed the north shoulder, the path of the bus (or how it arrived at its final position) could not be determined from witnesses. Passengers were being bounced about, and the bus was temporarily out of sight of other highway traffic. The bus was found at the bottom of the 50-foot embankment (vertical drop about 31 feet), lying on its left side, facing east, the left side of the roof resting against some small trees, and its underside facing the embankment. See Figure 1 for final position of the bus. (Reconstruction of the bus kinematics is discussed in Part III - Analysis.)

## 3. The Highway

### a. Geometrics

This accident occurred on the westbound lanes of U.S. 22 (Interstate 78), approximately

<sup>1</sup>Detailed questioning was precluded because felony charges against the driver (and others) had not been finally adjudicated prior to publishing of this report. This is discussed in detail later in the report.

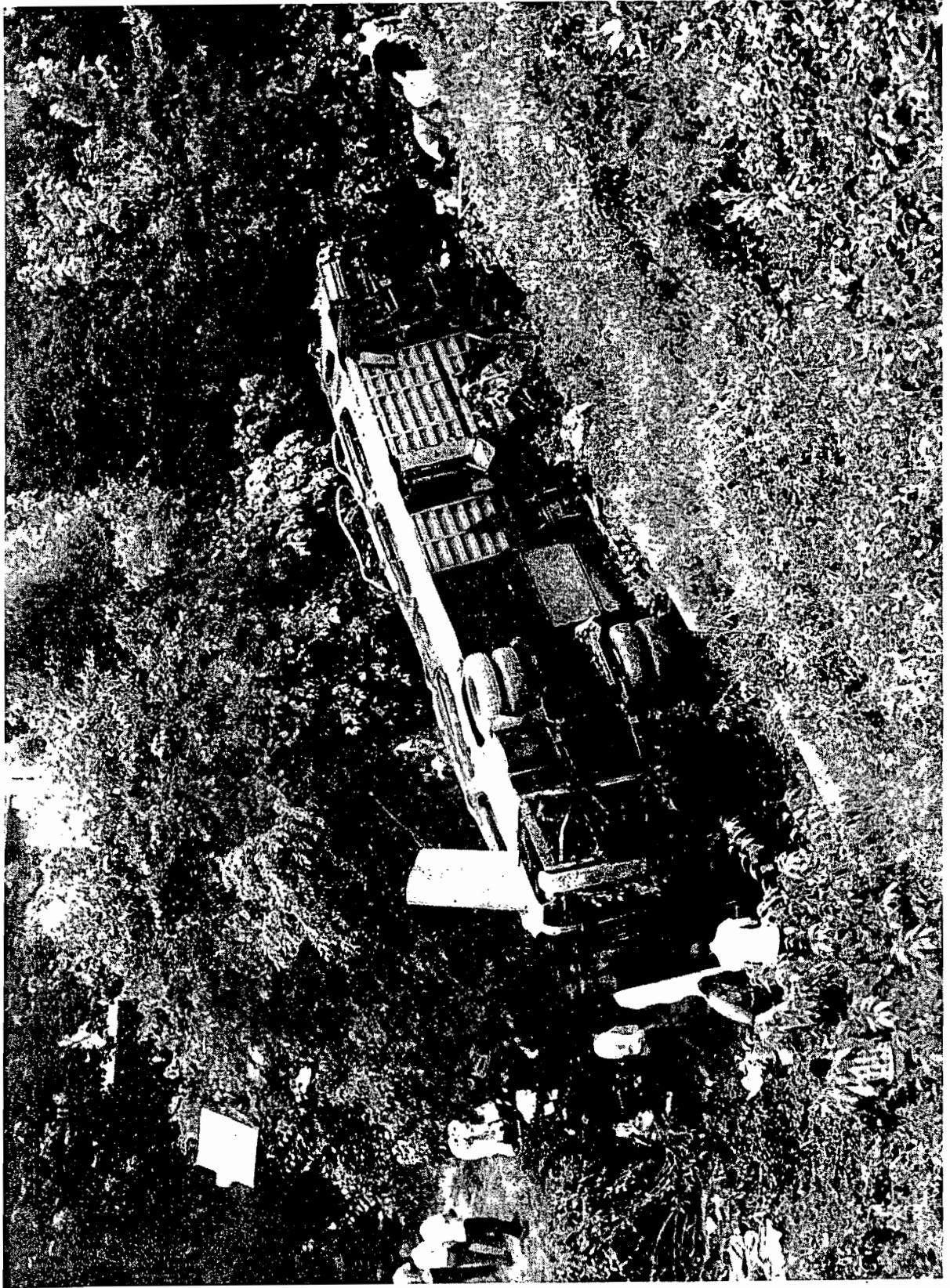


Figure 1: Final position of bus at bottom of embankment, off U.S. 22.

155 feet east of the Berks-Lehigh County Line.<sup>2</sup> The road has a 2° curve to the left followed by a compound curve to the right, beginning with a 2°30' curve, changing to a 2°11' curve and reaching a tangent 283 feet east of the county line. The highway dimensions are detailed in Appendix H.

#### b. Water Drainage

At a point 700 feet east of the county line, the outside (south) edge of the eastbound lanes was 1.6 feet higher than the outside (north) edge of the westbound lanes, because of super-elevation of the curve.

On July 22, 1970, after the accident and before improvements had been effected on the highway, water-flow tests were conducted at the site. Photographs were taken of the tests and of conditions along the median strip and at the paved median crossover point (see Appendix D and Figure 2).

The water runoff flow pattern, obtained by releasing some 150 gallons of water, headed slightly west of north in its general flow. It was observed that any water which may have been on the eastbound lanes, for a distance of several hundred feet to the east of the paved median crossover, would have flowed westward along the south edge of the median without entering the drains, then funneled across the paved median crossover. The flow would then have fanned out in crossing the westbound lanes, with the spread of the fan depending on the amount of water present. A heavy rainfall could cause a "fan out" of some 100 to 150 feet as it crossed the westbound lanes, where the side-sliding of the bus is believed to have started. This is supported by the testimony of a witness who lives adjacent to the accident site, who testified that when it rained, the water had a tendency to "puddle" in the westbound lanes and was "thrown up" by cars as they went by.

<sup>2</sup>The Berks-Lehigh County line is used as the zero reference point from which all distances east are measured.

It was found that:

- 1) Water released onto the south edge of the eastbound lanes, opposite the paved median crossover area, flowed north and slightly west across the eastbound lanes, thence northward across the paved median area, and onto the westbound lanes, without flowing into the drains in the median (Figure A, Appendix D).
- 2) The water then crossed the westbound lanes, continuing to flow slightly west of north, and across the westbound (north) shoulder into some deeply eroded washes in the north embankment (Figure B, Figure C, Appendix D).
- 3) There was noticeable erosion of the median area, 2 to 3 feet in from the eastbound pavement, extending for several hundred feet east of the paved median crossover. This eroded strip had the appearance of a dry wash or streambed (Figure E, Appendix D).
- 4) Water released along the eastbound lanes, for several hundred feet east of the crossover point, would have been unable to reach the drains in the median area because of accumulated road-material debris and matted vegetation which would have blocked the flow and caused it to flow along the median paralleling the eastbound pavement edge (Figure D, Appendix D). Debris and matted vegetation had also accumulated to form dams around the edges of the drains.
- 5) Considerable quantities of loose gravel (or crushed stone, 1/4- to 1/2-inch diameter), which littered the paved median crossover, had the appearance of eroded paving material which could have washed from the median east of the paved crossover point (Figure B, Appendix D).

On July 27, 1970, the Penn-DOT maintenance department conducted tests at the accident location to check the functioning of the water drains located in the median area. Water was discharged directly into the drains located in the median, 17 feet east and 260 feet west of the crossover; the drains were found to be open. However, tests were not conducted to determine the course flow of water poured onto the eastbound lanes. Soil erosion on the north embankment of U.S. 22 opposite the opening in the median strip was noted at the time the drains were checked.

### c. Skid Resistance of U.S. 22 at the Accident Locale

#### 1) Skid-Resistance Criteria

Penn-DOT, from July 1969, had a written policy establishing a prescribed course of action on skid-resistance criteria for State-maintained highways. When the skid number of the wet surface was below 30, the various Transportation Districts were required to take corrective action immediately. Work to improve surface traction was to be supported out of emergency funds, if necessary. When the skid number was between 30 and 40, corrective action was to be scheduled and undertaken as funds were available. When the skid number was between 40 and 50, the project area was scheduled for future consideration for surface grooving or pavement resurfacing, as appropriate.

The Federal Highway Administration (FHWA), in a 1968 Instructional Memorandum,<sup>3</sup> outlined recommended skid-test criteria and methods by which the States could apply for Federal aid or Federal fund participation in pavement-improvements projects.

In that memorandum, the FHWA distinguished between skid resistances above and

<sup>3</sup>Bureau of Public Roads (FHWA) Instructional Memorandum 21-3-69, 32-01, "Construction of Pavement Surfacing to Provide Safer Coefficient of Skid Resistance."

below the skid number of 35 (wet, @ 40 m.p.h.). Below a value of 35, the highway was generally classed as lacking in safety quality, and corrective action was called for. When the value was 35 or above, and accident experience was suspected to be related to the slipperiness of the highway, other design characteristics (alignment, grades, cross section, and super-elevation) of the highway were to be evaluated to determine whether improvements in design or in the skid-resistance quality of the highway would be the more beneficial. FHWA did not prescribe any specific corrective action for either alternative, as the maintenance of Federal-aid highways is a matter left to the States.

#### 2) Prior Skid Tests and Penn-DOT Response

In October 1968, following a request from District 5-0 relating to a need for pavement improvements in the area (where the bus accident later occurred), Penn-DOT conducted skid tests. Skid numbers found at that time averaged out to 35. No highway improvements were made, but District 5-0 did post "Slippery When Wet" signs, on their own initiative, on approaches to the high-accident-frequency area.

#### 3) Additional Report Relating to Highway Surface Condition

A short time (20 to 30 minutes) after the bus accident, a truckdriver going west on U.S. 22 came upon the scene and stopped his vehicle to lend assistance. He explained that, just before he reached the series of curves at the bus accident site, his tractor-semitrailer unit had started sliding around as if on ice. He commented on the slippery condition of U.S. 22 from Easton, Pennsylvania, to the accident site as compared to less slippery highway surface conditions west of the accident site (to Harrisburg, Pennsylvania).

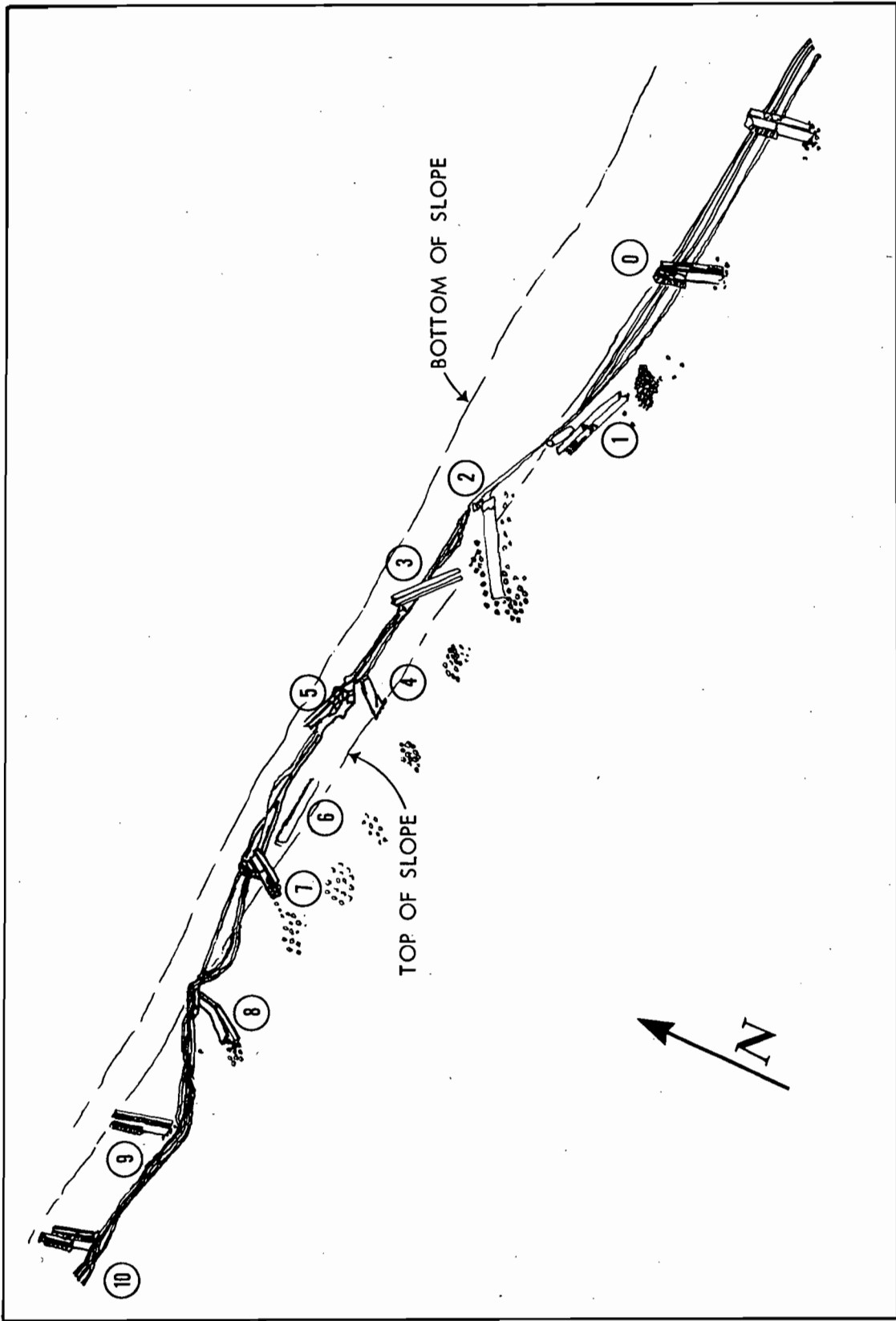
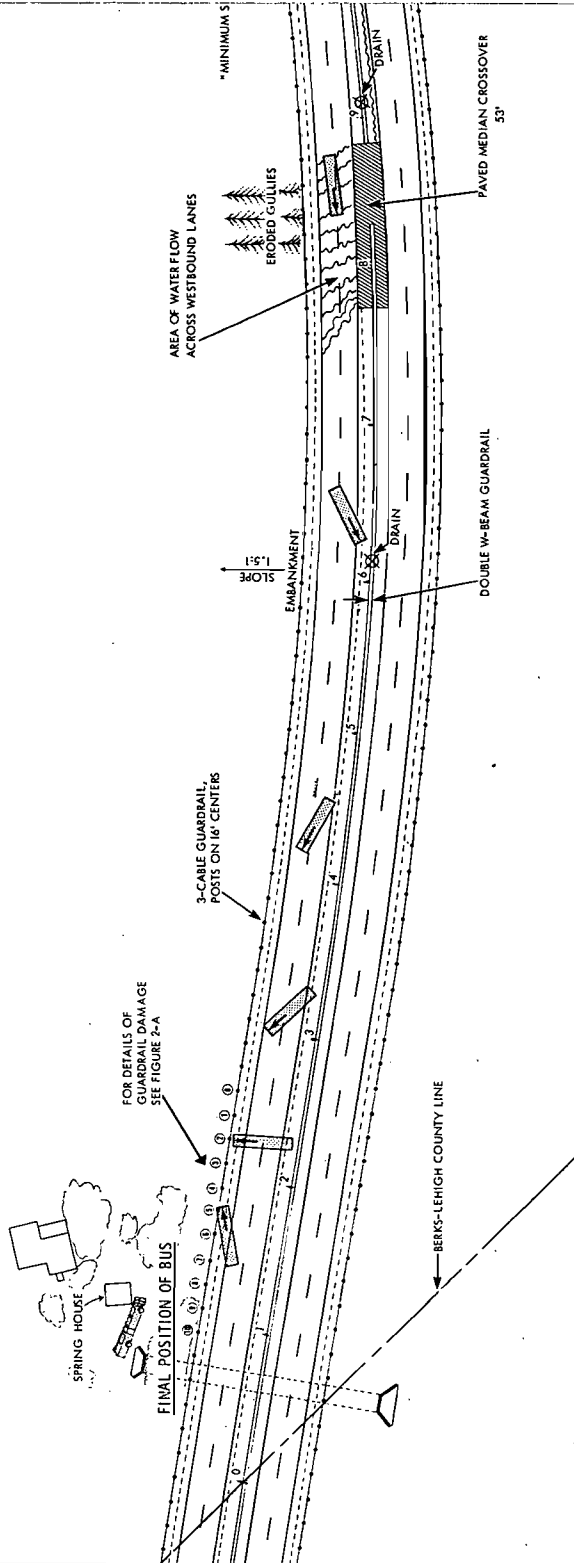


Figure 2-A Approximate position of guardrail posts after impact.



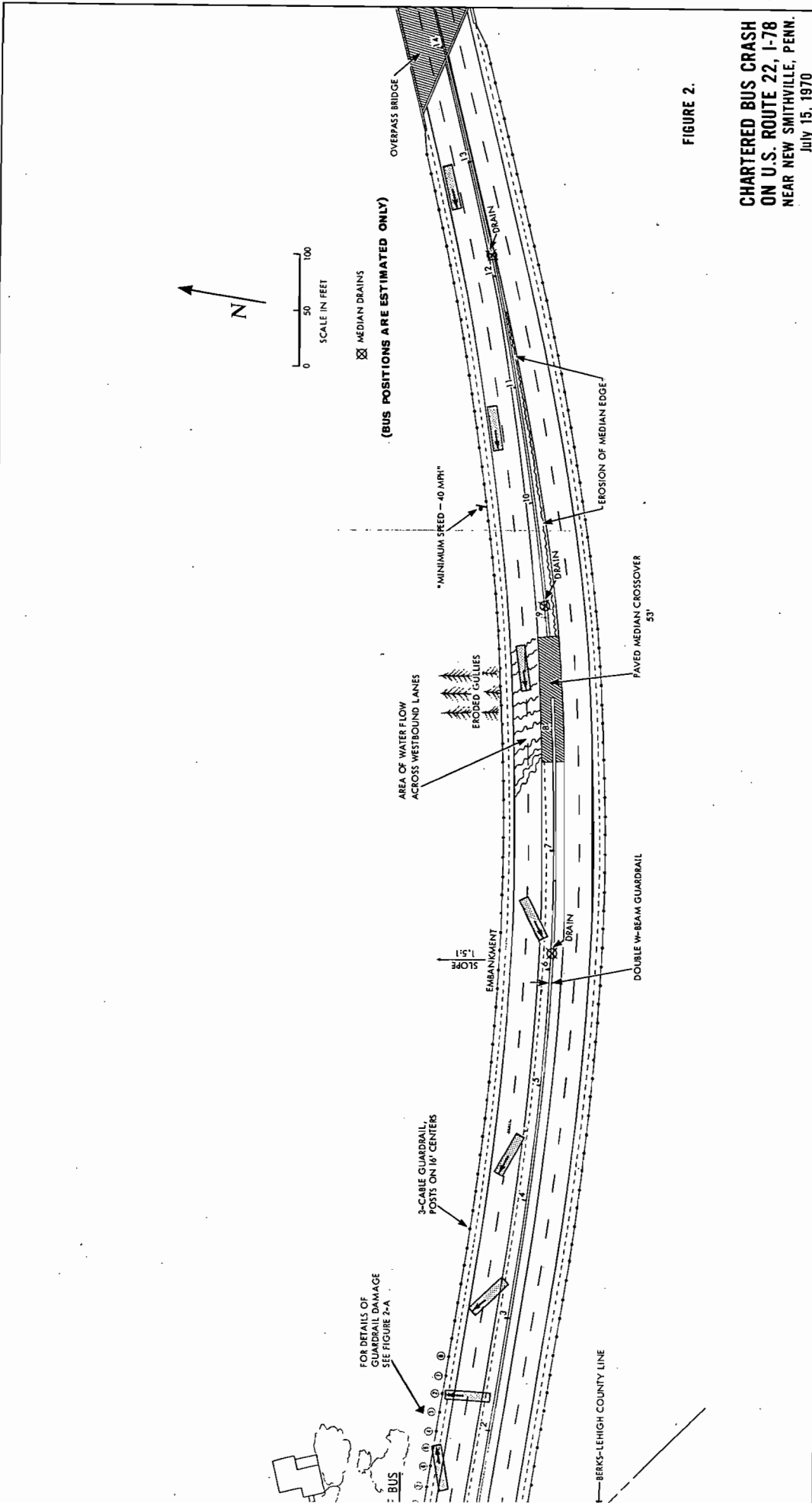


FIGURE 2.

