

NATIONAL TRANSPORTATION SAFETY BOARD

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HIGHWAY ACCIDENT REPORT

INTERSTATE BUS-AUTOMOBILE
COLLISION AND ROLLOVER
ON INDIANA ROUTE 57, SOUTH
OF PETERSBURG, INDIANA
NOVEMBER 24, 1969



NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C. 20591

REPORT NUMBER: NTSB-HAR-71-4

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SS-H-7

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ADOPTED: FEBRUARY 10, 1971

E R R A T A

The following change should be made to the subject report:

Page 17, line 1 of Recommendation
No. 2

Change "National Highway Safety
Bureau" to "National Highway
Traffic Safety Administration"

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<p>16. Abstract: Report of collision involving a bus and an automobile. The bus was traveling southbound on a two-lane highway in dense fog and darkness at 40 to 45 mph. While rounding a right hand curve on a downgrade and approaching an intersection, the busdriver saw headlights of an automobile which he thought was entering the highway from the right and coming toward him. He steered to the right and applied the brakes. The bus swerved clockwise, skidded, and struck the automobile broadside, brushing it southward away from the bus. The automobile had been stopped at the intersection. The fog condition, the curvature and downgrade of the road, and position of the automobile at the intersection caused the busdriver to misperceive the location and position of the automobile. The bus slid sideways and rolled over. There were no injuries to busdriver or passengers during impact with the automobile. The busdriver and all passengers were injured during the bus rollover, three seriously, and a female infant was ejected and fatally injured. The driver of the automobile was slightly injured.</p> <p>The Safety Board determines that the probable cause of this accident was that the busdriver misjudged the location of the automobile because of the illusion created by the fog. Contributing factors were the excessive speed of the bus in dense fog on a wet road and the geometrics of the intersection which compounded the illusory effects of the fog.</p>			
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FOREWORD

This accident was designated a "major accident" by the National Transportation Safety Board because of the Board's interest in the results of collisions between vehicles of different sizes and weights. This report is based upon information taken from reports of investigation prepared by the Indiana State Police, the Bureau of Motor Carrier Safety, Federal Highway Administration, the Multidisciplinary Accident Investigation Team from the Institute for Research in Public Safety, Indiana University, under contract to the National Highway Safety Bureau, and evidence gathered by the Board during its onscene and followup investigation of the collision and rollover. The recommendations contained herein are those of the Board.

INTERSTATE BUS-AUTOMOBILE COLLISION AND
ROLLOVER, INDIANA ROUTE 57, SOUTH OF
PETERSBURG, INDIANA, NOVEMBER 24, 1969

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HIGHWAY ACCIDENT REPORT

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INTERSTATE BUS-AUTOMOBILE COLLISION AND
ROLLOVER, INDIANA ROUTE 57, SOUTH OF
PETERSBURG, INDIANA, NOVEMBER 24, 1969

I. SYNOPSIS

At 5:15 a.m., c.s.t., on November 24, 1969, a scheduled interstate bus carrying 27 passengers was traveling south on Indiana Route 57, in a dense, freezing fog and complete darkness, at 45 miles per hour. While rounding a 3° curve to the right, and approaching the intersection of County Road 125-S (Oatsville Road), 5.6 miles south of Petersburg, Indiana, the busdriver saw headlights of a car which he thought was entering Route 57 from the west and coming toward him. He steered the bus to the right and applied the brakes sharply. However, the car was standing on County Road 125-S, waiting to enter Route 57 from the west. The bus swerved clockwise, skidded sideways, and struck the car broadside. The car was pushed some 110 feet south onto Route 57. The bus continued to slide sideways in a southwesterly direction, and rolled over 270° onto a turfed embankment. No fire ensued.

Neither the busdriver nor any of the passengers were injured during the impact with the car. However, the driver and all passengers were injured during the bus rollover; a female infant passenger was ejected and fatally injured. Only three of the passengers sustained serious injuries. The driver of the car (its only occupant) was slightly injured.

The Safety Board determines that the probable cause of this accident was that the busdriver

misjudged the location of the automobile because of the illusion created by the fog. Contributing factors were the excessive speed of the bus in dense fog on a wet road and the geometrics of the intersection which compounded the illusory effects of the fog.