CHARTERED BUS CRASH  
ON U.S. ROUTE 22, I-78  
NEAR NEW SMITHVILLE, PENN.  
July 15, 1970



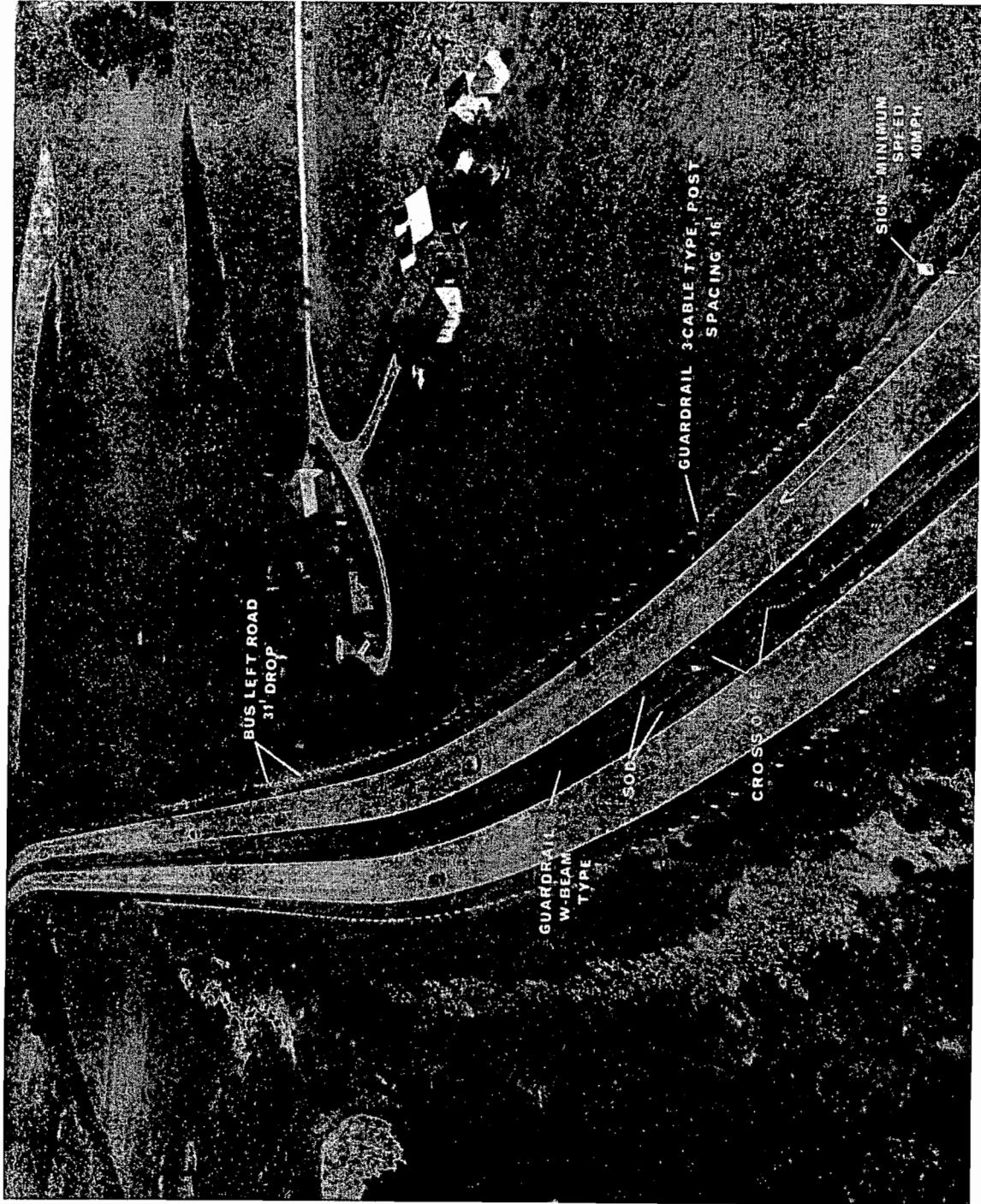


Figure 3: Accident site, westbound lanes of U.S. 22, looking west.

4) Skid Resistance of the Highway after July 15, 1970

On July 20, 1970, skid tests were conducted by Penn-DOT in the area of the bus accident, between points 2,845 feet east and 690 feet west of the accident. Tests were made at five sites at 40 m.p.h., on both the travel and passing lanes, for each direction of travel. The skid numbers obtained, corrected to a common comparison base of 70° F., were as follows:

	<i>Range</i>
Westbound travel lane	40-46
Westbound passing lane	42-52
Eastbound travel lane	36-45
Eastbound passing lane	40-55

On August 5, 6, 7, 1970, FHWA conducted skid tests in the accident area at five locations westbound and one eastbound (see Appendix A). The two test sites east of, and the one approximately at the accident site, selected as the most pertinent, are summarized below:

		<i>TEST SITE</i>			
<i>Westbound Lane</i>	<i>Test Speed</i>	<i>D</i>	<i>E</i>	<i>F</i>	
Travel	40	38	36	33	
Travel	50	33	31	29	
Travel	60	29	26	24	
Passing	40	38	28	40	

- D - Overpass, 1,245 feet east of accident location
- E - 720 feet east of accident location (at the paved median crossover)
- F - 5 feet west of accident location

Additional skid tests were conducted on July 22, 1970, and on August 5, 6, and 7, 1970, at the same time as the FHWA tests. The data from these tests are included in Appendix A.

d. Guardrail

1) Design

The median guardrail was constructed of double-faced steel W-beams, attached to steel posts spaced on 6-foot 3-inch centers. There was no evidence that the bus struck this guardrail. The shoulder guardrail (State standard type 1-B) consisted of three steel cables of 3/4-inch diameter attached to steel posts spaced 16 feet apart. The posts were driven into the ground (fill area) to a depth of 3 feet 6 inches and extended above the ground 27 inches. The distance between the median guardrail and the north shoulder guardrail was 43 feet.

2) Guardrail Damage prior to July 15, 1970

The last reported accident causing guardrail damage occurred on July 3, 1970, approximately 45 feet east of the point where the bus left the highway. The maintenance department completed the repairs on July 9, 1970.

Witness testimony at the hearing revealed that an unreported accident had occurred between July 9 and July 15, 1970, resulting in the uprooting of two guardrail posts and the bending of a third, adjacent to the point where the bus crashed through. These posts had not been replaced prior to the July 15, 1971, bus accident.

3) Guardrail Damage caused by the July 15, 1970 accident

When the bus left the highway, it went through the shoulder guardrail and uprooted eight steel guardrail posts. None of the cables broke.

e. Traffic Controls

The westbound lanes of the highway were separated by broken, white lines, 16 feet long, with 24-foot spacings. A 4-inch-wide solid, white, edge line was painted on the outer edges of the pavement. The median barrier was

posted every 90 feet with clearance markers painted black with white hash lines.

Pertinent traffic control signs, and their distances east of the point where the chartered bus left the highway, are as follows:

- |  |       |
|--|-------|
| 1) "Speed Limit 60 m.p.h., Trucks 55 m.p.h."   | 5,349 |
| 2) "Slippery When Wet" (posted 8/11/68)  | 3,300 |
| 3) "Bridge Freezes Before Roadway Surface"   | 1,990 |
| 4) Black arrow on yellow background pointing to the right indicating a right-hand turn | 1,860 |
| 5) "Minimum speed 40 m.p.h."   | 860   |

The sign maintenance department, staffed by nine men including a foreman, conducted no regular patrols to inspect the condition of the signs.

#### f. Highway Damage Control

The highway maintenance department, District 5-0 (a crew of four men plus a foreman), was responsible for maintaining approximately 55 miles of State highway. The maintenance foreman received reports of guardrail and highway damage from his supervisor, State Police accident reports or highway patrols, calls from private citizens who had observed the damage, or from maintenance department patrols. The frequency of maintenance patrols depended upon the existing workload.

#### g. Traffic Volume

The Average Daily Traffic (ADT) volumes on U.S. 22 for the years 1966-1970, for both directions of travel were as follows:

Year	<i>Vehicles ADT</i>
1966	11,120
1967	11,565
1968	12,160
1969	12,646
1970	13,152

#### h. Accident Experience

##### 1) Accident Statistics

Penn-DOT and State Police statistics, summarizing the accident experience on U.S. 22 from the Lehigh County line to a point 1,200 feet east, for both directions of travel, 1966 through July 19, 1970, are shown in Appendix E.

Although the official records indicate a total of 59 accidents in this period, information from interviews of residents and witness testimony at the public hearing indicates a higher figure because, in many minor property-damage accidents, the individuals involved left the scene without reporting the accidents. No reliable estimate of this added number could be obtained.

##### 2) Recent Accident Experience in the Accident Area.

A tractor-semitrailer driver testified that he was involved in an accident in this area on July 3, 1970. This experienced driver (30-plus years) was traveling west on U.S. 22 and was approaching the compound curve to the right. It was raining, and his windshield wipers were on high speed. He said his unit went out of control for no explainable reason, crashed through the

guardrail, and went down the embankment at approximately the same location as the bus. The driver said he had never before experienced this type of control loss and sliding.

On July 20, 1970, a woman accompanied by three children was driving west on U.S. 22 in a thunderstorm. For no apparent reason, she lost control of her car. Its rear end skidded to the left at the median crossover point, at what was believed to be the same place where the chartered bus began to slide. It then spun 180° and crossed the north shoulder. It crashed through the temporary barricades (set up July 15), and came to rest with its front end facing down the embankment and its rear wheels held by the already loosened guardrail cables.

On June 13, 1969, while going about 50 miles per hour in a heavy rainstorm, a westbound driver suddenly felt his car slipping at (he found later to be) the same place where the chartered bus started to slide. He had good tires all around, and had not touched his brakes or taken any other action which could have started the sliding. The front of his car suddenly slid to the left; then, as he steered to try to correct the slide, his car drifted to the right, knocked down six guardrail posts and rolled over, down the embankment. He said that a truckdriver following him almost lost control in trying to avoid his skidding car.

### 3) Accident Analysis by Penn-DOT

In Penn-DOT accident-records processing, computer sheets were compiled by the central office to consolidate accident reports from the State Police, local police, or other official sources. The Accident Review Section then analyzed the data according to groupings, or "cluster areas" (20 or more accidents in any 1,000 feet of highway in a 3-year period). When a cluster area had occurred, or appeared to be developing rapidly, a "Phase I" report was prepared, scrutinizing high-accident locations

(cluster areas) for some design fault of the highway, traffic controls, highway maintenance, or other highway factor. From such analyses, corrective measures were then to be initiated.

#### i. Highway Improvements

In their request of October 1968, Penn-DOT District 5-0 had observed a high frequency of accidents in the area where the bus accident later occurred, and asked for remedial action on U.S. 22 from the Berks-Lehigh County line to a point 1,200 feet east. In addition to improvements to the road surface, they asked for replacement of the cable-type guardrail with W-beam type, paving the shoulder and extending it to 10 feet (from 8 feet), and paving the median area. Available funds were needed on projects of higher priority elsewhere, however, so the requested work was not done.

On July 22, 1970, the Safety Board sent a letter to the Governor of Pennsylvania recommending that, pending permanent improvements to the highway, immediate temporary steps be taken to: (1) reduce the speed limit under adverse weather conditions, (2) increase the surface coefficient of the roadway, (3) improve the guardrail, and (4) post warning signs well in advance of the high-accident-frequency location (see Appendix F).

By August 10, 1970, the following improvements of a permanent nature were completed in the accident area:

- 1) Grooving of 1,150 feet of highway in the westbound lanes and 1,320 feet in the eastbound lanes (grooves were 1/8 inch deep, 1/8 inch wide, 3/4-inch centers);
- 2) Replacement of 3,000 feet of cable guardrail with W-beam type;
- 3) Paving of 2,000 feet of shoulder on both sides of the highway, and re-grading and paving the median area.

It is significant that following these highway improvements, no further accidents had occurred in the immediate area, to date.

#### j. Traffic Controls Improvement

The only change in traffic controls made as a result of the accident was the installation of a yellow blinking light on the "Slippery When Wet" sign, to call further attention of drivers to this condition pending completion of repairs. No data were obtained to measure any possible effect of this change. The blinking light was left in place after the highway improvements were completed.

### 4. Environment

#### a. Topography

Topography of the area was hilly. The highway where the accident occurred was relatively flat, in a valley between two hills. Sight distances appeared to be ample, and the route presented no appearance of hazard. Patches of forest were scattered among numerous farms that dominate the area.

#### b. Weather

Testimony from bus occupants, from eyewitnesses to the accident, from a nearby resident, and from accident investigators at the scene indicated that a light drizzling rain was falling at the time of the accident, and the roadway was wet. Shortly before the crash, a heavy downpour had occurred.<sup>4</sup>

#### c. Air Pollution — Possible Effects on Skid Resistance

An incinerator, located approximately 5,600 feet southeast of the accident site, off U.S. 22,

<sup>4</sup> Allentown-Bethlehem-Easton Airport, about 15 miles east of the accident site, reported rain in the early afternoon, but no weather or rainfall readings were available for any point in the New Smithville vicinity.

had been for several years reclaiming copper wire by burning off the plastic coating (polyvinyl chloride, a plasticizer and a polyethylene compound). If incinerator smoke blew across the highway when rain fell through the smoke, hydrochloric acid (HCl) theoretically could precipitate onto the highway. The Safety Board raised the question of whether the reaction of hydrochloric acid with the concrete could cause the highway to be slippery. The Pennsylvania Department of Health and Penn-DOT conducted tests to answer this question, taking ambient air samples for hydrochloric acid on August 25, 1970, in the immediate area of the incinerator. Due to variable wind conditions, the sampling was only 75 to 90 percent efficient, but, in combination with several assumed operational and environmental conditions, it was estimated (Pasquill-Gifford equation) that the accident site would receive a maximum of about 1.4 parts hydrochloric acid per million parts (p.p.m.) of air. This estimate was based on the assumed worst condition—maximum stack emission and minimum dispersion. However, the *probable maximum* that could reasonably be expected was estimated to be 0.4 p.p.m.

The Bureau of Materials, Testing and Research, Penn-DOT, conducted simulated skid tests on core samples of concrete, using levels of hydrochloric acid (HCl) of 1 and of 10 p.p.m. This latter figure represented a HCl concentration approximately seven times the theoretical maximum that could be experienced in the accident area, and some 25 times the probable maximum.

The concrete core samples were of two kinds: new pavement as constructed and polished core samples with a surface that was considered smoother than would ever be found on the highway. These samples presumably represented the best and worst conditions that could exist.

Skid test values, obtained with a British Portable Tester, both before treatment with the HCl concentrations and after, indicated that the small concentrations (1 p.p.m. and 10 p.p.m.) of HCl employed had no significant effects on the skid resistance of the pavement. In previous tests the Bureau of Materials, Testing and Research had found that skid resistance increased with increasing concentrations of HCl. Experts explained that the higher concentrations of HCl tended to expose the siliceous particles in the concrete resulting in increased resistance of the surface.

## 5. The Driver

The busdriver was a male, aged 45, married, and a resident of the State of New Jersey. His driving credentials, Federal and State, included a current New Jersey license, special busdriver license, and a Bureau of Motor Carrier Safety (BMCS) doctor's certificate dated February 7, 1969. Both of his New Jersey licenses were conditional on the wearing of glasses while operating a motor vehicle. The BMCS doctor's certificate listed no limitations or waivers noted. The driver's New Jersey traffic record, November 1961 through April 1970, revealed a history of nine accidents, six traffic law violations convictions, and five actual, and one proposed, license suspensions. Three of his accidents occurred during periods of license suspensions.

He had busdriving experience through employment with four individual passenger motor carriers over a period of 16 months, for a total of less than 5 months' actual driving employment. Reasons for the termination of employment included suspected poor health. He suffered from hypertension, and experienced an intracerebral hemorrhage with secondary hypertension while he was driving a bus on a charter trip in August 1969. On the July 15, 1970, accident trip the driver was sober, not suffering from any physical discomfort, and his driving of the bus was ac-

ceptable. He was not familiar with the bus or the route. His crash injuries were moderate and he required hospitalization.

Several days after the crash, the driver (along with the bus owner and garage supervisor) was charged by Pennsylvania authorities with seven counts of involuntary manslaughter, and the New Jersey Division of Motor Vehicles revoked his driving privileges in that State. Because of criminal charges pending against the driver, the bus owner, and the superintendent of the bus garage, the Safety Board was prevented from conducting interviews of these individuals with regard to the personnel, operations, and maintenance records of the bus company. Criminal charges against all three defendants were dismissed in court on April 19, 1971, but the State of Pennsylvania appealed.<sup>5</sup> The driver's traffic record, licensing history, medical condition, and pertinent background facts are chronologically set forth in Appendix G.

## 6. The Bus Company

All vehicles operating in interstate commerce are subject to the economic regulations of the Interstate Commerce Commission, and to the Motor Carrier Safety Regulations of the Federal Highway Administration, Bureau of Motor Carrier Safety.

The Tedesco Bus Company, registered owner of bus No. 2075, a New Jersey passenger motor carrier, did not hold operating authority from the Interstate Commerce Commission. The MC number (106207) lettered on the bus was issued to another company with the same principal owners as this company under ICC Certificate of Public Convenience and Necessity dated May 27, 1969. This certificate defined and limited the service and the termini

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<sup>5</sup>To the date of release of this report, the Superior Court had not acted on the State's appeal.

from which the carrier was authorized to operate:

“Passengers and their baggage, in special operations, in roundtrip sightseeing or pleasure tours, beginning and ending at Keansburg, Hazlet, and Middletown, New Jersey, and extending to points in the United States, including Alaska, but excluding Hawaii.”

This tour began in Lawrence, New York, and was scheduled to end in that city, not an authorized terminus or service point for the carrier.

Bureau of Motor Carrier Safety personnel conducted a post-crash inspection of the bus company's maintenance and personnel records and served the owner with a copy of Motor Carrier Safety (MCS) Regulations. There was no record of any prior inspection or copy of MCS Regulations having been served.

## 7. The Broker

Neither the Broker nor the bus operator was licensed by the Interstate Commerce Commission. See Appendix I.

## 8. The Vehicle

### a. Specifications and Features

The bus was a 1967 General Motors coach model No. SDM 5302, serial No. 1013, of a type generally used in suburban transit operations, with a seating capacity of 53 persons (plus driver).

This model bus had the same general configuration and body dimensions as the regular GM transit-type buses, but differed in that the seats were raised above the line of the fender and the aisle floor was at a lower level. Individual-type seats were semi-reclining and fully upholstered. An overhead parcel rack was

provided. The bus had only one door, at the right front; emergency exit was provided for through the pushout window design, which met existing MCS requirements.

The engine was rear mounted. The air-conditioning unit was mounted in the bus top at the extreme rear.

Additional details are in Appendices B and C.

### b. Tires

Both front (steering) tires were 11.50 by 22.5 heavy-duty Firestone, with tread depths ranging from 10/32 to 12/32 inch. These were rented tires. All four rear tires were 11.00 by 20 Michelin X (type XZZ-PR-12), tube type, their tread depths and inflation pressures after the accident were as follows:

Right side: both tires, 8/32 to 13/32 inch tread. Pressure, cold, was 80 pounds per square inch (p.s.i.), outside tire, and 77 p.s.i. inside tire;

Left side: outside tire smooth except for traces of tread configuration in outer edges, 2/32 inch maximum, 104 p.s.i., cold; inside tire smooth except for one visible tread pattern trace at the outer edge, 82 p.s.i., cold.

### c. Pre-crash Inspections and Maintenance

The Tedesco Bus Company had four maintenance personnel in its Bayonne, New Jersey, facility. Maintenance records were kept, but the latest entry found by BMCS for the accident bus was dated 1969. Maintenance personnel stated that buses were inspected prior to being dispatched, but no records kept; and that tread depth of tires was measured only when they appeared to be worn near the point of rejection (under 2/32 inch). Minor vehicle damage repair was normally done at the Bayonne shop; major repairs were sent to the



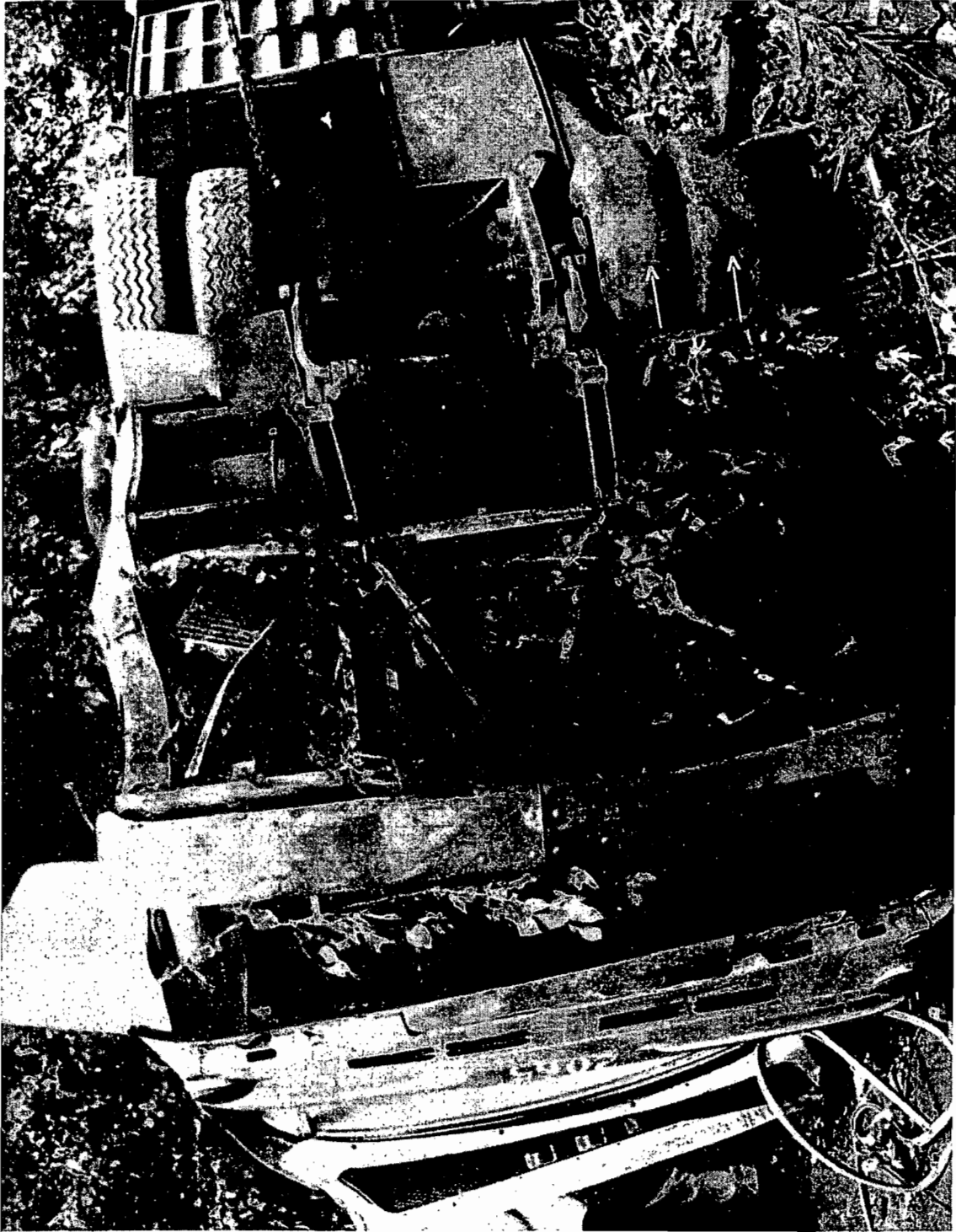


Figure 4: Post-crash view of rear underside of bus, showing condition of tread on rear tires. Arrows indicate left rear tires.



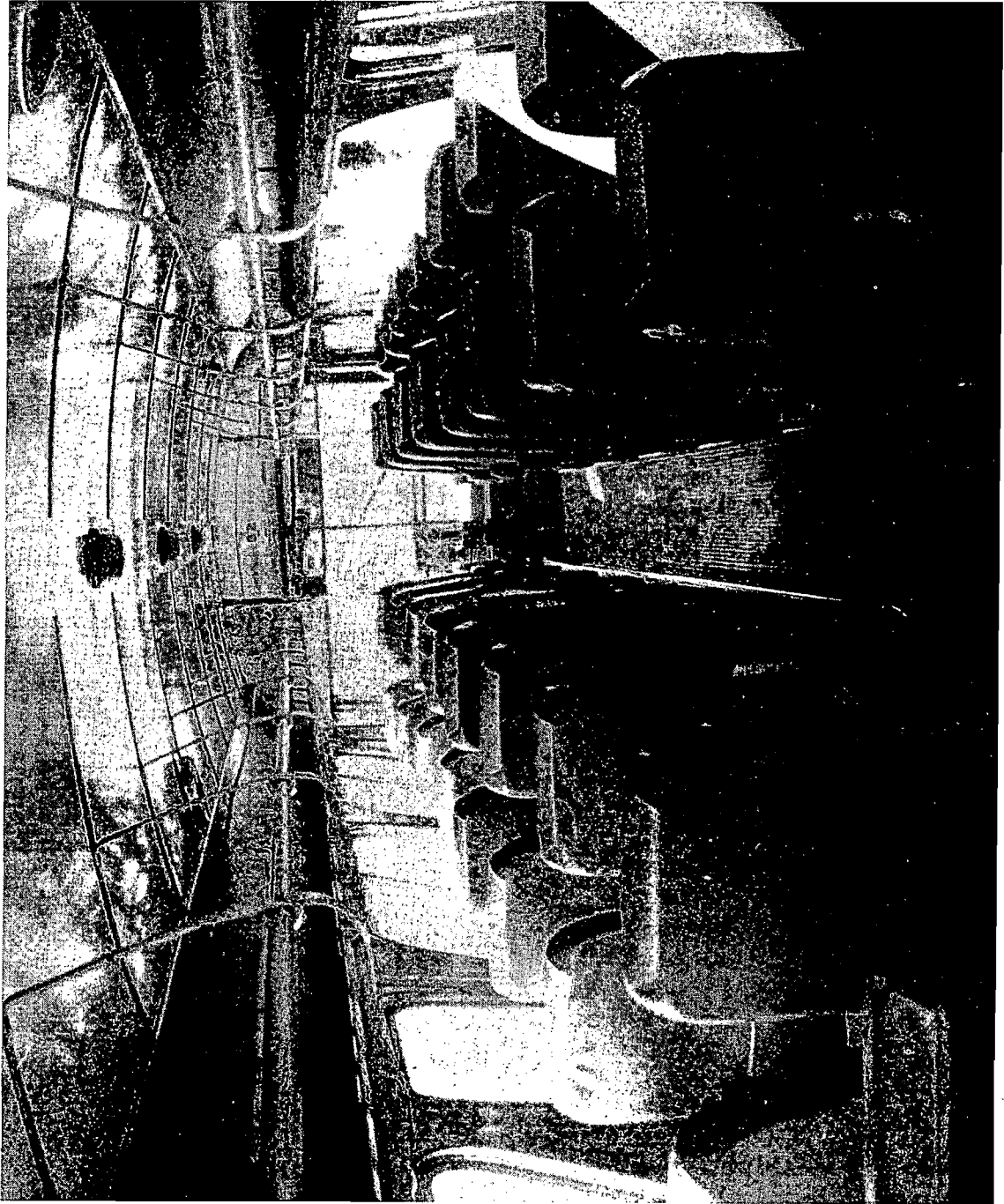


Figure 5: Interior of bus of same type as accident bus, looking forward.

New York-Keansburg Bus Line garage in Leonardo, New Jersey.

The New Jersey Public Utilities Commission (NJPUc) normally inspected buses each 6 months. The last NJPUc inspection was May 12, 1970. "Hubodometer"<sup>6</sup> reading of the accident bus was then 87,825 miles. At the time of the crash, it read 102,111, showing some 14,300 miles of travel in about 2 months. The May 12 inspection noted the following deficiencies:

- Right-side headlamp bulb not functioning;
- Rear cluster lamp bulb out;
- Three switches for inside reading lamps inoperable; and
- Number 4 right-side window glass needed repair.

Other than the defects noted above, the NJPUc inspection report showed no discrepancies. It made no mention of the non-functioning speedometer or tachograph, or of looseness in the steering wheel.

#### d. Other Pre-crash Damage or Conditions

Examination of the bus (after the accident) showed that the bus had been damaged in one (or more) front-end accidents prior to the July 15 crash. This was apparent at the lower front body panels, where sheet metal had been replaced or repaired, and nonproduction-type rivets and techniques were used to accomplish the repairs. This damage involved the front bumper and bumper brackets, the right front wheel-well area, the entrance doorstep well, and possibly some steering components. There was no indication that repairs had not been properly made.

The Board later learned that a prior accident had occurred on February 15, 1970, on State Route 22 near Amenia, New York, and that no

<sup>6</sup>"Hubodometer" is a built-in mileage recorder in the rear-wheel hub.

mechanical or steering-component damage was involved.

The speedometer, incorporated as a part of the tachograph unit, was inoperative and the drive cable was broken. A witness said that the speedometer was not operating before the accident, and that on a trip in April 1970, in this same bus, the driver (on that trip) had told him that the speedometer had been broken for "quite some time previous. . . ." This condition apparently existed before the NJPUc inspection.

It was apparent that a front brake-line protection valve lever (as required by MCSR 393.44 front brake lines, protection) had been broken off some time prior to the July 15, 1970, accident. There was a parabolic crack in the left windshield, which was also noted by a bus occupant before the crash. Because the NJPUc inspection made no reference to these items, their date of occurrence cannot be established.

#### e. Vehicle Weight Distribution

Weight distribution of the bus at the time of the accident was estimated to be: 9,145 pounds on the front axle and 21,875 pounds on the rear axle, a total estimated weight of 31,020 pounds. This estimate assumed an average weight of 115 pounds per passenger and 35 pounds of baggage each. The fuel tank held 91 gallons of diesel fuel at the time of the accident.

The center of gravity was estimated to be 283 inches from the front bumper and about 45.7 inches above the ground, at the time of the accident.

#### 9. Post-Crash Activities at Scene

##### a. First Aid and Rescue

Significant assistance in first-aid and rescue was provided by truckdrivers, nearby residents, and other citizens, much of it before the arrival

of official and volunteer units. It was continued until rescue had been completed.

The Pennsylvania State Police at Fogelsville (4 1/2 miles east of the accident site) received notice of the accident about 2:10 p.m. from an off-duty trooper at the scene, and requested assistance from Bethlehem and Hamburg State Police units, as well as from numerous emergency units. A total of 23 State Police officers participated at the scene. The Allentown city police also responded with a police ambulance, emergency patrol car, and a rescue truck.

Seven separate volunteer rescue companies responded with a total of 11 ambulances and three rescue trucks.

Of the 60 occupants, seven were fatally injured, 47 sustained varying degrees of injury, and six were reportedly not injured. At least 18 are known to have been ejected, six of whom were fatally injured. The seventh is believed to have incurred injuries within the bus, but the victim made his exit before he died.

Most of the victims were on their way to hospitals or aid stations within 30 minutes, but of six trapped under the bus, four were not released for some 60 minutes. The location of the trapped victims prevented determination of the extent of their injuries. The bus could not be righted for fear of further injury to some. Efforts to jack up one edge of the overturned bus failed initially because the bus side skin or skirt structure would not support the concentrated jack loadings. Eventually, with hydraulic jacks and wrecker cables, the bus was partly raised so that some victims could be removed, then raised further to remove the remainder.

Pending extrication and transferral to hospitals, victims were given such first aid as the situation permitted. Occupants were taken to one of three Allentown hospitals—Sacred Heart, Allentown Osteopathic, and Allentown (city) hospital. Here again, concerned citizenry volunteered housing, meals, and personal assistance to those not requiring hospitalization and

to the families of the students as they came to Allentown.

#### **b. Bus Retrieval**

Following removal of trapped victims, two wreckers with cables righted the bus. An attempt was then made to turn the front wheels to the right, to head the bus up the embankment. It was found that the steering wheel had been jammed by the deflected left "A" pillar. An attempt to saw through the steering-wheel spoke failed, so a crowbar was used to pry the "A" pillar away from the steering wheel rim. This effort bent the steering wheel rim. Two men then forcibly turned the steering wheel by hand, to point the front wheels to the right, which required great effort because the front wheels were in soil and loose shale. The steering wheel was then lashed to a vertical stanchion.

A "V" chain, linking the front of the bus to the wrecker winch cable, had been attached to the front axle of the bus instead of its frame-mounted towing hooks. Two wreckers then pulled the bus up the embankment and onto the highway, where one of the wreckers took it in tow (front wheels raised) to Fullerton-Atlantic Service Station at Fullerton, Pennsylvania. The bus was later towed to the Allentown, Pennsylvania (Penn-DOT), garage, where it was lifted with a wrecker preparatory to complete inspection.

### **10. Accident Damage to Bus**

#### **a. Body Damage**

##### **1) Left Side**

Just forward of the front wheel, the outer skirting was torn, with cable imprint striations in the torn skin and on the forward edge of the front wheel well. The aluminum skirting was torn and penetrated midway along the bus side in several areas.

The structural members of the engine compartment (rear of the bus) sustained severe deformation in a forward and upward direction.

The glass was missing from all windows except the triangular one just aft of the driver's seat; it was cracked. Some side-window frames were missing. Those remaining were still attached at the hinges, but were badly distorted in an outward position (see Figures 1 and 6).

The top left rear corner, in the area of the air-conditioner fan, was deformed downward.

## 2) Roof

The left front roof area was distorted 1 foot to the right (see Figure 7). The entire left side of the roof was distorted downward and to the right to such an extent that in places the overhead parcel racks on the left side were in contact with the tops of seat backs (see Figure 8).

About midway back, the center of the roof was pushed downward and to the right to the extent that center-located lamp fixtures were directly over, and in contact with, the right side aisle seat backs—a lateral distortion of about 2 feet and downward distortion of at least 3 feet. There was a lateral break in the roof panel at this point, with separation of sheet metal extending almost across the roof.

The rear of the roof, from side to side, had been crushed downward and deflected slightly to the left. Dirt was embedded in crevices and in the right rear clearance light.

## 3) Right Side

There was no evidence of direct impact damage. Window fixtures and frames were out. There was outward distortion along the side, varying from about 1 foot at the top front to little or no distortion at the rear. This distortion appeared to have been transmitted

through the roof structure from inward distortion on the left side.

## 4) Interior and Windows

All side windows had opened; both right and left windshields had been ejected and broken; and the three rear windows had been ejected. The windshield frame was distorted to the right at the top.

The ceiling panels of melamine were deflected downward to the right, paralleling the roof distortion. Several panels had broken loose and split in areas of extreme roof deflection, particularly in the front, middle, and rear areas, and where occupant impacts had occurred during the accident sequence. The broken edges of this paneling were sharp and jagged.

The left side overhead parcel rack, of aluminum tubing, was severely distorted in the direction of the roof deflection. The tubes were bent and had separated at the joints, leaving exposed ends.

Overhead lamps had broken, and their glass lenses left sharp and pointed edges.

None of the seats broke loose in the accident sequence, but some had been removed or loosened afterward to permit rescue of trapped occupants. The seat back of the long rear seat came off its mounting and was partly ejected through the right rear window.

## b. Mechanical Damage

Inspections of the bus following the accident were made under the direction of the National Transportation Safety Board by NHTSA personnel, by FHWA (BMCS) personnel, by Penn-DOT, and by representatives of General Motors. The pre-crash mechanical condition of the bus, including the evidence (reported above) of prior front-end damage, was determined during these inspections.