II. FACTS

A. Terrain

The accident occurred at 5:15 a.m., c.s.t.,¹ on November 24, 1969, on Indiana Route 57, at the intersection of county road 125-S (Oatsville Road), 5.6 miles south of Petersburg, Indiana. This is a moderately built up area of residences and small businesses, with some four accesses per quarter mile. At this point, Route 57 enters gently rolling hills. On the northeast corner of the intersection is a store set back 50 feet from the highway, and on the other three corners are residences some 60 to 100 feet back from the highway. (Figure 1 and Appendix 3.)

Southwest of the intersection, a lawn embankment rises gradually from the highway right-of-way. A cement-lined drainage ditch begins on the south side of Oatsville Road and curves south to parallel Route 57, 15 feet from the pavement and 3 feet below the highway level.

¹All times herein are central standard time.

Other than limitations imposed by the horizontal and vertical curvature of the terrain and highway, there are no obstructions to the view just north of the intersection.

B. Highway

Indiana State Route 57 is a 24-foot two-lane highway of traffic-polished asphaltic concrete, in good repair.

There is one 12-foot lane in each direction, north and south, separated by solid, double yellow lines between which there is an intermittent white line. A transitional curve to the right, southbound, begins 600 feet north of the accident site; at the scene, the curve is a steady 3° per 100 feet to the right, with a superelevation (west to east) of 5 percent, and a grade of minus 1.2 percent. South of the scene, the downslope gradually increases. The posted speed limit on the highway is 65 m.p.h.

On the right side, southbound, the asphaltic concrete shoulder is irregularly defined, 3 to 4 feet in width, and blends into a graded soil area. For a distance of 100 feet north of the intersection, the shoulder of mixed gravel and soil widens to about 12 feet, and has been worn by traffic which turns right (west) into Oatsville Road.

Oatsville Road is a 20-foot wide asphaltic concrete road, which crosses Route 57 at an angle of about 68 degrees. Beginning 100 feet west, it approaches Route 57 in a minus 2.7 percent grade. Starting at a point 40 feet west of the intersection, the sides of Oatsville Road have been filled to form widened turning areas for traffic entering or leaving Route 57. At the western pavement alignment with Route 57, Oatsville Road is flared to a width of 56 feet.

C. Traffic Control Devices

There are no traffic signals at the intersection of Route 57 and Oatsville Road. On Route 57, there are solid double yellow centerlines, between which is an intermittent white line. Painted solid white lines, 4 inches wide, mark the outer edges of the pavement. All painted lines terminate at the point where Oatsville

Road flares into Route 57, and resume at a point 56 feet south of the intersection. All lines were well painted and clearly visible.

The following signs were located north of the intersection for southbound traffic:

1. "Slippery When Wet"—1 mile.
2. Right Curve (black arrow on yellow background)—1,500 feet.
3. "Do Not Pass"—1,000 feet.

There was no painted centerline or stopline on Oatsville Road. A conventional stop sign was located on the south side of Oatsville Road 55 feet west of Route 57.

D. Weather

On the morning of this accident, a dense fog had formed over a broad area extending many miles to the north. Residents and drivers said the fog was about the worst they had experienced locally, with visibility ranging from 20 feet to 100 feet. One driver said he considered it unsafe to drive more than 15 or 20 miles per hour that morning; the State trooper who responded to the accident said he could safely drive no more than 25 m.p.h. in responding to the call.

Daylight had not yet begun to break, and, with no artificial lighting, total darkness prevailed. Air temperature was just above freezing and the wind was virtually calm. Ice formed on exposed metal accessories of moving vehicles. There was no measurable precipitation, but the road was wet as a result of fog condensation.

E. Accident Scene

The point of impact was identified by gouge marks in the pavement on the north side of Oatsville Road, west of its intersection with Indiana Route 57. (Figure 2 and Appendix 4.)

A set of skid marks, which began at the painted white line marking the outer edge of Indiana Route 57 on its west side, 85 feet north of the point of impact, angled to the west into Oatsville Road, and continued beyond the initial point of impact approximately 28 feet to a turfed embankment.

**SCENE OF
BUS-AUTOMOBILE
COLLISION**

NOV. 24, 1969

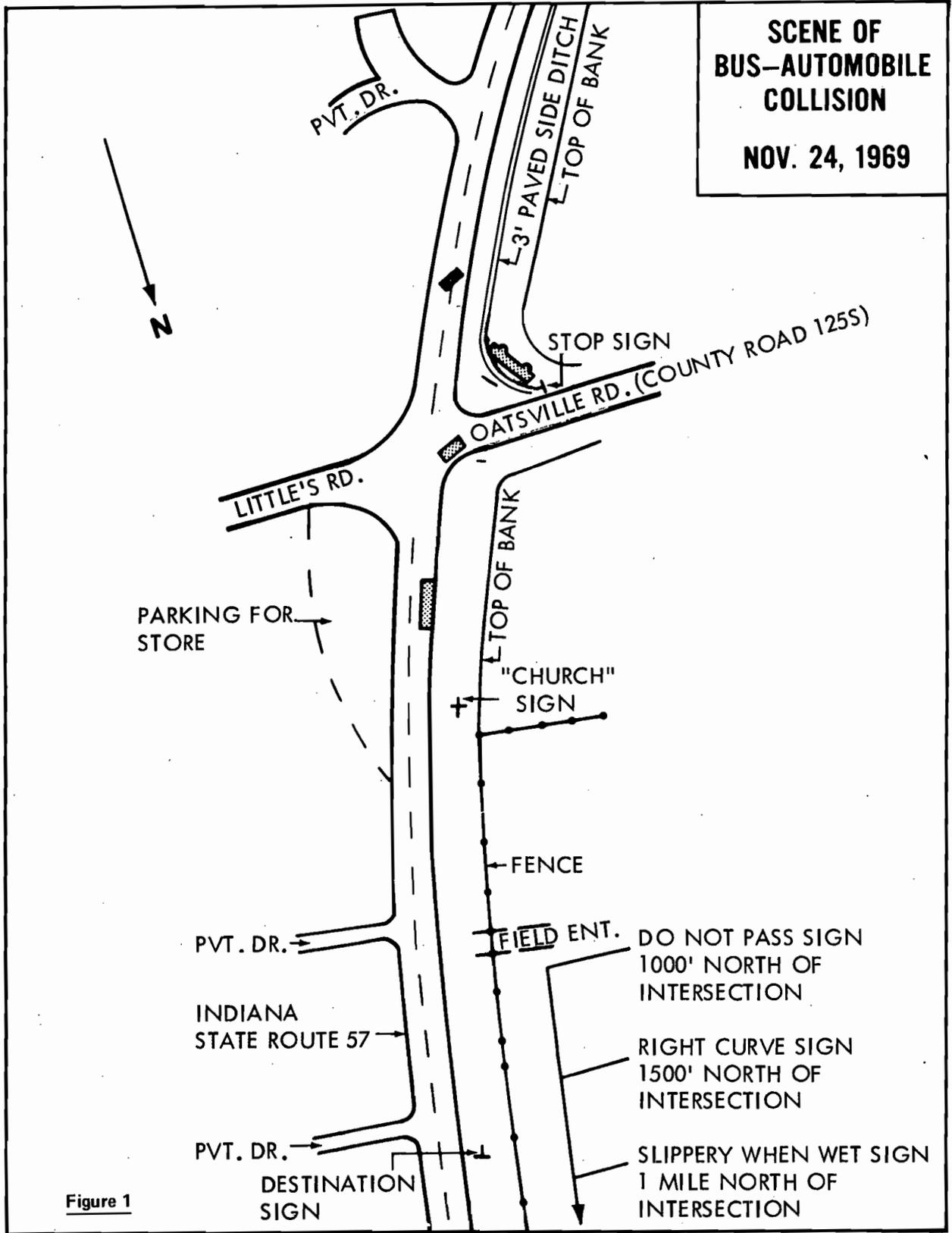


Figure 1

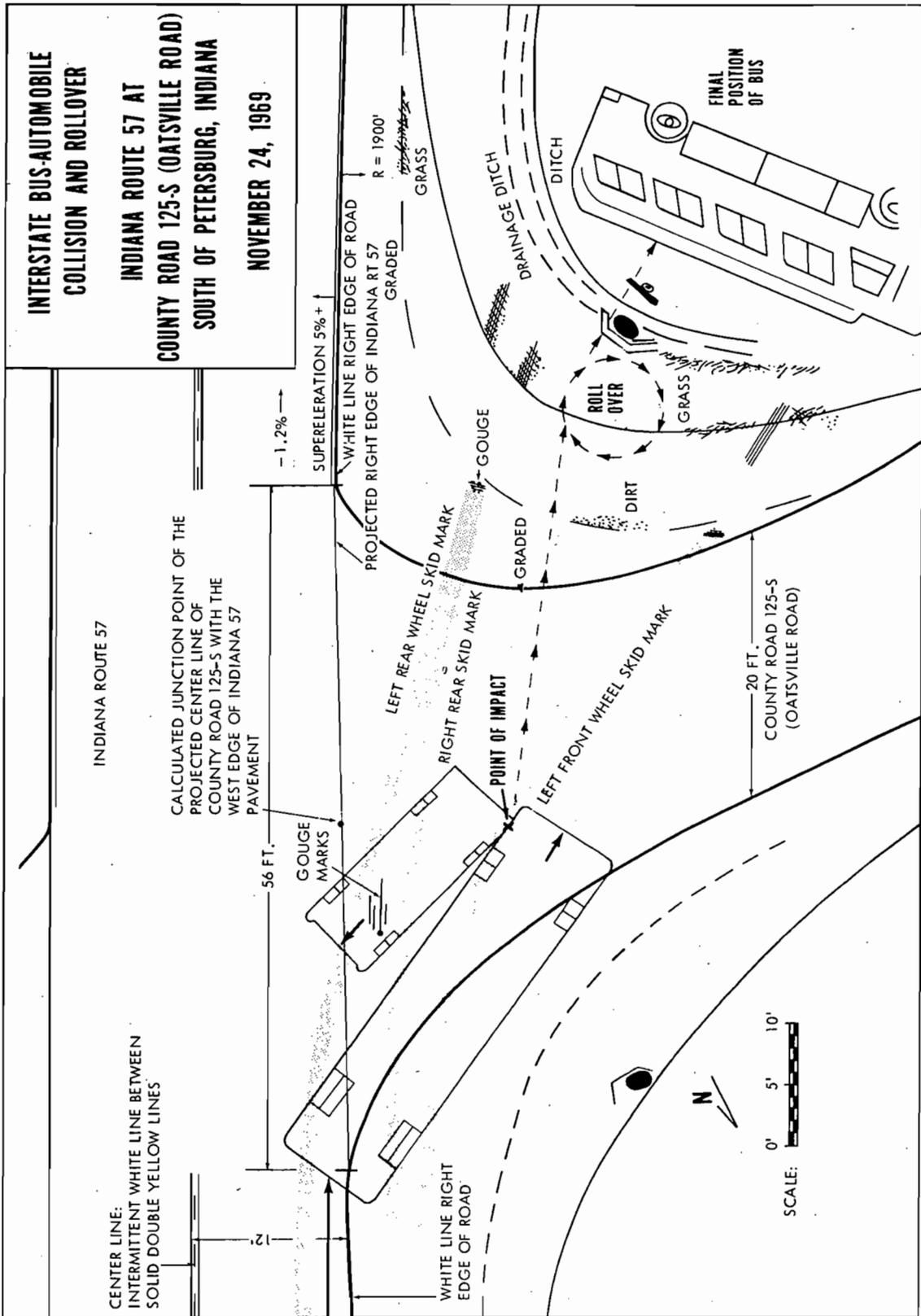


Figure 2

When it came to rest, the bus lay on its right side on the grassy upslope beyond the drainage ditch south of Oatsville Road and approximately 32 feet beyond the initial rollover point, headed in a northwest direction.

The automobile remained upright, but was propelled to the center of Indiana Route 57, 110 feet south of the point of impact, and came to rest headed in a northeast direction. Its only occupant, the driver, remained in the vehicle.

F. Vehicles

1. **Bus:** The bus was a 1966 General Motors, 38 passenger coach, Model PD-4107, equipped with a diesel engine, four-speed manual transmission, power steering, and airbrakes. It was equipped with air conditioning and a lavatory. This bus model features a raised deck monocoque, primarily aluminum over steel design, with two steps up from the driver's level to the main passenger area. The roofline is stepped up 18 inches at this point.

The bus had four long side windows on each side, hinged at the top and latched at the bottom, of "pushout" design,² one-piece windshield and a rear window, and two small windows adjacent to the driver's seat, with a large somewhat triangular fixed window in the "step-up" area, on each side.

Ceiling material was laminated melamine-type plastic. Overhead parcel shelves were on each side, suspended at the aisle edge from the ceiling, with extruded aluminum edging and plastic-coated plywood shelf material. Seats are individual semireclining type, with 10 rows of paired seats on the left side, and nine rows on the right. The lavatory occupied the extreme right rear, with access from the aisle.