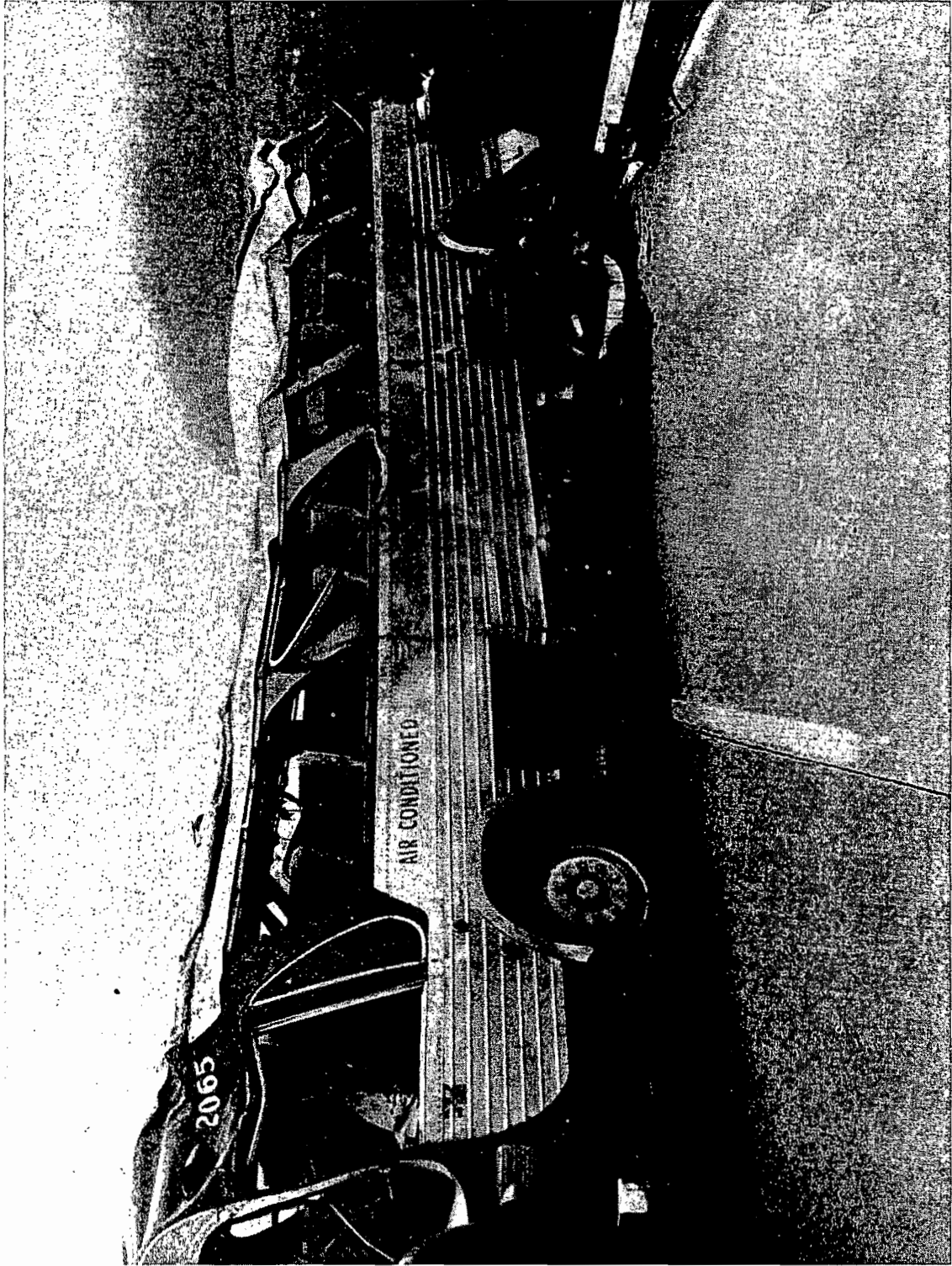


Figure 6: Left side of bus after removal from bottom of embankment. Some of the damage just ahead of the rear wheel was incurred during retrieval operations.



Figure 7: Deformation of bus roof from left to right. Note lack of impact damage to front of bus.



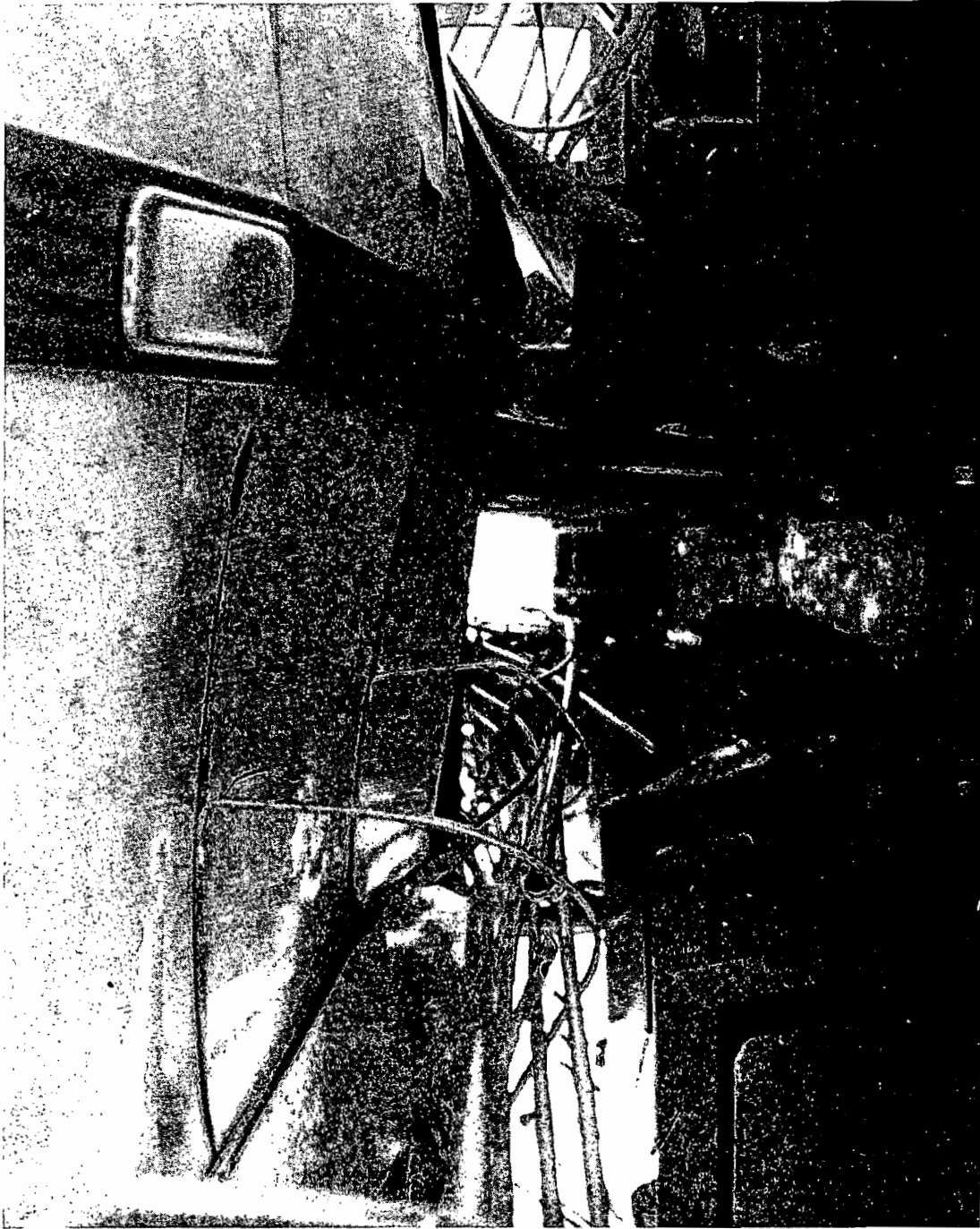


Figure 8: Interior of accident bus, looking forward. Note sideward and downward deformation of roof.  
(Compare with Figure 5.)

Other conditions included:

1) The left (driver's) side windshield wiper motor switch was operating intermittently, permitting interruption to wiper operation.

2) The transmission bellcrank and linkage which selected first, reverse, and second gears at the transmission were broken off, presumably during the accident sequence, rendering the shift mechanism partly inoperable.

3) Steering assembly inspection by Penn-DOT personnel showed 10 inches of play at the steering wheel rim, with no motion at the front wheels. The retaining bolts securing the bevel gear housing to the frame were not drawn up tight. They removed the bevel gear assembly, steering drive shaft, and the worm-and-sector gearbox. The worm-and-sector gear housing cover was removed to determine whether there were any broken parts in the worm-and-sector assembly. They observed none, but found the assembly out of adjustment. They reinstalled the cover and reset the lash adjuster for proper backlash.

While reinstalling the steering gear on the front axle, Penn-DOT personnel found that the output Woodruff drive key was broken off flush with the outer circumference of the bevel gear output shaft. The coupler pinch bolt was found to be loose on disassembly. It bore marks of severe denting and "coining"<sup>7</sup> at the points where the bolt would engage the bevel gear output shaft, and appeared to be bent.

In reassembly, the bent and coined coupler pinch bolt was reinstalled in a loose condition, similar to that found during its removal. After complete reassembly, the steering wheel rim was found to have about 5 inches of free play.<sup>8</sup>

<sup>7</sup>"Coining" marks are those impressed into metal by the pressure or impact of another component (or of a die, as in coining money or medals).

<sup>8</sup>This reduction in free play was attributed by Penn-DOT to the adjustment made in the worm-and-sector gear lash adjuster. Their analysis did not make any examination or appraisal of the cumulative play which could have been induced in all linkage in the crash loadings, including a stress-induced change in the lash adjustment components.

The pitman arm was twisted at its splined end, at the point where it was attached to the worm-and-sector gear output shaft. Later examination showed that the splines on the output shaft had also been slightly bent at their outer ends.

## 11. Detailed Examination of Steering Damage

In order to determine the significance of steering-component damage, and particularly whether the broken Woodruff key was sheared some time before the accident, and thus could have been a contributing factor, the Safety Board contracted with the National Bureau of Standards (NBS) to examine the bus steering assembly parts in detail.

Subsequently (February 5-12, 1971) General Motors Corporation (GM) at the request of the Board made a series of tests on a steering gear assembly of the same type used in the accident bus. The detailed report of NBS, and a summary of GM's findings, are in the accident report docket. Pertinent findings of these examinations and tests included the following:

- a. The steering gear worm-and-ball nut was distorted; the ball tracks were cracked and burnelled; the edges of the cracks in the ball tracks revealed no evidence of the balls having rolled across the cracks after they were formed;
- b. A force of (about) 450 foot-pounds of torque and a rotation of some 7° to 10° on the shaft were required to shear a tested Woodruff key;
- c. It could not be determined just when the Woodruff key had been sheared, other than that there had been some steering input after the shear occurred;
- d. Bending and coining of the coupler pinch bolt indicated some steering input after the Woodruff key failed. In a series of tests, GM found it could duplicate the coining marks (found on the accident pinch bolt) by applying three successive



turning input forces of 250 foot-pounds (torque), with alternate reversed loadings of 75 foot-pounds. A test drive of a sister bus without a Woodruff key, produced no coining of the pinch bolt. A ring of scored marks of a type not found at all on the accident bolt was produced on the test bolt in only 10 miles of driving. With additional driving, this ring of scoring marks was proportionately increased, but no coining or bending of the bolt was produced;

- e. The amount of looseness in the steering which may have existed immediately prior to the accident could not be determined;
- f. The steering shaft worm and pitman arm were distorted by a severe external lateral force applied at the front wheels while the wheels were in a left-turn position.

### III. ANALYSIS

#### 1. The Highway

##### a. Geometrics

The American Association of State Highway Officials (AASHO) recommends for a two-radii compound curve that "the radius of the flatter circular arc (R1) should not be more than 50 percent greater than the radius of the sharper circular arc (R2), or R1 should not exceed 1.5 R2." Just east of the accident site, the radius of the flatter curve (2,620 feet) is only 14 percent greater than the radius of the sharper curve (2,292 feet). Thus, this curve was within the AASHO recommendation, and it is unlikely that it would have caused any driver-vehicle control problems. The transition would not produce a greater lateral force than the sharper curve.

#### b. Skid Resistance and Accident Experience on U.S. 22.

Based on a skid number of 35, found in their tests of October 1968, Penn-DOT concluded that there was no immediate need for corrective action. From January 28, 1966, to September 10, 1968, however, 39 accidents had occurred in both directions between the county line and a point 1,200 feet east, including a number of fatalities; 21 of these accidents occurred on wet surfaces and two on snow. Penn-DOT's posting of "Slippery When Wet" signs would indicate knowledge that wet-weather adhesion was inadequate even though skid numbers were not indicative of need for immediate improvement. Sign placement appears to have been an effort to compensate for inadequacies of policy or criteria which would reflect the true need for corrective action.

Skid testing done by Penn-DOT and FHWA after the accident indicated that four of the test sites were one to four skid numbers above, and one was two skid numbers below, the FHWA-recommended figure of 35. But it cannot be concluded that the FHWA-recommended skid number of 35<sup>9</sup> (minimum), or the Penn-DOT figure of 30, is actually the point of demarcation between a "safe" and an "unsafe" road surface. Theoretically, this curve could have been safely negotiated, without sideslip, assuming a skid number of 35, at about 100 miles per hour. The selection of any such figure as a "standard" is necessarily arbitrary, and must allow a substantial margin of safety. In this instance, the continuing incidence of accidents should have alerted the Penn-DOT to the fact that some factor other than the marginal skid number was involved as an important causal factor.

Accident experience from the Lehigh County line to a point 1,000 feet east offers

<sup>9</sup> The FHWA-established figure of 35, at 40 miles per hour, was obtained with an automobile-type rib-design tire inflated to 24 p.s.i. (ASTM E274 65T).

strong evidence of the effects of highway improvements on accident frequency and causation in this area. The 3-year accident total (1966-68) had reached 37, which would represent an average of over one per month. However, in the 13 months following highway improvements not a single accident occurred in this area for either direction of travel. Because no changes were made in geometrics of the highway, the increase in safety can be attributed to improved traction, elimination of excessive surface water drainage across the highway, and improved recovery areas (shoulders and median).

### c. Water Drainage and Hydroplaning

Topography and tests of the highway showed that water did drain across the highway, from the eastbound onto the westbound lanes, in the area of the paved median crossover. Erosion patterns on the northern embankment opposite the paved median indicated a greater flow of water at this point than at others nearby. Following the accident, Penn-DOT checked the functioning of the water drains (in the median) but did not check the flow of water from the eastbound lanes into the drains. No evidence was available as to the actual flow of water during the time of, or immediately preceding, the chartered-bus accident.

Independent waterflow tests indicated clearly that (before the median was regraded and paved) water would flow from the eastbound lanes, across the paved median crossover point, and across the westbound lanes, and that the condition of the median for several hundred feet to the east (upgrade) was such that water on the eastbound lanes for some distance east would have followed an eroded course in the median and crossed the highway at the paved median crossover point. Thus, if a heavy rain had fallen just before the accident (as indicated by witnesses), a definite flow of water could have been crossing the westbound

lanes at the paved crossover point, and fanning out westward, at the time the bus came through.

An accepted empirical formula for determining "dynamic hydroplaning" speed, in miles per hour, is  $10.3 \times \sqrt{\text{Tire Pressure}}$ , assuming that the water depth exceeds the depth of tire tread grooves.<sup>10</sup> The much greater weight of a bus wheel on the pavement, as compared to a passenger-car wheel, is accounted for in the differences in tire air pressure and the much greater size of the bus tire "footprint." Consequently, a passenger car wheel would normally "hydroplane"—or skim over the surface of water film—at a much lower speed than would a bus wheel. If all the tires on the bus had had air pressures at the level of the least pressure found after the accident (77 p.s.i.), the hydroplaning speed of the bus would have been about 90 miles per hour. However, this speed would have represented total hydroplaning, or complete loss of contact of the tire with the highway surface. The same authority<sup>10</sup> has subsequently indicated that partial hydroplaning—or partial loss of tire contact with the surface—can actually occur at much lower speeds, and possibly as low as 50 miles per hour under the conditions given for the bus. Because the bus speed was reportedly about 55 miles per hour, and considering the probable presence of considerable water on the highway and the low skid number<sup>11</sup> at the point where the unexplained sideslipping of the bus began, it seems likely that partial hydroplaning did occur.

"Viscous (or thin-film) hydroplaning" can occur at much lower speeds, when oil or other foreign substances on the highway mix with relatively small amounts of water. However,

<sup>10</sup> Walter Horne, "Skidding Accidents on Runways and Highways can be Reduced," in *Astronautics and Aeronautics* (magazine), August 1967.

<sup>11</sup> Reported by Penn-DOT as 23 at 60 miles per hour, and 29 at 50 miles per hour, in the area opposite the paved median crossover (see Appendix A, Test Station E).

there is no evidence of foreign film on the highway in the area in question, and under heavy rainfall conditions such foreign film, if any, tend to be washed away. The effect of viscous hydroplaning, if it occurred, would have been to reduce further the amount of lateral force necessary to induce sideslipping of the bus.

Tests by Pennsylvania State Department of Health found that traces of hydrochloric acid (which would theoretically have formed from rain passing through the incinerator smoke onto the highway) would have had no measurable effect on the roadway surface, but that larger amounts would have tended to improve surface traction. This tends to rule out this smoke pollution as a contributing factor.

Supporting the hydroplaning postulation is the fact that post-accident longitudinal grooving of the pavement was followed by a dramatic reduction in wet road accident experience in the area. With longitudinal grooving, surface water is reduced and tires can mechanically engage the grooves to improve traction. This reduces the chances of initiating a slide, and improves chances of regaining control should a slide begin.

Reestablishment of proper drainage (into the median outlets), and the elimination of excessive surface drainoff, lend further support to the hydroplaning theory. Facts surrounding other "unexplained" accidents near this point, before highway improvements were made, are fully compatible with this theory.

The concurrent improvement to pavement and to the median area prevents a clean-cut determination of the effects that either improvement, taken alone, might have had on accident reduction. However, the FHWA-recommended skid number of 35—a minimum acceptable level for wet highways—should have provided a reasonable margin of safety, and not caused vehicles suddenly to go "out of control" with no driver input, even at normal highway cruising speeds. Thus it appears far

more likely that the presence of excessive rainfall runoff, prevented from reaching the provided drainage outlets, and providing the conditions necessary for partial hydroplaning, was the greater causal factor.

Hazard-warning signs appeared to be adequate for the hazards which were identified. However, Penn-DOT had not identified hydroplaning with the high accident rate in that location. Drivers had no means to detect the presence of hydroplaning conditions, no warnings as to its occurrence, and no indicators of safe driving speeds under such conditions. Thus, while "speed too fast for conditions" is an obvious conclusion where hydroplaning resulted in accidents, it must be realized that the speeds of hydroplaning vehicles were not necessarily too fast for the conditions forewarned, and not necessarily classifiable as driving errors.

The identification of rainfall runoff funneled onto the westbound traffic lanes as a factor in this accident, leads to a question of why this occurred. It appears clear that maintenance practices permitted the accumulation of highway debris, the encroachment of unwanted vegetation, and the erosion of the median edge from traffic and weather, and thus prevented proper surface drainage into the drain fixtures. Such maintenance setup was inadequate to the need, and served to set up the conditions necessary for hydroplaning. Regrading and paving median area in the accident vicinity (and eastward) after this accident, reestablished the capability of the drainage system to function.

One further improvement made to the accident area was the regrading and repaving of shoulders, and widening them to 10 feet. This improvement provided a greater and safer recovery area for vehicles in difficulty, and thus may interrupt the chain of events which formerly led to crashes, but which now may be reduced to a "near-miss" category.

#### d. Guardrails

The capacity of the cable-type guardrail to deflect the bus, or to retard it, was compromised in two ways, so that it was ineffective:

1) Guardrail posts driven into dirt fill at the accident site did not offer a sufficient degree of resistance to impact and were easily uprooted;

2) The displacement of several guardrail posts some days before the crash had caused excessive looseness in the cables, so that they were lying partly on the ground.

The absence of guardrail performance tests or standards, involving vehicles such as trucks and buses, does not permit a clear evaluation of the relative merits of the old-type cable guardrail as compared to the W-beam type with which it was replaced at the accident site. Effectiveness of the W-beam type to contain buses and trucks is still unknown, as has been observed in other Safety Board highway accident reports.

#### e. Traffic Controls

The traffic signs westbound in the vicinity of the accident site could have been confusing to some motorists. A little more than a mile east, the posted speed limit was 60 miles per hour. About 2,000 feet west of that sign was one reading "Slippery When Wet." The average driver would reasonably assume this meant the exercising of due caution with respect to vehicle speed during wet weather, but such speed was left entirely to the individual driver's judgment. Another 2,440 feet westward a minimum speed of 40 m.p.h. was posted. Under Pennsylvania law, it is illegal to drive slower than the minimum speed limit except when necessary for safe operation. Thus, it is lawful to drive less than 40 m.p.h. if conditions warrant, where the minimum posted speed is 40. Should a driver not know the law, or should he interpret the 40-mile-per-hour minimum literally, he might believe that his speed had to be somewhere between 40 and 60

miles per hour. In this instance, the positioning of the "Minimum Speed. . ." sign following the hazard warning signs could, conceivably, lead some motorists to infer that the hazards had been traversed, and speed was to be resumed. There is no indication that this inference was in any way a factor in the crash of the chartered bus, but the signs illustrate a need for study of the inferences to be drawn by motorists which may affect overall safety of a highway.

State Police accident data indicate that 51.6 percent of the accidents (in the bus accident area) for the period 1966 to July 19, 1970, were classified as caused by "above safe speed for road conditions." The implication is that motorists carelessly (or otherwise) disregarded the "conditions" and drove at unwarranted speeds. However, the nature of the warning signs preceding the accident area provided only vague and generalized information as to the hazards ahead—a curve, and a road that is "slippery when wet," leaving the selection of a "safe" speed entirely to judgment. Under such conditions, any enforcement action based on the basic speed rule, particularly on a modern interstate highway, places an unwarranted requirement on the motorist to (1) know exactly what conditions he is to meet, and (2) know that the safe speed in this instance is far below what his experience might have taught him regarding similarly appearing conditions on similar highways.

This suggests a need for better accident investigation and analysis, and more definite warnings or control signs to alert the motorist, if local enforcement programs are to achieve their primary purpose.

#### 2. Kinematics of the Bus

The primary questions of causation relating to the movement of the bus are:

1) What was the track of the bus during its non-normal movements before it struck the cable barrier?

2) What were the elements involved in the initial skidding of the bus and what was their relative importance?

3) Could control of the bus have been regained by practical steering efforts of the driver?

All witnesses are agreed that the initial non-normal movement of the bus was a counterclockwise rotation. However, there is disagreement as to whether this was initiated by a leftward movement of the front wheels or by a movement to the right of the rear wheels. The driver believed that the rear of the bus slid to the right as the first action upon striking a "slick spot." However, a passenger on the bus believed that the front of the bus first skidded to the left and partly onto the median; he heard gravel thrown about.

The question of whether the front of the bus first broke to the left or the rear of the bus broke to the right is resolved by analysis of the possible forces.

The busdriver's statement that he was going about 40 miles per hour is less credible than that of the witness who had "clocked" the bus speed at 55 miles per hour. The bus speedometer was not working and the 55-mile-per-hour speed was based upon an automobile speedometer reading.

The net centrifugal force on the bus in the curve, assuming a minimum radius of 2,292 feet, a bus speed of 55 miles per hour, and superelevation of 3 to 4 percent, would have been about .05 to .06g, or about one-fifth of the lateral force which could be sustained with the existing skid number. This outward force of about .05 to .06g would have been felt at the center of gravity of the bus applied to both the front and rear wheels, and resisted by friction or adhesion. Because the center of gravity of the bus was approximately two-thirds of the distance rearward along the bus axis, the rear wheels would have had to resist about two-thirds of the centrifugal force and the front wheels about one-third of the

centrifugal force. The forces would have tended to direct both front and rear wheels to the left; the front wheels were the first to traverse the low-resistance road surface, and thus would tend to move left while the rear wheels were still providing traction. There was no force available which could have opposed the effects above and directed the rear wheels to the right. Thus it must be concluded that the counterclockwise rotation of the bus originated with leftward movement of the front wheels, and not the movement of the rear wheels to the right.

The outward force of .05 to .06g at which breakaway occurred corresponds to a skid number 5 or 6, only one-fifth the measured skid number. The breakaway of the front wheels of the bus to the left therefore, definitely indicates that there was substantially less lateral adhesion at that instant than was measured by a skid number test made under moderate wetness. The only known phenomenon which could explain such a low stress breakaway is that of partial hydroplaning.

The tendency of vehicle tires to hydroplane is partially dependent upon the depth of the water in which the tires are operating. As already noted, water drainage across the pavement occurred in this general location as a result of drainage conditions in the median; however, the exact location of the loss of control of the bus in relation to zone of demonstrated waterflow could not be determined, nor could it be determined how much waterflow was occurring at the time of the accident. Nevertheless, partial hydroplaning is the only explanation for the initial leftward movement of the front wheels under the very low lateral g being produced by rounding the curve. This would also explain some of the numerous previous experiences of other vehicles at or near the accident site on other occasions during rainy weather. However, it is unlikely that all these accidents involved the drainage area.

As the forward part of the bus moved leftward and outward on the curve, the driver steered to the right in an effort to regain control, as described by bus occupants. That is the correct steering action, but according to bus occupants the bus did not respond. Then the front of the bus suddenly began to respond, turning sharply to the right, reversing the earlier rotation.

These observations appear plausible. While operating in a skidding mode, the front wheels could exert no turning force on the bus. However, if the front wheels then left the hydroplaning area or if they engaged some frictional surface of the median, while turned to the right, the resultant clockwise turning force would have been both sudden and substantial.

Once the clockwise rotation began, the proper corrective steering action would have been to turn the wheel to the left, which action was reportedly also taken. Again, however, control was not reestablished. As the bus continued to rotate back toward the right (north) shoulder and the front end of the bus scraped the right guardrail, the front wheels would have entered upon the relatively rough shoulder paving, thus suddenly tending to retard the sideward sliding of the front wheels, and further accelerating the rotational movement clockwise. At this point the rear wheels, having no measurable tread on the left rear tires, were still on the smooth, wet, low-friction pavement. The very low resistance offered by this combination would have facilitated full breakaway of the rear of the bus, and rapid sliding. The bus actually rotated clockwise in this phase slightly beyond 180° from its original position, finally moving backwards to the northwest. It crossed the north shoulder at an acute angle, at which time both front and rear wheels would have encountered greater resistance to lateral skidding. Still traveling backward, it uprooted several guardrail posts which offered little resistance.

In the short statement which the driver made initially, there is no indication that he

attempted to use his brakes during this sequence. It is unlikely that the use of brakes at any time would have assisted in regaining control of the bus. The probability is that use of brakes, once the skid started, would have prevented any possibility of regaining control. There is no indication in evidence of any abrupt wheel movement or pavement roughness.

The effect of the smooth tires in regaining control can be described in terms of a general tendency, but it is not possible to determine whether it governed the outcome. The smoothness of the left rear tires would have decreased the margin against breaking away of the rear of the bus when the rear wheels reached the alleged "slick spot." Such a breakaway would have tended to straighten the bus in its course, producing a relatively straight path instead of the rotation. At that point the front wheels were probably producing a drier track for the rear wheels. However, in the second phase, after the clockwise rotation developed, and the front wheels entered upon the much greater adhesion area of the north shoulder, the smooth rear tires would have speeded the clockwise rotation of the bus. It is not known whether the 180° rotation would have been completed with tires of adequate tread.

Regaining control of his bus after the lateral sliding of the front wheels would have depended upon the amount of rotation and the driver's ability to keep the front wheels headed essentially parallel to the road alignment (i.e., the direction of movement of the center of mass of the bus) at each part of the sequence. Once lateral sliding is initiated, the adhesion which allows steering effect cannot be regained until the surface of the tire is rolling without sliding. After rolling is again achieved, the regaining of steering force is limited by the degree that lateral sliding will not recur. In practical terms, the driver must first turn the wheels with considerable exactness to a direction that would restore front-wheel rolling. He must then continue to direct the

wheels with such exactness that the axis of the bus is slowly brought back toward the axis of the highway. During this time, the steering must be so precise that it does not produce a lateral force greater than surface adhesion can support.

Even a highly skilled busdriver may find it difficult to do this beyond a very acute skid angle, because he does not know the exact position of the front wheels relative to the alignment of the highway after a skid begins.<sup>1 2</sup>

This accident at New Smithville is another example in which the driver had no means of knowing the direction of the bus front wheels with the exactness required to regain sufficient effect to steer out of the skid. Once the front wheels had contacted the rough north-shoulder paving, during its clockwise rotation, there was no possibility of recovering control by any steering action.

Beyond the guardrail, it could have gone down the embankment at an angle, rearend first, remaining on its wheels in a near-overturn attitude. However, if the guardrail cables had briefly restrained the lower part of the bus as it slid broadside off the shoulder, the combination of this tripping action and the relatively steep embankment slope could have imparted a vaulting type lift to the right side, causing a flipover at the bottom of the embankment. Crushing of the length of the left side of the roof, downward and to the right, indicates a severe deceleration impact while the bus was in a one-quarter to one-half rollover attitude. The bus also slid into some small trees, and the roof midsection struck a masonry farm outbuilding (which may have prevented further overturn) before it settled back onto its left side to rest.

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<sup>1 2</sup>The Safety Board has reported this problem earlier in the accident which occurred at Beaver Falls, Pennsylvania, December 26, 1968. That accident involved an effort to regain control on dry pavement after skidding on a snow-covered surface, but the problem was similar. The Safety Board recommended then that consideration be given to equipping buses with steering-angle indicators so that the busdriver could know, in an emergency situation, in what direction his steerable wheels were pointed.

As the bus fell onto its left side, severe lateral force was imparted to the side of the left front wheel, which was in a left-turn position and protruded beyond the bus side. This force was severe enough to bend the pitman arm and the steering worm gear.

### 3. Kinematics of Occupants

Deceleration forces, acting on the bus in certain phases of the accident sequence, can be translated into their probable effects on bus occupants:

- a. In the 180° rotational sliding on the highway, occupants decelerated toward the left and rear of the bus. Based on the low g force (about .30g, maximum) and occupant statements, no occupant was dislodged from his seat.
- b. When the bus vaulted (or rolled over), most occupants were shaken from their seats and were tumbled about the bus interior, striking the ceiling and interior components; some may have been ejected.
- c. When the bus struck on its left roof area, all occupants were dislodged from their seats. Many were probably thrown from the right-side seats into (or through) the left windows. Some may have been ejected through the rear window area, while others were tossed about within the bus.
- d. When the bus roof impacted the masonry outbuilding and the small trees, additional occupants may have dropped out the left windows.
- e. When the bus settled back onto its left side, it came down upon a number of the occupants who had been thrown or shaken out earlier.

Occupants who were ejected onto the embankment, and who escaped being crushed by the bus, were probably saved because the bus was not sliding on the embankment and dropped the occupants behind the roll. After the bus came to rest, one occupant exited through the rear window area and made his way some distance beyond the bus before he died.

During the rollover and deceleration impacts of the bus, occupants impacted various interior components, such as seat fixtures, overhead parcel shelves, windows, window frames, ceiling panels (which fractured), and overhead light fixtures. An occupant-by-occupant injury analysis was made by the National Highway Traffic Safety Administration. Their detailed report is in the docket.

If seat belts had been available, three events before the accident could have induced seat-belt fastening directions by the driver. These were: (1) The occurrence of the rain, (2) the occurrence of the earlier skid near Easton, or (3) the passage of the "slippery when wet" sign. The absence of seat belts precluded their use under any circumstances, as well as the development of any rules which might provide for direction by the driver.

#### 4. The Driver and Licensing Procedures

The Safety Board has been unable to find any aspect of driver error in this case related to the driver's handling of the bus at the time of the accident. Although he had accumulated a substantial record of accidents and violations under the New Jersey "point system," and had an adverse health history, he held all the Federal and State paper credentials required for the legal operation of a passenger bus in interstate commerce.

The ensuing analysis focuses on aspects of the driver-licensing system related to its failure to meet its purpose; it is the system rather than the driver that is being scrutinized.

The basic purpose of driver-licensing systems—laws, regulations, and procedures—is

to promote and preserve highway safety, to assure that only those applicants who qualify will be licensed, to deny the privilege to those who do not, and to remove the privilege from drivers who, through repeated accidents and violations, demonstrate their unfitness to drive.

By their very nature, driver licensing, traffic law enforcement, the courts, and driver improvement systems are interrelated and interdependent. The driver's accident record, traffic violations record, licensing history, medical background and condition are issues of interagency and intra-agency coordinative interest—the "right hand" must know what the "left hand" is doing if the system is to function properly. However, in the case of the accident driver, there were concurrently in motion, through different channels, processes to grant the driving privilege and processes to suspend or revoke that privilege, with little apparent interface of the two. (see appendix G.)

#### 5. The Bus

##### a. Design Factors

**Crashworthiness:** The basic monocoque structure withstood the severe induced dynamic loads adequately. No injuries were traced to collapse of structural members or components. Riveted joints held together except across the top midsection where a load was highly concentrated when the bus struck a stone building. Inward collapse of the left roof area absorbed considerable impact energy, and was a major decelerating force.

**Side Windows:** Side windows opened in the extreme distortion of the entire upper body to the right, transmitted to the right side through the roof bows and skin. Long "picture windows" interrupted the continuity of roof bows with body side structure, and may have permitted distortion. Whether such distortion alone was sufficient to unlatch all windows, or whether some opened on impact of occupants, cannot be determined. Standards for bus



windows in effect when this bus was built are now the subject of proposed rulemaking. (NHTSA Docket No. 2-10, Bus Window Retention and Release, dated August 15, 1970.)

The side windows of the bus as constructed met the requirements of both the Motor Carrier Safety Regulations (§ 393.61) and the New Jersey Public Utility Commission regulations. Testimony at the public hearing indicated that a force of (1) 75 to 80 pounds applied at one of the latches, (2) 125 pounds between the latches, or (3) 175 to 190 pounds at the center of the window glass, would open the windows. Such forces were available in the form of the bus occupants' being thrown about in the bus when it overturned (or vaulted) down the embankment. It is probable, therefore, that at least some of the side windows were opened by accidental impact by occupants before the bus body was subjected to the distortions which imposed severe loadings on the side-window mechanisms.

NHTSA Docket 2-10, Notice 2, dated August 15, 1970, (still under consideration as this report is printed) proposes a window-retention capability which conceivably could have prevented (some of) the occupant ejections experienced in this accident—at least up to the point where severe structural distortion loads were applied. Docket 2-10 specifies requirements for the retention of all windows (excluding windshields) in buses and specifies operating forces and opening dimensions for pushout windows to minimize the likelihood of occupants being thrown from the bus and to provide a means of accessible emergency exit.

**Windshields and Rear Windows:** Ejection of windshields and rear windows resulted from distortion to the body area in which they were mounted. Their openings created additional egress routes for occupants and entranceways for rescue crews.

**Interior Components:** Ceiling paneling fractured in sharp knife-like edges from roof

distortion and from occupant impacts, contributing to injury. Overhead baggage rack tubes became disconnected due to roof distortion; exposed ends presented undesirable injury-producing possibilities, but were not identified specifically with injuries. Internal (overhead) lamps, surface mounted in the ceiling centers, were damaged when struck by occupants; fractures of glass lenses showed evidence of having inflicted occupant injury. All passenger seat mounts remained secure, but the backrest of the rearmost (transverse) seat separated from its mount and was propelled through the rearmost right-side window.

**Other Components:** There was no direct impact force in the area of the fuel tank, mounted just forward of the right rear wheels; there was no loss of fuel to the fuel system. Failure of transmission linkage in no way contributed to the accident. However, the failure of the first, second, and reverse transmission bellcrank, coupled with the testimony of the wrecker operator who stated that he moved the gear shift lever "forward," supported the deduction that the transmission was in fourth gear at the time of the accident. The speed range for fourth gear according to GM testimony at the hearing, was 43 to 73 m.p.h. This supports the other testimony that the bus was traveling at 55 m.p.h. just before the skidding.

The lack of sufficiently resistant points along the body side panels delayed attempts to raise the bus to release persons trapped under the bus. Attempts to jack up the bus side were frustrated by inward yielding of the side structure. With the condition of four victims not immediately determinable, this failure could have contributed to fatalities, as the administering of medical aid was delayed.

#### b. Prior Accident Damage

The findings regarding prior front-end damage could not be related to the causation of this accident. There was no indication that

damage to steering components had occurred. The New Jersey bus inspection report, dated 2 months before the July 15 accident, which did not note any steering defects, showed no evidence of a detailed inspection of the front-end alignment.

It was considered unlikely that any of the steering damage found after the July 15 crash (sheared Woodruff Key, bent steering-shaft worm, bent coupler pinch bolt) dated back to any prior accident.

### c. Role of the Sheared Woodruff Key and Damaged Components

The Board is of the opinion that the damage found in the worm-and-sector gear assembly, the twist of the pitman arm shaft, the indentation and cracking of the worm-and-ball nut, and the deformation of the housing upper cover were all caused by a single application of a very heavy load (10,000 lbs. or greater) from a blow forcing the wheels to the right, during the accident sequence. The shearing of the Woodruff Key occurred subsequently from a force or forces applied at the steering wheel.