The 8-cylinder diesel engine was rear-mounted, driving dual wheels. Gross vehicle weight (g.v.w.) at the time of the accident was estimated at 26,400 pounds, with 10,100 on the front wheels and 16,300 on the rear wheels. Center of gravity (c.g.) was calculated to have

²Windows met the "push out window" requirements of Bureau of Motor Carrier Regulations 393.61(c).

been 162 inches back of the front axle and 52.3 inches above the ground. Calculated stability factor³ was approximately 0.86.

The tires, singles on the front and duals on the rear, were Goodyear 11.50 by 22.50 inches, tubeless. The air pressure and tread depth were as follows:

	<i>Air pressure</i>	<i>Tread depth</i>
Left front	85 p.s.i.	15/32 inches
Right front	85 p.s.i.	18/32 inches
Left rear outside	75 p.s.i.	6/32 inches
Left rear inside	95 p.s.i.	6/32 inches
Right rear outside	78 p.s.i.	5/32 inches
Right rear inside	75 p.s.i.	5/32 inches

The treads were torn around the circumference of both left rear tires. The two front tires had the original tread. The four rear tires had each been regrooved. Each tire contained four grooves and the grooves were in a straight line extending around the circumference of the tire.

There was no evidence to indicate other than normal performance of all safety-related items before the crash. Inspection of airhoses, brake drums, brake linings, and power steering after the accident reflected normal conditions.

2. **Automobile:** The automobile was a 1964 Pontiac Bonneville Brougham, four-door hard-top, equipped with automatic transmission, power steering, and power brakes. The odometer indicated 64,431 miles. The headlights were on low beam, the windshield wipers and defroster were in operation, and the left front window was rolled down. All relevant systems were operating normally. The automobile was owned by a relative of the driver. The automobile was equipped with front seat lap belts. The driver was the only occupant of the automobile and he was not wearing his seat belt.

G. Drivers

1. **Busdriver:** The busdriver was a male, aged 43, and married. At the time of the accident, he

³Stability factor is a measure of the resistance to overturn of a vehicle; it is derived by dividing one-half the wheel tread (to the center of the outer tire) by the center of gravity height.

held an Indiana public passenger chauffeur's license, without restrictions, and a current medical certificate. He had been employed by his current employer since 1951 without being charged with an accident. He had driven the model bus involved in the collision for the past 3 years. He had covered the bus route for 16 years, averaging two round trips per week. His driving log was a day in arrears, but no irregularities in his hours of duty were found. His Indiana driver file contained no record of accidents or convictions for traffic violations. The driver said that he had adequate sleep the night before the accident. He reported for duty at 11:40 p.m. for a scheduled 1:05 a.m. departure from Indianapolis.

2. **Automobile Driver:** The driver of the automobile was a male, aged 18, and married. He had a probationary Indiana driver's license with a clear status and no restrictions noted. He had been driving for about 2 years, with no record of accidents or traffic convictions. He had been driving this automobile for several weeks. He resided a half-mile west of the accident scene, on Oatsville Road, and was familiar with the intersection where the accident occurred.

There was no indication that either driver had been drinking, experienced illness, or had any other condition that would have adversely affected his safe-driving ability.

H. Accident

The bus was on a scheduled run from Indianapolis, Indiana, and was scheduled to depart at 1:05 a.m.; however, it did not leave until 1:15 a.m. From the outset, the driver experienced heavy fog, which caused him to limit his speed to "about 45 m.p.h." There was a 10 to 15 mile stretch between Indianapolis and Bloomington where he encountered almost no fog. The remainder of the trip was made through uniformly heavy fog that gradually worsened.

The bus passed through Petersburg between 5 a.m. and 5:05 a.m., running 20 to 25 minutes late. Petersburg was a flag stop, and, since there

were no passengers, the bus did not stop at the depot.

The bus continued south out of Petersburg in dense, freezing fog and total darkness, traveling at 40 to 45 m.p.h. The road was wet from fog condensation. The bus headlights were on low beam, and the interior lights were off. The windshield wipers and defroster were operating.

The driver said that as he approached the accident site, his mind was on his driving and he was "reaching out to see." He said he was not concerned because he was behind schedule, and did not feel compelled to make up time.