The National Bureau of Standards testified that "the damage to the Pitman arm and the parts of the steering gear assembly was probably due to impact at the time of the accident not related to the cause of the accident." The NBS found no evidence that the steering gear was in operation after the application of the heavy load which caused the cracks in the gears.

The NBS further concludes that due to the multiple indentations on the clamp bolt and the scraping of the fracture surface of the Woodruff key, the steering assembly was operated for "some time" with the Woodruff key sheared. This would seem to indicate that the key had been sheared prior to the accident. Results of tests conducted by General Motors were consistent with the Board's opinion that the Woodruff key was sheared after the

accident and after the worm-and-sector gear damage occurred.

General Motors' tests established that the damage to the worm-and-sector gears had to come from a force on the wheels and that the force that sheared the Woodruff key had to be imparted through the steering wheel. Due to the reverse locking effects of the gear box which prevented the transmission of torque due to forces applied to the wheels, it was impossible to impart enough force to shear the Woodruff key through the wheels. It was possible for three men to exert load through the steering wheel to cause key failure.

Such a loading was applied at the steering wheel after the accident during the retrieval operations. The wrecker operator testified that he and his assistant used a pry bar to force the bus A pillar away from the outer circumference of the steering wheel, distorting the steering wheel rim; that it was necessary to turn the wheels to the right to guide the bus up the embankment; that the wheels were locked in the shale; that it required great force by the two men to turn the steering wheel; that after turning the wheels, the steering wheel was lashed in its right turn direction; and that the wheels had to be turned several times during the retrieval of the bus up the steep embankment. It is the Board's opinion that the Woodruff key was sheared and the coupler clamp bolt was coined following the failure of the key during these retrieval maneuvers.

GM was able to reproduce clamp bolt coining similar to that on the accident bolt, by application of a single force through the steering wheel sufficient to shear a Woodruff key. When the key sheared the steering drive shaft was under severe torque. Following the key failure the torque induced a rapid alternate loading which coined the clamp bolt at the shaft in a manner similar to the accident clamp bolt.

The busdriver could not be interviewed, but his statement that he was going "about 40" could not be interpreted in terms of his intended speed just before the accident. The

inoperable speedometer left him only "seat-of-the-pants" experience as a basis for knowing how fast the bus was going. If he was driving according to an evaluation of the conditions he observed, then the inoperative speedometer was only incidental to, and not a causal factor in, the accident. However, if he had intended to go "about 40" to accommodate highway conditions, but was actually going "about 55" as stated by witnesses, then the inoperative speedometer was a factor in the accident. An actual speed of "about 40" would probably have averted the loss of control.

Nonavailability of pre-crash front-wheel alignment data prevented analysis of the effects of possible alignment factors in relation to loss of control.

#### d. Tires

The tire pressures on the right and left rear wheels were not in balance. Testimony<sup>13</sup> was received to the effect that unequal tire pressure will seriously affect the operating efficiency of a vehicle. "Unless correct air pressure is constantly maintained, tires will not function as they should; consequently, safe, economical operation of a vehicle will be affected — an underinflated rear tire can destroy the value of the most efficient brakes."

However, the Board could find no evidence of the effect on wet road skidding of tires with unequal tire pressure.

The question of the mix of Firestone front tires with the Michelin (radial) rear tires was discussed with the tire manufacturers, NHTSA tire specialist, and General Motors. It was unanimously indicated that this mix would have had no adverse effect on wet road skidding.

The smooth rear tires had no effect on the first hydroplaning of the front of the bus to the left. However the smooth tires did have an

<sup>13</sup>GM Maintenance Manual (X-6326), section 19, pages 402, 403.

adverse effect on any subsequent recovery actions or movements. (This is discussed in detail under "Kinematics of the Bus").

There is experience and authority available<sup>14</sup> to show that a skidding vehicle will rotate clockwise if the greater traction (skid resistance) is on the right wheels, as was the case in this accident. It is possible that the bus would not have rotated so severely clockwise in the second phase of the skid if all the bus tires had had adequate tread depth, but the traction differential cannot be determined.

#### e. Miscellaneous Pre-Crash Damage

There is nothing to indicate that the parabolic crack in the left windshield interfered in any way with safe driver vision. Malfunctioning of the windshield wiper switch was not observed to have occurred at any time prior to the accident.

While there is nothing to indicate a gross disregard of safe speed on the part of the driver, a properly functioning speedometer might have induced him to choose a speed more nearly appropriate to conditions.

#### f. General Maintenance of Bus

That there was generally inadequate maintenance of the bus is shown by the numerous conditions which were in violation of applicable MCS Regulations—worn tires, inoperative speedometer and tachograph, broken brake protection valve lever—in addition to unequal tire pressures, a cracked windshield, and a lack of maintenance records.

### 6. The Bus Company

Compliance with Motor Carrier Safety regulations was virtually nil. These regulations and requirements are established for a

<sup>14</sup>J. Stannard Baker, et al., "Traffic Accident Investigators' Manual for Police," Northwestern University Traffic Institute.

purpose, a major part of which is the assurance of qualified drivers, of safe equipment and safe operating procedures by carriers in interstate commerce. The long and extensive operations by the operating company in interstate transport tend to rule out any conclusion that its disregard of regulations was in any degree based on ignorance or inexperience.

Existing limitations of Motor Carrier Safety field personnel, FHWA, must be considered a factor in permitting the continued operation of carriers, particularly of transient and charter transport, in disregard of the applicable regulations. With adequate frequency of inspections, greater operational surveillance, and appropriate sanctions by BMCS against non-complying operators, disregard of the regulations would more effectively be discouraged.

#### IV. CONCLUSIONS

1. Although there is no direct evidence that water was draining across the highway at the accident site at the time of the accident, erosion marks and subsequent tests showed that water had been draining across the paved median instead of into the drain outlets. Under the existing rain conditions, at the time of the accident, water was probably flowing in the established abnormal path, which included discharge of water across the lanes in which the bus initially lost control.
2. The initial skidding of the bus was counter-clockwise and began when the front wheels of the bus lost adhesion and moved leftward and outward on the curve.
3. The speed at which the bus was moving in the curve, approximately 55 miles per hour, was not sufficient to have forced a loss of adhesion on a surface which actually possessed the measured skid number of 30.
4. The loss of adhesion at the front wheels was occasioned by some condition which reduced the adhesion to only about one-fifth the measured amount.
5. The bus probably encountered an increased depth of water on the pavement in the area near the median crossover.
6. The left rear tires on the bus were worn beyond legal limits, and the condition was readily visible.
7. The initial skidding of the bus was not contributed to by the worn left rear tires, but the rapidity of the clockwise skid would have been influenced by reduced lateral skid resistance of the left rear tires.
8. The busdriver's efforts to regain control by steering were in the proper direction during the two phases of the skid; however, the results of these efforts were limited by varying skid resistance of different areas of the pavement, the inherent lack of sense of steered wheel direction provided by current steering systems, the large amount of rotation of the bus which developed, and, in the latter part of the second phase, reduced lateral skid resistance of the left rear tires.
9. The median drainage system east of the paved median crossover could not function as designed because of erosion of the median edge and impeding of waterflow resulting from accumulated debris and vegetation. These conditions resulted from inadequate maintenance of the median.
10. The posting of "Slippery When Wet" signs in 1968 had no apparent effect in reducing the frequency of accidents at this accident site. The "Slippery When Wet" sign was an inadequate substitute for correction of conditions in that it advised of no specific speed action, and the duration of its effect was indefinite.

The sign was not erected to correct for drainage across the pavement, and it did not adequately warn against that condition.

11. The post-and-cable guardrail on the north shoulder of the highway was inadequate to retain the bus, and there is evidence that it was inadequate to retain passenger cars under typical impact conditions. The W-beam guardrails which replaced the older guardrail, although considered to be superior, are still not tested or rated insofar as vehicles heavier than passenger cars are concerned.
12. The inoperative speedometer of the bus constituted an operational hazard, and could have led the driver to operate at a speed higher than he later estimated. However, the speed of operation on the curve was below the speed limit and produced only one-fifth of the lateral acceleration which this road surface, as measured, should have been capable of sustaining before adhesion was lost.
13. The sheared Woodruff key and damaged coupler pinch bolt, were not contributing factors in causing the accident.
14. No specific driving error could be shown to have been committed by the busdriver to precipitate the accident.
15. The large picture windows of the bus met the requirements of the State of New Jersey and MCS Regulations 393.61, yet 18 occupants were ejected from these windows which opened during the rollover down the embankment. Six of the ejected occupants were crushed, four of them fatally, when the bus later rolled back onto them.
16. Integrity of window structures on the bus, and of side-window closures, was compromised by the unnecessarily long window spans, permitting greater distortion to the windows and mounts in the rollover than might otherwise have occurred.
17. Although the bus body sustained general battering over most of its length, and a concentrated blow against a masonry structure, there was only one major separation of structured panels at a joint, and that failure occurred as one part of a general failure of surrounding structure, rather than as a critical failure which initiated disintegration.
18. The availability and use of occupant restraints, such as seat belts, would probably have served to mitigate the degree of injury sustained by many occupants.
19. The large reduction in highway crashes in the general area of the bus accident site, which followed this post-accident grooving of road surface, improvement of median, shoulders, and guardrails, amounting to complete suppression of the accident rate, suggests that the value of such changes may have been underestimated.
20. Increased supervision over the leasing or brokering of charter buses is essential to maintaining a desired level of safety in such charter equipment and operations.
21. The availability of increased supervision by BMCS personnel over the operations and equipment of this interstate carrier would probably have had a salutary effect on the quality of bus maintenance and the qualifications of drivers employed by the carrier.
22. Administrative arrangements in New Jersey allowed drivers who, for cause, were being processed for loss of their driving privilege to be issued new (or renewed) driving licenses of any type, even of temporary nature, without

resolution of questions of their qualifications and fitness to drive.

23. The medical examination form used by NJDMV was inadequate in that it failed to require a report of past medical conditions or a detailed statement of current medical shortcomings affecting driving safety.
24. The NJDMV (driver-licensing authority) does not conform to the Federal Highway Safety Program Standards insofar as performance of the following is concerned:
  - a. The "single license" concept (instead, having separate licenses for regular operation and for busdriving, both held concurrently);
  - b. Rapid communication of data (which was on the records, but not transmitted to the point of need); and
  - c. Professional interview for "points" traffic violators or drivers with high accident experience.
25. The operation of the bus on this trip was without Interstate Commerce Commission authority.

#### V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was either dynamic or viscous hydroplaning of the front wheels of the bus which initiated a skid from which the driver could not recover. Contributing factors included low basic skid resistance of the pavement in wet weather, and the probable presence of water draining across the pavement in an abnormal manner. The fatalities and injuries were caused by an ineffective highway guardrail which failed to prevent the bus from rolling down an embankment, by bus windows which failed to prevent ejection of some passengers, and in

some cases, by the absence of occupant restraints.

#### VI. RECOMMENDATIONS

The National Transportation Safety Board has directed recommendations to the State of Pennsylvania, dated July 22, 1970, which are shown in Appendix F. The Safety Board further recommends that:

1. The Federal Highway Administration (FHWA) initiate a program to standardize the determination of wet-highway skid resistance criteria, and to define a specific "skid number" below which surface (and other needed) improvement must be made, to prevent accidents at locations having substandard skid numbers; or use of the highway be suspended; or specific speed controls be instituted. FHWA-approved remedies should be made available to the States in conjunction with FHWA financial assistance in their implementation.
2. The FHWA, in conjunction with the American Association of State Highway Officials (AASHO), initiate a program of testing highway guardrails with a view to establishing standards for guardrails to contain or deflect large or heavy vehicles, such as trucks or buses, under a defined range of accident-impact conditions.
3. The Department of Transportation, in full recognition of the existing limitations on the scope of services renderable by the Bureau of Motor Carrier Safety, FHWA, because of manpower limitations, seek authorization and appropriations from the Congress to expand the strength and operations of said Bureau to enable it to provide the level of supervisory and inspectional

service over interstate chartered buses and charter-bus operations necessary to assure a level of safety commensurate with the public's right to safe travel in chartered vehicles. Notwithstanding any extended delay in attaining a level of greater manpower and service capabilities, the Bureau should take all immediate steps necessary to serve copies of existing Motor Carrier Safety Regulations on all known interstate charter-bus operators and companies, including those operating in the so-called "commercial zones" and municipalities.

4. The several States with the assistance of the Bureau of Motor Carrier Safety (BMCS), of FHWA, and the National Association of Motor Bus Owners (NAMBO) jointly develop and institute programs to establish uniform guides and procedures for promoting safety in intrastate chartered buses and charter bus operations, including the designation of State oversight responsibility.
5. The New Jersey Department of Motor Vehicles (and all States not now doing so) expedite action to bring State driver licensing requirements and procedures into full conformance with the Highway Safety Program Standards promulgated by the National Highway Traffic Safety Administration.
6. The Pennsylvania Department of Transportation (Penn-DOT) review the priority status of the extraordinarily effective highway improvements made after this accident to U.S. Route 22 (I-78), to determine whether some or all of those methods should not be given higher status in relation to other possible highway improvements.
7. The American Association of State Highway Officials recognizing the importance of proper highway drainage

in preventing or minimizing the opportunities for vehicle "hydroplaning," emphasize to all its members the need to provide aggressive inspection and maintenance of median and shoulder drainage systems, and to keep debris, vegetation, and erosion from rendering drainage systems ineffective.

8. FHWA take positive steps toward making available to the bus-traveling public convenient restraints against being ejected from their seats in a crash or rollover, such as are available to motorists and to airline passengers, so that bus passengers will not be denied their rightful opportunity to employ them whenever they so desire. (This recommendation, with similar intent but varying in language, has been made in four prior interstate bus crash reports issued by the Safety Board.).
9. The National Highway Traffic Safety Administration expedite its rulemaking procedures relating to Docket 2-10, "Bus Window Retention and Release," advance notice of proposed rulemaking of which was first issued October 14, 1967, in order to make its contents a mandatory standard at the earliest possible date.
10. The National Highway Traffic Review Administration and the Bureau of Motor Carrier Safety, FHWA, review the Safety Board's Recommendation No. 6 in its Highway Accident Report SS-H-5, "Chartered Interstate Bus Crash Interstate Route I-80S, near Beaver Falls, Pennsylvania, December 26, 1968," which recommendation the Board now reiterates, relating to the question of whether there is need for an indicator to show the direction of heading of the front wheels, and necessary steering-wheel movement, in recovering from emergency situations.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED  
Chairman

/s/ OSCAR M. LAUREL  
Member

/s/ FRANCIS H. McADAMS  
Member

/s/ LOUIS M. THAYER

Isabel A. Burgess, Member, was absent, not voting.



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**APPENDIX A.**  
**Skid-Resistance Tests, U. S. 22 (I-78) near New Smithville, Pennsylvania**

Pennsylvania Dept. of Transportation August, 5, 6, & 7, 1970			Federal Highway Administration August 5, 6, & 7, 1970			Stevens Institute of Technology July 22, 1970		
Test Site 1/	Speed 2/	Skid No.	Test Site	Speed	Skid No.	Test Site	Speed	Skid No.
A (5000)	T-40 T-50 T-60	39 34 30	A	T-40 T-50 T-60 P-47	39 33 31	Before first bridge	T-40	38
B (3000)	T-40 T-50 T-60	40 33 30	B	T-40 T-50 T-60 P-40	37 32 29 47	---	---	---
C (1800)	T-40 T-50 T-60	38 33 26	C	T-40 T-50 T-60 P-30	39 34 29 47	Between the two bridges	T-40 P-40	38 44
D (1400)	T-40 T-50 T-60	39 33 28	D	T-40 T-50 T-60 P-40	38 33 29 38	---	---	---
E (875)	T-40 T-50 T-60	35 29 23	E	T-40 T-50 T-60 P-40	36 31 26 38	After 2nd bridge  Between 2nd bridge and cross- over At the median crossover	T-40 P-40  T-40 P-40  T-40 P-40	34 41  29 39  31 43
F (150)	T-40 T-50 T-60	33 28 23	F	T-40 T-50 T-60 P-40	33 29 24 40	At the accident site (155)	T-40 P-40	31 38
---	---	---	G (1100)	T-40	35	---	---	---

<sup>1</sup> Test site numbers represent distance (feet) east of county lane.

<sup>2</sup> Speeds are in miles per hour. "T" is travel lane, "P" is passing lane. Skid numbers have been rounded off to nearest whole number.

**APPENDIX B.  
VEHICLE SPECIFICATION INFORMATION**

General	Owner: Tedesco Bus Company – Bus . . . . . No. 2065 Manufacturer . . . . . General Motors Corp. Date Delivered by Manufacturer . . . . . May 11, 1967 Model Number . . . . . SDM 5302 Serial Number . . . . . 1013 Seating Capacity . . . . . 53 (plus driver)
Dimensions	Length, Bumper to Bumper . . . . . 40 feet Width . . . . . 95 3/4 inches Height . . . . . 120 1/4 inches Wheel Base . . . . . 284 3/4 inches Front Axle to Bumper . . . . . 82 1/2 inches Rear Axle to Bumper . . . . . 112 1/2 inches Estimated Weight (as loaded 7/11/71) . . . . . 31,020 pounds Front Axle Weight . . . . . 9,145 pounds Rear Axle Weight . . . . . 21,875 pounds Center of Gravity, fore and aft . . . . . 283 inches from front bumper Center of Gravity, above ground . . . . . 45.7 inches above ground
Engine	Manufacturer . . . . . General Motors Corp. Model . . . . . 8V-71 Diesel, Rear Mounted Horsepower . . . . . Governed Speed (no load) . . . . . 2150 RPM
Transmission	Type . . . . . Four-speed, Mechanical Attainable Speed in Shift Position: First Gear . . . . . 16.9 MPH Second Gear . . . . . 25.9 MPH Third Gear . . . . . 43.1 MPH Fourth Gear . . . . . 73 MPH
Rear Axle	Ratio . . . . . 4 1/9 to 1
Tire Size	Front (tube-type Firestone) . . . . . 11.50 x 22.5 Rear, Duals (tube-type Michelin) . . . . . 11.00 x 20
Fuel Tank	Capacity . . . . . 125 Gallons (Diesel) Location . . . . . Ahead of right rear wheels (Anti-spill device in filler neck)
Brakes	Conventional air-brake system with DOT Spec. 393.44 emergency rear-brake application and front-brake line cutout valve.
Speedometer	Wagner Tachograph with speedometer incorporated.

## APPENDIX C

### VEHICLE DESIGN

#### General

Basically, the bus was of monocoque construction, with stress loadings supported by the aluminum outer skin riveted to frame components. This design had been subjected to accident environments, including rollover tests.