As the bus entered the 3° curve to the right, just north of the intersection of Oatsville Road, the driver suddenly saw headlights and believed that a motor vehicle was on the highway, coming toward him. The bus driver turned the bus to the right and braked suddenly. The bus swerved to the right and skidded clockwise. It impacted an automobile standing on Oatsville Road, broadside. The vehicles collided left-side-to-left side. The impact shoved the automobile south onto Route 57. The bus continued to slide sideways until its left wheels came off the south edge of Oatsville Road, and the bus rolled over a three-quarter turn into the drainage ditch and up onto the grassy embankment. The bus came to rest on its right side, heading in a northwesterly direction.

The automobile driver was en route to work. He approached the intersection of Route 57 on Oatsville Road with his lights on low beam, and his windshield wipers and defrosters operating. He stopped at the west edge of the intersection, with the front of his car protruding several feet onto Route 57, and rolled down the left window to obtain better visibility of southbound traffic. As he stood there, he heard the sound of the bus sliding on gravel and then saw the bus coming toward him.

I. Witnesses

Most of the passengers on the bus were asleep or otherwise preoccupied. One passenger said she had traveled with this driver many times before, and evaluated him as a safe driver. One

woman recalled seeing the lights of the automobile in front of the bus, and she, too, thought it was entering the highway and coming toward them. Only one passenger specifically indicated that he believed the bus was going too fast for the dark and foggy conditions.

An independent witness, standing at the intersection opposite the point of collision, saw the automobile stopped on Oatsville Road. He heard a sound of gravel being thrown about, and saw the bus strike the automobile. He said the fog was too thick for him to see the details of the collision.

J. Damage to Bus

Most significant damage to the bus was on the left upper front and rear of the body. (Figure 3.)

The upper left front area was distorted about 8 inches to the right, with impact marks above the left side of the windshield and on the left leading edge of the stepped-up roof, which was distorted outward (to the right) about 5 or 6 inches, at a point just above the left front wheel. (Appendix 6.)

The left rear top was bent inward and downward, beginning 6 feet forward of the rear end of the bus. Severe impact marks showed on the exterior, in this area. (Appendix 7.)

Along the left side, beginning just aft of the front bumper, was a long indentation and scrape mark. The forward end of the left front wheel housing outboard frame (aluminum L-type extrusion) was bent rearward and inward about 5 inches.

The left air-conditioner access door and air intake grill, just behind the left front wheel, was bent in slightly. The sheet metal framing at the rear edge of the air intake grill was deformed inward and to the rear about 2 inches. The left forward baggage compartment door was deformed inward slightly. The left rear baggage compartment door was torn off. The vertical body frame member at the rear of the left rear baggage compartment was bent inward and rearward, and the battery cage at that point was

crushed inward. There was no short circuit in the batteries (four 12-volt batteries with two above and two below) or in any part of the electrical system. Horizontal abrasion marks showed along the bottom panels of these compartment doors. The outer edge of the floor and the frame of the left rear baggage compartment were bent inward.

The windshield was missing, and the windshield area was distorted to the right. The left side (driver's) forward window was bulged outward and partly broken out, and the rearward pane was cracked but in place. The large fixed window back of the driver's area (in the step-up portion of the bus) was cracked but intact. Of the four large passenger windows on the left side, the first had a damaged frame and missing rear pane; the second had a damaged frame but both glass panes were in place; the third and fourth had lost their frames and panes completely. The body over the fourth window was crushed downward and inward approximately 18 inches at the rear.

The rear window glass was missing and the frame area was distorted downward and partly inward along the left side. (Appendix 7.)

The door at the right front of the bus was hanging by its top hinge only. The door glass and the small pane just to its rear were intact. The large fixed window in the "step-up" area was missing. Of the four large right side passenger windows, the front one was missing its frame and glass; the second had a cracked forward pane and a damaged rear frame; the third had a damaged frame and a cracked rear pane; and the fourth had both panes missing and a damaged frame.

Clumps of sod were adhering to the upper parts of window frames along the left side, most prominently along the front and rear areas.

All vehicle exterior lights, front and rear, were intact, except that the clearance light at the top left front was smashed and torn off.

The vehicle appeared to have suffered no alignment distortion or damage to its running gear. The fuel tank and fuel system showed no failure or fuel leaks.