1. Ceiling Paneling: Melamine plastic material fastened to the inner flanges of the transverse structural roof bows.
2. Internal Overhead Lamps: Center mounted on the aisle ceiling, with glass lenses.
3. Overhead Baggage Racks: Mounted over the seats on each side of the aisle, consisted of seven aluminum tubes, horizontally strung from front to rear, suspended from the bus ceiling. The tubes were not continuous, and were joined with plugs inserted in the ends of the two adjoining tubes. A large tube facing the aisle doubled as standee-passenger grab rail.
4. Passenger Seats: Fastened to a fore-and-aft track by means of bolts and nuts. The rears of seat backs were cushioned to reduce injury on impact.
5. Windows: Designed to meet Department of Transportation (DOT) Regulations 393.61(b) and (c), and State regulations. The forces required to push out the windows are designed to be: 75 to 85 pounds at the latch on the bottom sill, 125 pounds between the latches at the bottom sill, and 175 to 190 pounds at the center of the window.

Windows were of the elongated two-pane "picture-window" type with sliding panes. Air conditioning voided the need to open these windows for ventilation.

#### Brakes

Brakes were designed to meet DOT Regulations, including Part 393.44 of the regulations. The bus had a hand-operated valve to the right of, and below, the driver's seat. Actuation of this valve would simultaneously isolate the front-axle brakes, apply air to the rear-axle brakes, and actuate the stop lights.

Normal brake air pressure was 95 to 105 pounds per square inch (p.s.i.) Stopping distance (at 65 p.s.i. air pressure) was 30 feet from 20 miles per hour (m.p.h.), and 120 feet from 40 m.p.h., with the bus fully loaded. Average deceleration was 14.3 feet per second.

#### Transmission Shift Control

The shift control lever had a conventional "H"-type pattern, four forward speeds, with offset reverse position, operating through two shift rails to the rear-mounted transmission for gear selection.

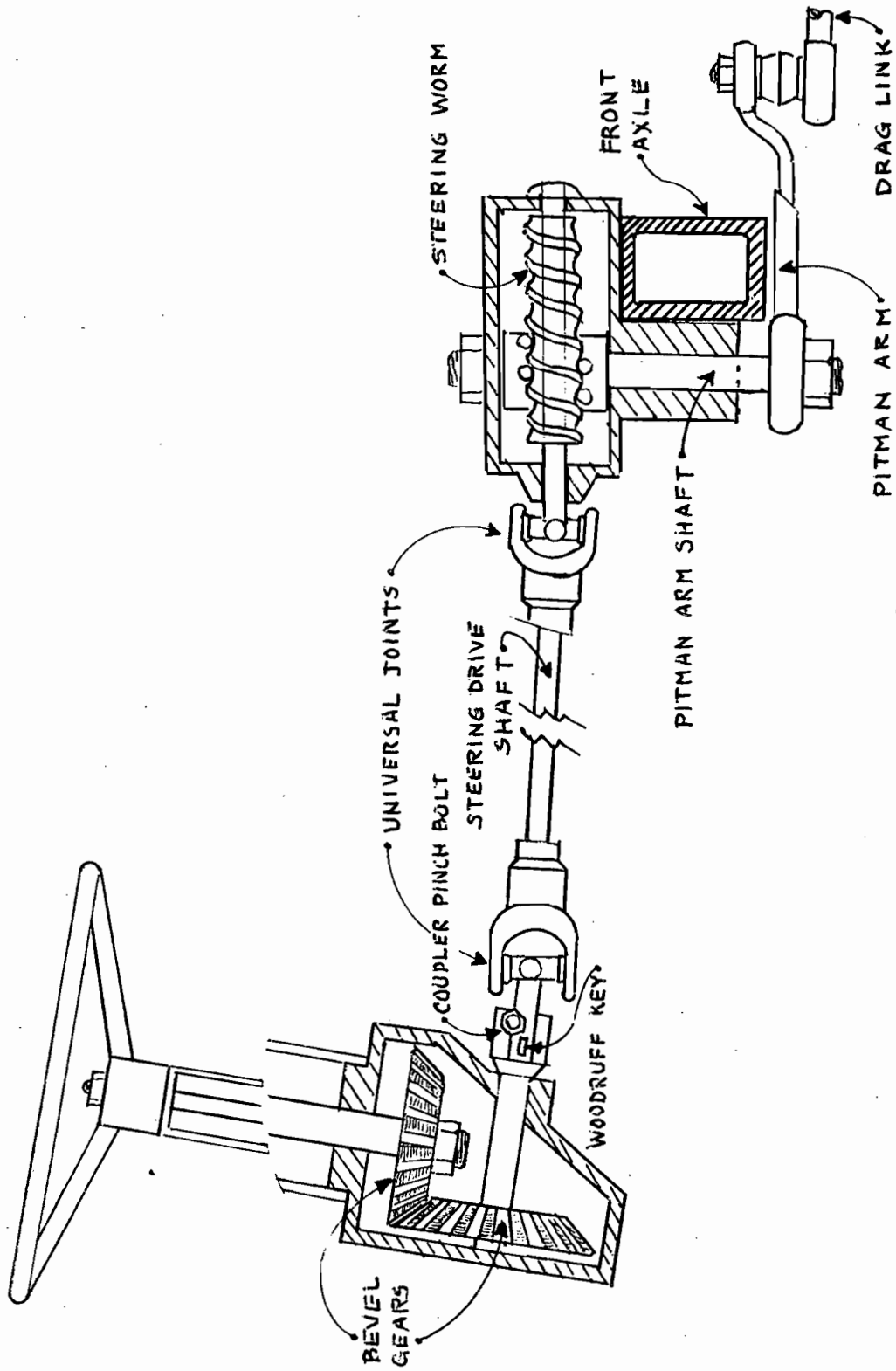
#### Steering Assembly

To provide the basis for understanding the significance of damage and looseness which was found in certain steering components, the principal components of the steering system are described briefly: (see Fig. A, App. C)

1. *Steering Wheel*, 22 inches in diameter, splined to a

2. *Steering Wheel Shaft*, enclosed in a tube, which went down almost vertically to the
3. *Bevel Gears*, contained in a bevel-gear box located at the front of the chassis; these gears changed the direction of rotation of the steering-wheel shaft input, at the same time providing a reduction of 1.5 to 1 on the
4. *Steering Drive Shaft*, which linked the bevel gears to the
5. *Steering Worm Gear*, mounted on the front axle, which reduced rotational input 26.5 to one, and converted rotational motion of the steering drive shaft to a right-and-left motion of the
6. *Pitman Arm*, located beneath the steering worm gear. Through a
7. *Drag Link*, the right-and-left motion of the pitman arm was transmitted to the
8. *Steering Lever Arm*, on the left front wheel, which turned the left wheel right or left. From the left wheel, a
9. *Tie Rod* linked the left-wheel movement to the right wheel. To prevent rotational slippage, an input ("Woodruff") key locked the steering-wheel shaft (2, above) to the input bevel-gear shaft. An output ("Woodruff") key locked the forward end of the steering drive shaft (4, above) to the output bevel gear, and a *split type coupling* with *pinch bolt* prevented the shaft (2) from slipping off the output bevel-gear shaft. Near the front and rear ends of the steering drive shaft (4) were universal joints to allow flexing of the shaft as the bus position (in relation to the front axle) reacted to highway irregularities and load variations.

Final steering ratio was 38.4 to one (that is, a turn of  $38.4^\circ$  at the steering wheel would produce  $1^\circ$  of turn at the front wheels), with seven and three-quarters turns of the steering wheel required to turn the front wheels from full-right to full-left position.



APPENDIX C

FIGURE A. SCHEMATIC OF STEERING SYSTEM COMPONENTS

#### APPENDIX D.

This Appendix item consists of five photographs which were taken to illustrate the findings of water runoff tests, identified as follows:

- A. Looking southeast across highway U.S. 22 (I-78) with westbound lanes in foreground, at the paved median crossover point.
- B. Looking northwest across the westbound lanes of U.S. 22, taken from approximately the same location as Figure A, above.
- C. Looking westward along the westbound shoulder area, U.S. 22, directly opposite the paved median crossover point.
- D. Looking westward along the south edge of the eastbound median, U.S. 22, just east of the paved median crossover point.
- E. Looking eastward along the south edge of the median, U.S. 22, taken from about the same location as Figure D, above.

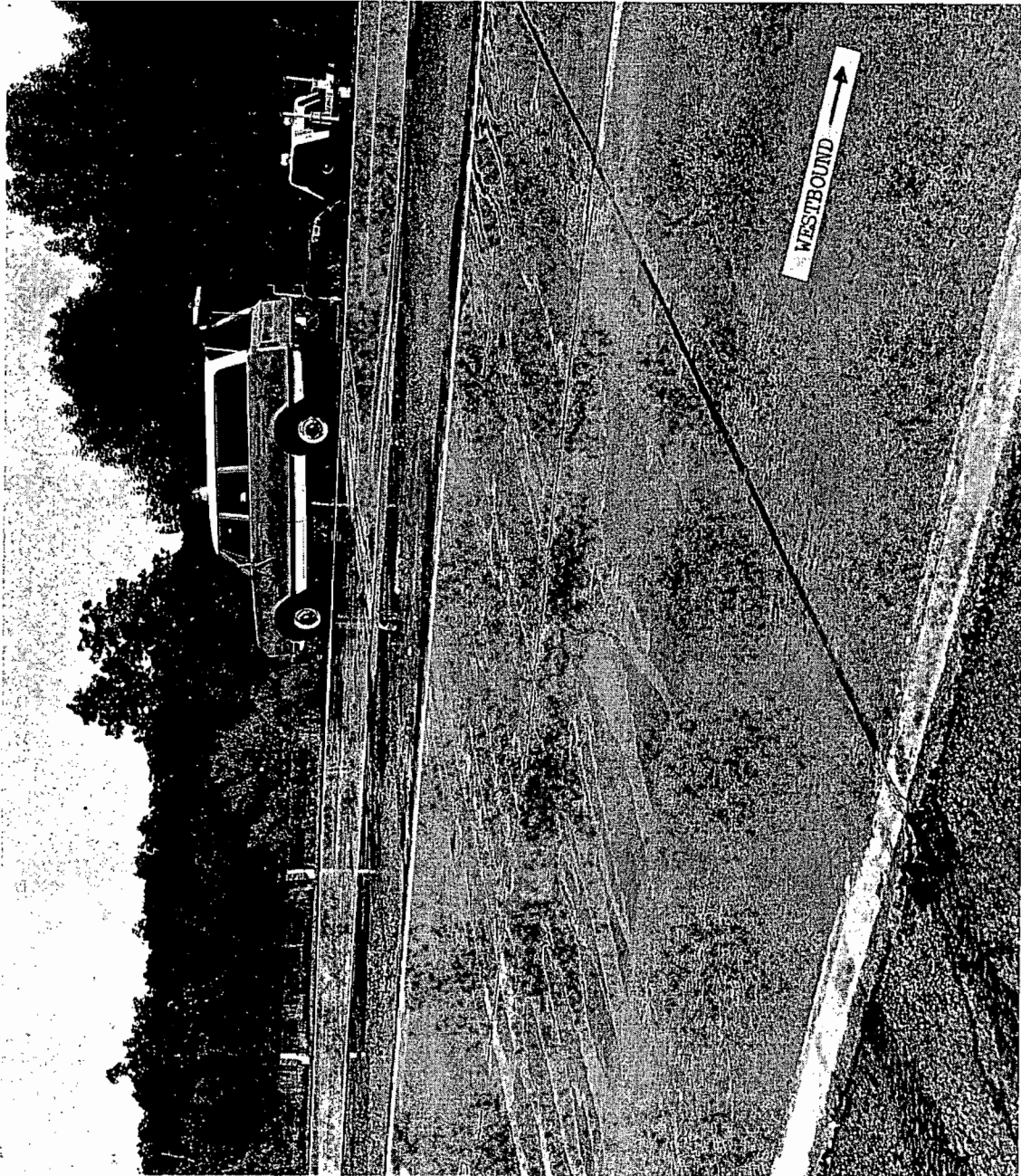


Figure A. Course of water released on eastbound shoulder, collecting and crossing to westbound lanes at the paved crossover point.



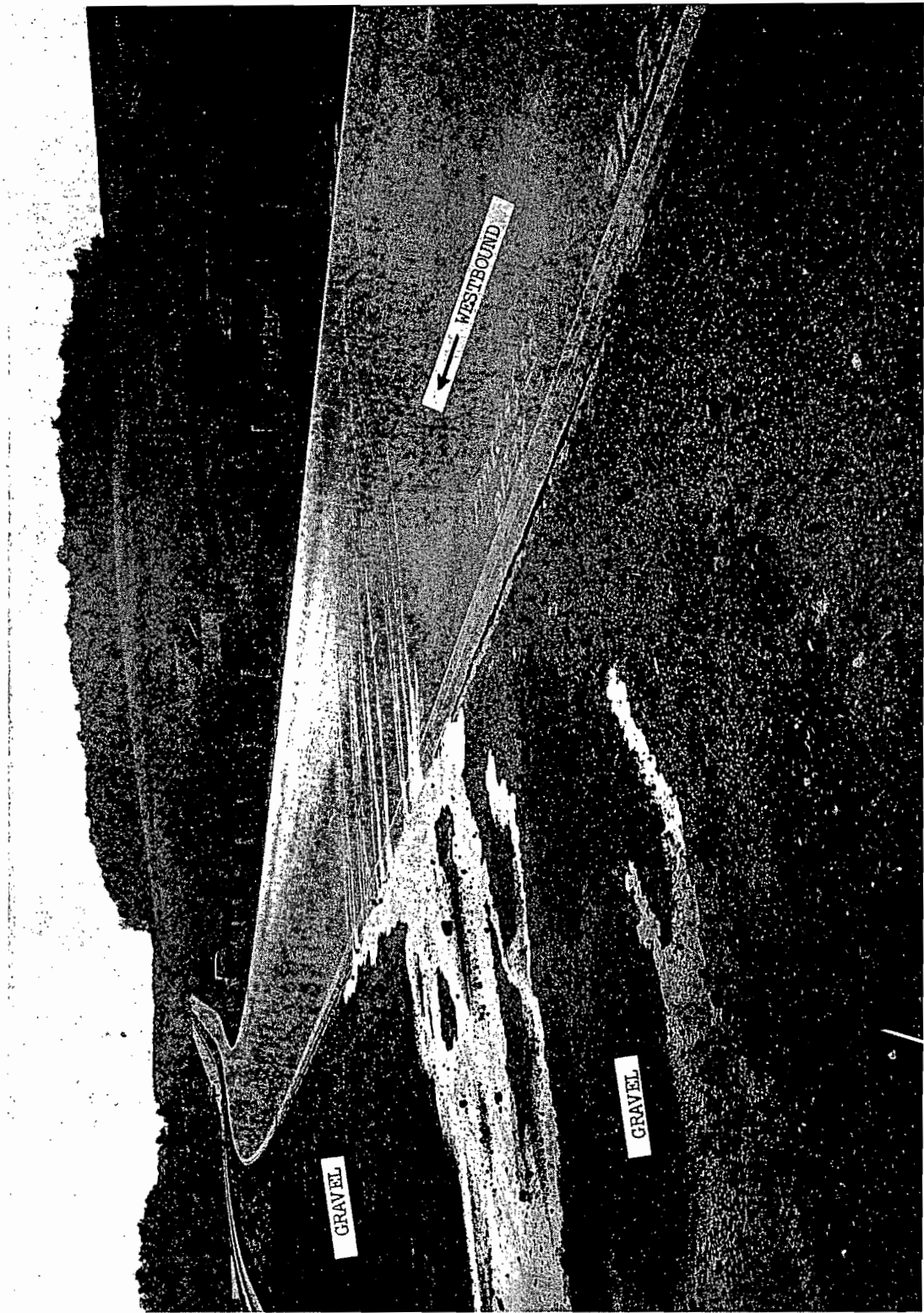


Figure B. Course of water released on eastbound shoulder, crossing to westbound lanes at the paved crossover point. Coarse gravel deposits appear to be crushed stone washed from the eastbound median, resulting from water flow several hundred feet eastward of the crossover point.



Figure C. Course of water released on eastbound shoulder, as it left the westbound lanes via the westbound shoulder. Erosion of westbound shoulder appears to be caused by excessive runoff at the area opposite the paved median crossover point.



Figure D. Looking west along the westbound median. Erosion of the median edge denotes the course of water runoff (arrows) which had bypassed the median drain outlets and crossed the median at the paved crossover point.

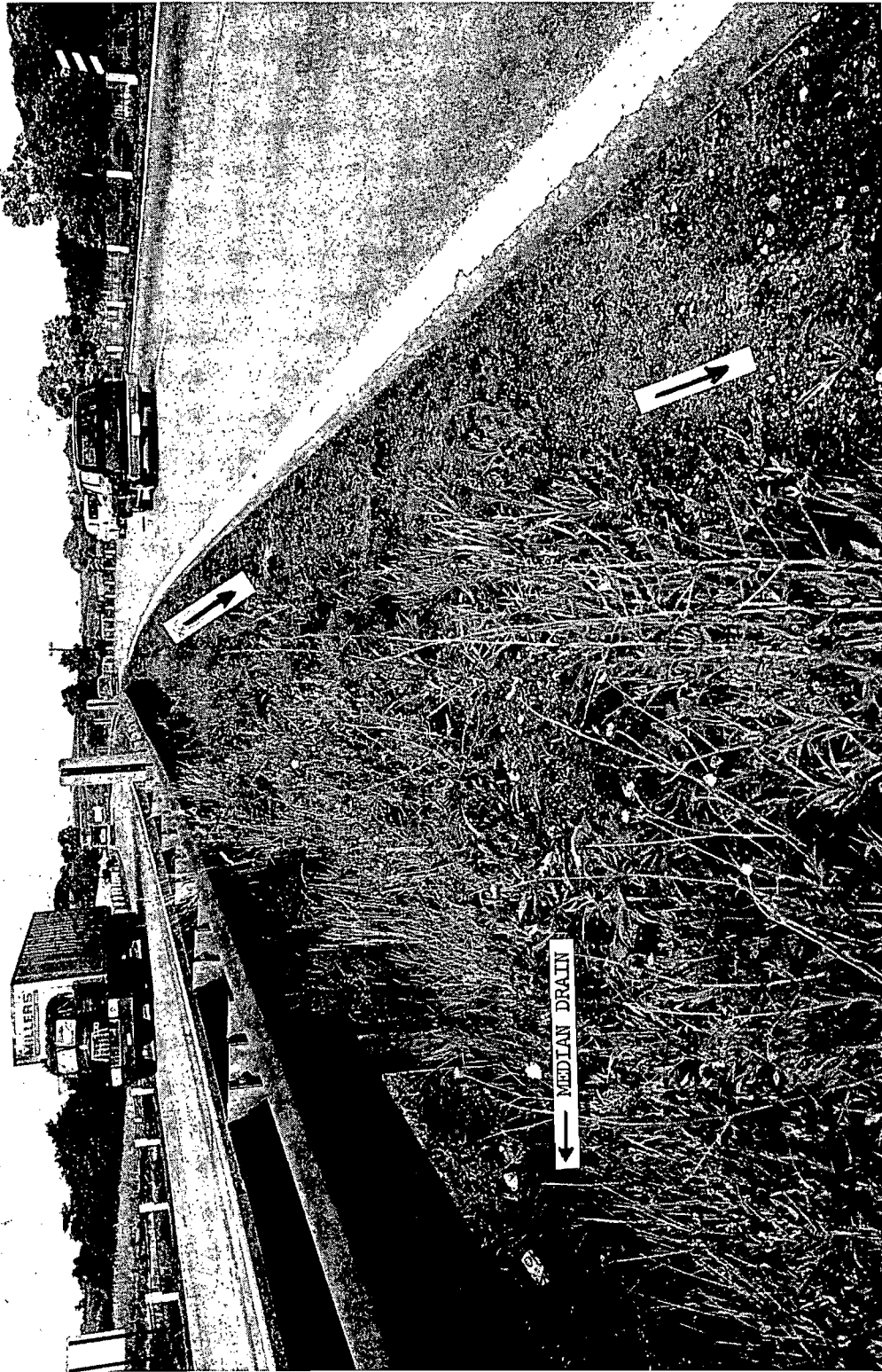


Figure E. Looking east along the eastbound median. Erosion of the median edge denotes the course of water runoff (arrows) which had bypassed the median drain outlets and run westward to the paved median crossover point. Erosion extended for several hundred feet to the east.

**APPENDIX E**

**FREQUENCY OF ACCIDENTS AT VARIOUS LOCATIONS EAST OF LEHIGH COUNTY LINE U. S. 22, FOR THE YEARS 1966-70**

Distance East of County Line	1966		1967		1968		1969		1970*		TOTAL
	W	E	W	E	W	E	W	E	W	E	
At County Line	0	3	2	1	1	0	1	2	3	0	13
100 Feet	2	2	1	0	4	0	2	0	1	0	12
200 " **	0	0	1	0	1	1	2	0	2	0	7
300 "	0	0	0	0	0	0	0	1	0	0	1
400 "	0	0	0	0	0	2	0	0	1	0	3
500 "	1	1	1	1	2	1	0	0	0	0	7
600 "	1	0	0	0	0	0	0	0	0	1	2
700 "	0	0	0	0	0	1	0	0	0	0	1
800 "	0	0	0	1	0	1	1	0	0	0	3
900 "	0	0	0	0	0	1	0	0	0	0	1
1000 "	0	1	0	0	0	3	0	0	1	0	5
1100 "	0	0	0	0	0	0	1	0	0	0	1
1200 "	1	0	0	0	1	1	0	0	0	0	3
Sub Total	5	7	5	3	9	11	7	3	8	1	W 34 E 25
TOTAL	12		8		20		10		9		59

\*To July 19, 1970                      "W" is Westbound                      "E" is Eastbound  
 \*\*Accident Site was 155 Feet East of County Line

**ACCIDENT SEVERITY**

Fatal Accidents                      5    Persons Killed                      11  
 Injury Accidents                      27    Persons Injured                      98  
 P.D.O. Accidents                      27    Total Property Damage                      \$200,000  
 TOTAL ACCIDENTS                      59    (Reported Accidents Only)

## APPENDIX F

Excerpted below is a portion of a letter addressed to the Honorable Raymond P. Shafer, Governor of the State of Pennsylvania, on July 22, 1970, which excerpt relates to interim recommendations of the National Transportation Safety Board, based on its initial findings in this accident:

“Considering the frequency and severity of the accidents occurring at this location, the Safety Board recommends that until permanent improvements can be made, the State of Pennsylvania take immediate temporary steps in the subject vicinity to:

1. Reduce the existing speed limit of 60 m.p.h. to a safer speed for adverse weather conditions.
2. Increase the skid resistance (coefficient of friction of the surface of the road) to prevent additional skidding accidents.
3. Improve the guardrail to support heavy trucks and/or buses that may impact it and prevent these vehicles from plummeting down the embankment.
4. Post warning signs well in advance of the accident-prone area advising motorists to reduce the speed of their cars through the dangerous area.

“It is further recommended that the State of Pennsylvania consider the correction of this stretch of roadway as a part of the Bureau of Public Roads’ Spot Improvement Program which has been established for the purpose of correcting dangerous high accident frequency locations such as this. . . .”

(s) John H. Reed  
Chairman



## APPENDIX G

### Busdriver's Medical History and Driving Record

The following is a brief chronological summary of the busdriver's medical history and driving record for the period February 1969 through July 21, 1970:

#### a. February 1969

The driver was issued, through his family physician, a BMCS doctor's certificate. The certificate designated the holder as being physically qualified, without limitations, to operate a motor vehicle engaged in interstate commerce.

#### b. March 1969

The driver applied for a New Jersey special license as a busdriver and schoolbus driver, preparatory to employment as a schoolbus driver. After completing the necessary forms, he was tested for visual acuity, knowledge of the law, and bus driving skill. He passed the law and road test portions of the applications process, but was found to have impairment of vision which required him to wear glasses when driving. A temporary license was issued.

The driver was denied a schoolbus driver license, but he retained the temporary license and, in April 1969, commenced driving a charter bus for a local passenger motor carrier.

#### c. June 1969

The driver's employment was terminated and, in July 1969, he commenced driving for another local passenger motor carrier.

#### d. August 1969

On the return portion of a charter trip to Washington, D.C., the driver gradually developed blurring vision, aphasia, and weakness in the right extremities. He was taken from the bus and admitted to the General Division of the Wilmington, Delaware, Medical Center. A summary of his hospitalization disclosed that he had suffered an intracerebral hemorrhage.<sup>1</sup> The summary further stated that he was suffering from severe hypertensive disease and had an abnormal electrocardiogram compatible with left ventricular hypertrophy<sup>2</sup> and myocardial ischemia.<sup>3</sup> This summary was forwarded to the driver's family physician, to whom he was released after 5 days of treatment. He did not return to work for that charter carrier.

<sup>1</sup> A leakage of blood from a blood vessel in the cerebral portion of the brain.

<sup>2</sup> An increase of muscle mass of the left ventricle of the heart.

<sup>3</sup> An area of heart muscle without adequate oxygen because of an inadequate blood supply to the muscle area so affected.

**e. December 1969**

On two separate dates during this month, the driver was convicted in a local court for individual traffic law violations, bringing his traffic violation accumulations within a 3-year period to a total of 14 points.<sup>4</sup>

**f. March 1970**

The driver again applied for a New Jersey special busdriver license. His medical examination, an integral part of the application process, was conducted by his same family physician and the findings recorded on the official form in response to general medical questions. Among other entries were: a diastolic blood pressure of 140 mm.Hg; heart, normal; no disqualifying abnormality or disease. It closed with a recommendation that the applicant was physically fit to operate a motor vehicle.

The completed application and medical examination forms were presented at a local Division of Motor Vehicles driver-qualification center, where the driver was tested for visual acuity and knowledge of traffic regulations. The road test portion of the process was waived on the basis of a similar test administered 1 year prior. He was issued a temporary special busdriver license, and his forms were forwarded to the New Jersey Division of Motor Vehicles.

**g. April 1970**

The driver's application form was found to contain two incorrect statements. A form letter was sent advising him of the "misstatement of fact" in each of the two statements, and provided him an opportunity to "submit any additional information" he might have in furthering the evaluation of his application. He appeared at the Division of Motor Vehicles and reversed his answers to the questioned statements. The application was then routed for processing, and subsequently approved.

Concurrently, a notation, "Proposed Driver License Suspension Point System," was entered into his traffic record.

**h. May 1970**

The driver received a Division of Motor Vehicles form letter advising him of the proposed suspension of his driving privilege as a traffic law violation repeater under the New Jersey Point System Regulation. The letter was accompanied by a form which offered him, in lieu of suspension, the choice of a hearing or attendance at a driver-improvement school. He returned the form indicating that he would attend the driver-improvement school.

He was issued a New Jersey special busdriver license, No. A4029, and was employed as a part-time driver by another local passenger motor carrier. His New Jersey driver's license expired.

**i. June 1970**

The driver renewed his New Jersey driver's license, No. D095534486-11242, and was scheduled for attendance at a driver-improvement school in August 1970. During June, he drove a charter bus on three separate occasions.

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<sup>4</sup>New Jersey law required that action to suspend a license be initiated when a driver had accumulated 12 (or more) points.



## j. July 1970

The driver was employed by the Tedesco Bus company, Bayonne, New Jersey, on the 9th of July, and on July 15 was assigned as the driver of the accident bus. Witnesses stated that during the trip, the driver had difficulty in shifting gears and commented on his unfamiliarity with this model of bus. Witnesses were unsure whether he wore glasses while driving the bus.

In the crash, he suffered a fracture of the left clavicle, abrasions of the left scapular area, lacerations of the scalp and right hand, and was admitted to the Allentown General Hospital. His hospitalization record revealed an old, posterior-wall myocardial infarction and a more recent anterior-wall ischemia. His blood pressure on admittance was 170/110, but subsequently rose to 220/160. After 6 days, he was discharged to the care of his family physician.

### Analysis of Driver Record

In 7 years, the busdriver was involved in nine accidents and was convicted for six traffic violations. His driving privilege was suspended on five separate occasions—three for failure to comply with the New Jersey Financial Responsibility Law, one under the New Jersey Point System Regulation, and one for driver improvement. Such a case history should have been promptly flagged, reviewed, evaluated, and coordinated with applications for new (or renewed) driver license or applications for special driving license.

The successful implementation of driver-improvement action requires that properly qualified driver-improvement analysts review drivers' records to diagnose driver problems through personal interviews with those identified as habitual violators, and to prescribe the appropriate course of corrective action. The New Jersey Division of Motor Vehicles (NJDMV) did not employ such driver-improvement analysts or the personal interview technique.

While his driver's license was under suspension, the busdriver was involved in three recorded accidents, suggesting a lack of coordination or communication among the public agencies involved in the driver-control process—police, courts, and driver-license agency. The communications and data handling system used by NJDMV did not have adequate response capability to meet the needs of agencies seeking license suspension information.

#### a. Licensing History of the Driver

When, in 1969, the driver applied for a special bus and schoolbus driver license, his traffic accident and violations record was already substantial, yet he was routinely issued a temporary license. A background check ruled out his employment as a schoolbus driver, but he retained his temporary license and used it to become a driver for a local charter passenger motor carrier.

In 1970, after a disabling illness, when he again applied for a New Jersey special busdriver's license, his driving privilege was then under question as violator of the New Jersey Point System Regulation. This did not prevent issuance of a temporary license. A simple review of his traffic record during the preceding year would have revealed one accident, two separate traffic violation convictions, and an accumulation of 14 traffic violation points (against a maximum allowable of 12 points). Such a record should have precipitated a critical review of his qualifications and fitness, at least to the extent of determining whether his problem stemmed from technicalities or from basic shortcomings in his driving capabilities.

When his application form was reviewed by NJDMV, and two misstatements of fact were found (normally considered as reason enough for rejecting an application), the driver was given an opportunity to correct the misstatements. His corrected application was accepted and he was routinely granted a special busdriver license.

Concurrent with receipt of his special busdriver license, he received a notice of proposed license suspension, based on traffic violations (and points) entered months before he applied for special busdriver license. By being routinely scheduled for driver-improvement school, suspension of his driving privilege was deferred, thus legally licensing him to continue to operate a motor vehicle.

The traffic record itself revealed that his application for special busdriver license was being processed concurrently with his proposed license suspension. There was no indication of interaction between these two processes, clearly related, but clearly opposite in function. The fact of a proposed license suspension, duly entered in the record, should automatically have aborted or delayed the issuance of a special busdriver license.

#### b. Driver's Medical Condition and History

According to medical standards,<sup>5</sup> any person with a chronic diastolic pressure of over 90 mm. Hg, left ventricular hypertrophy, or a history of hypertensive cerebral-vascular damage (intracerebral hemorrhage)—all symptomatic of hypertensive vascular disease—should be ruled not acceptable for passenger transport driver licensure.

August 1969, hospital records showed that the driver had suffered an intracerebral hemorrhage, was suffering from severe hypertensive disease, and had an abnormal electrocardiogram compatible with left ventricular hypertrophy and myocardial ischemia, and that this information was given to the driver's family physician. Despite this knowledge, this same physician only 7 months later indicated on the driver's medical application form that the subject's heart was "normal," and recommended him for special busdriver license.

The NJDMV Medical Examination form did not inquire into an applicant's past medical history, or require the examining physician to describe medical conditions (in other than general terms) which might impair the applicant's driving ability.

Recognizing this problem, authorities<sup>6</sup> have stated that unless specific entries are required to be completed, medical examination responses will be generalized and of minimal value:

"Because of the confidentiality of medical records and the professional nature of the physician-patient relationship generally, physicians will not report a patient's condition to licensing authorities unless *required to do so by law*." (Emphasis added.)

Because of the failure of this system, the driver-licensing authority was denied information that was essential to making a determination of the propriety of issuing a special busdriver's license in this case. This failure, in view of a physician's first loyalty to his patient, raises questions as to the appropriateness of permitting an applicant's family (or regular) physician to complete the medical examination forms for such special driver license.

<sup>5</sup>"Driver Licensing Guidelines for Medical Advisory Boards—Relating Functional Ability to Class of Vehicle," U.S. Public Health Service, 1969.

<sup>6</sup>"Physician's Guide for Determining Driver Limitation," American Medical Association, 535 N. Dearborn Street, Chicago, Illinois, 1968.

Upon receipt of an application form, the NJDMV checked it for completeness and for the examining physician's recommendation. This was a routine clerical review, rather than a professional evaluation of the responses. A positive endorsement by the examining physician routinely resulted in the acceptance of the form without further review. This procedure, as reflected in the form, tended to subvert the responsibility of the licensing authority by making an examining physician the one who decided, in effect, whether an applicant was medically qualified to drive a carrier, without a requirement to report pertinent medical facts.

Motor Carrier Safety Regulations, FHWA, in their recently amended driver qualifications,<sup>7</sup> state that a driver could be physically disqualified if he had a current clinical diagnosis of high blood pressure, or any of the cardiovascular diseases known to be accompanied by syncope, dyspnea, collapse, or congestive cardiac failure. Under these requirements, the applicant would almost certainly have been denied clearance for interstate carrier operation.

### c. Experience and Qualifications

The driver's employment record, revealing short tenures with four individual carriers, none of which lasted more than 3 months, and his lack of familiarity with this model of bus would suggest some lack of capability. However, only one former employer questioned his driving ability and suggested that it was a factor in his termination from that carrier.

Although there was no evidence that inability of the driver to perform safely was a direct factor in the causation of the accident, the system which was designed to deny licenses to unqualified (or to high risk) applicants failed to perform its intended role.

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<sup>7</sup>Motor Carrier Safety Regulations, FHWA, Part 391.41 (Qualifications of Drivers), (4), (6), effective January 1, 1971. While clearly not retroactive, these upgraded requirements now reflect what the professional and medical authorities in the field of driver licensing have espoused for some time.

## APPENDIX H

The following dimensions apply to U.S. Route 22 (I-78) in the vicinity of the accident site:

The roadway in the right curve is superelevated approximately 7/16 inch per foot (or 3.6 percent) maximum. Westbound, the highway grade in this area was -0.40 percent (downgrade).

This limited-access highway was opened to traffic in 1957. At the site of the accident, there are two 12-foot travel lanes in each direction. The pavement consists of 10 inches of uniform reinforced portland-cement concrete. The westbound right shoulder was 8 feet wide—5 feet paved with asphalt and stone, and 3 feet with dirt. The left (median) shoulder was 12 feet wide—8 feet grass and 4 feet asphalt. The median between the opposing lanes of travel is 20 feet wide. There is a 53-foot paved crossover opening in the median approximately 875 feet east of the county line. Water drains, located in the median area every 300 feet, connected to 18-inch drain pipes that carried runoff water underneath the eastbound lanes. At the accident site (a fill area), the embankment slope is 1½ to 1, with the terrain elevation about 30 feet below the level of the highway.

### Resurvey of U.S. 22

U.S. Route 22 in the area of the accident, was resurveyed by the Pennsylvania Department of Transportation (Penn-DOT) between July 23 and August 6, 1970. The compound right curve (west) was checked for superelevations, cross-sectional dimensions, and curvature. No discrepancies from the "as built" plans were found. (See Figure 2, drawing of accident site.)

## APPENDIX I

### Interstate Commerce Commission License Status of Broker and Bus Operation.

#### The Bus Company

All vehicles operating in interstate commerce are subject to the economic regulations of the Interstate Commerce Commission, and to the Motor Carrier Safety Regulations of the Federal Highway Administration, Bureau of Motor Carrier Safety.

The Tedesco Bus Company, registered owner of bus No. 2075, a New Jersey passenger motor carrier, did not hold operating authority from the Interstate Commerce Commission. The MC number (106207) lettered on the bus was issued to another company with the same principal owners as this company under ICC Certificate of Public Convenience and Necessity dated May 27, 1969. This certificate defined and limited the service and the termini from which the carrier was authorized to operate:

“Passengers and their baggage, in special operations, in roundtrip sightseeing or pleasure tours, beginning and ending at Keansburg, Hazlet, and Middletown, New Jersey, and extending to points in the United States, including Alaska, but excluding Hawaii.”

This tour began in Lawrence, New York, and was scheduled to end in that city, not an authorized terminus or service point for the carrier.

Bureau of Motor Carrier Safety personnel conducted a post-crash inspection of the bus company's maintenance and personnel records and served the owner with a copy of Motor Carrier Safety (MCS) Regulations. There was no record of any prior BMCS inspection or copy of MCS Regulations having been served.

The bus company's records were for the most part incomplete and not current. The last entry in a maintenance log book was in 1969; there were no vehicle condition reports on file, and personnel records were either nonexistent or unavailable for examination.

#### 7. The Broker<sup>8</sup>

A broker's responsibilities, under the regulations of the ICC, are mainly economic in nature. The only safety-related responsibility provided for in Section 211, Part II (ICC Act) Broker's License, is that a broker not employ any carrier by motor vehicle who or which is not the holder of an effective certificate or permit issued as provided in the Act.

This trip was arranged by a passenger broker who acted as an intermediary between the carrier and the passengers. He contracted with the carrier of his choice for the bus and the driver, and compensated them. He contracted with the passengers for transportation, lodging, meals, and tours, and they compensated him directly. He accompanied the passengers on this trip.

The broker, a New York resident, did not have a broker's license as required by Part II, Section 211(a) of the ICC Act, nor did he keep the appropriate records or furnish a bond to insure financial responsibility as required. He did employ a carrier which was not the lawful holder of an effective ICC certificate.

<sup>8</sup> A "Broker" is defined as any person not included in the term "motor carrier" and not a bona fide employee or agent of any such carrier, who or which, as a principal or agent, sells or offers for sale any transportation subject to this part (Part II of the Interstate Commerce Commission Act) or negotiates for or holds himself or itself out by solicitation, advertisements or otherwise, as one who sells, provides, furnishes, contracts or arranges for such transportation.