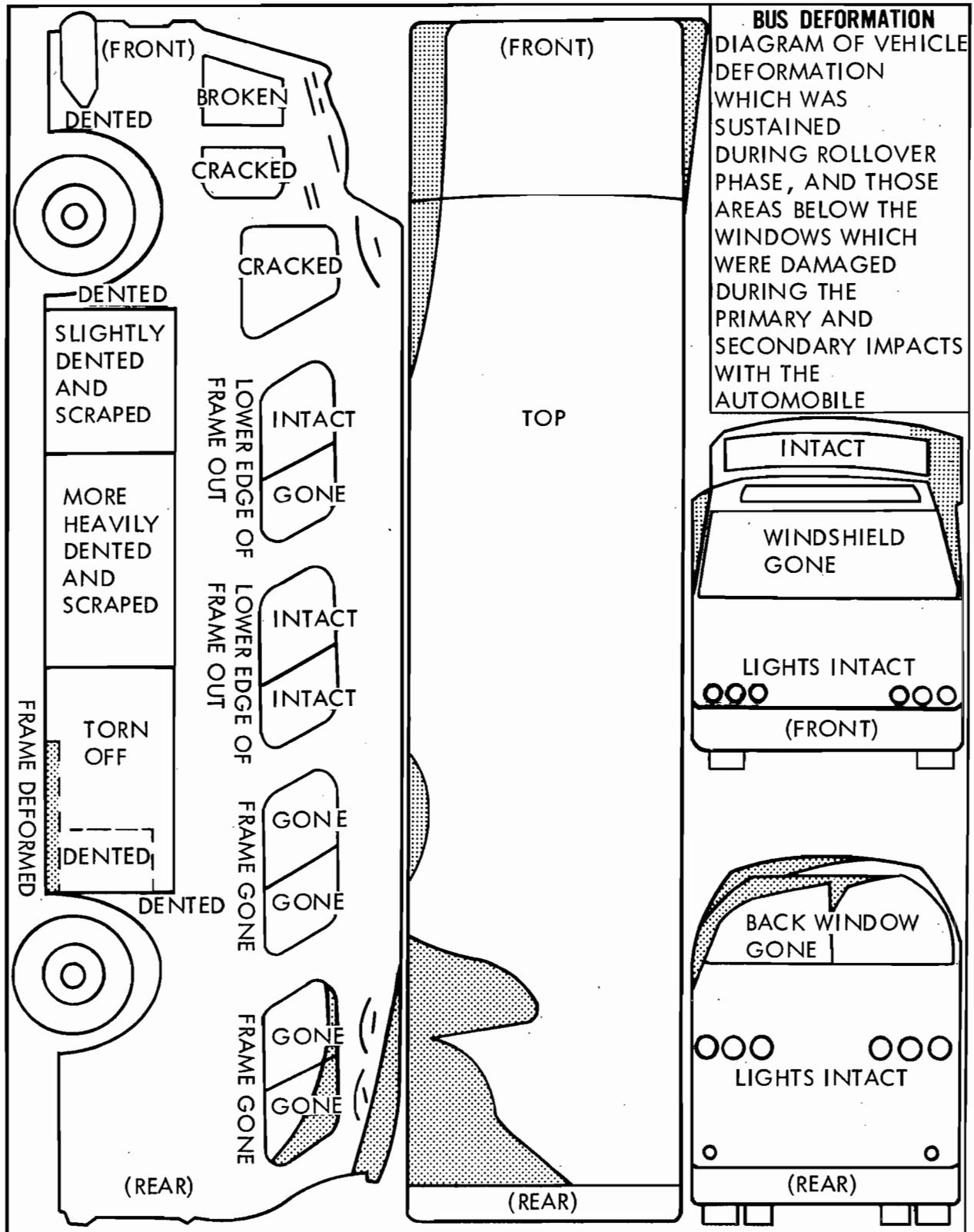


Figure 3

Interior damage to the bus consisted of the following: body deformation on the left side forced the body against several forward left seats and the two rear ones. None of the seats broke loose from the floor. The metal paneling covering the inside of the rearmost left roof support was torn loose and bent downward and inward, where its sharp edges protruded over the rear two seats. The overhead parcel shelf was bent upward in the right front area, and downward over the rear two seats on the left. (Appendices 8 and 9.) The interior ceiling liner material was fractured and distorted in the left rear area, and in two oval (football-sized) areas over the aisle—one near the third row, and one at the sixth row of seats. No human tissue, blood, or hair was found on these deformations.

K. Damage to Automobile

The most significant damage to the automobile was on the left front corner, the windshield, and the left rear corner. (Figure 4 and Appendix 10.)

The front bumper had been distorted rearward and to the right. The left front fender was distorted to the rear, 1 foot 7 inches, and inward (to the right) approximately 10 inches, buckling above the left front wheel, forcing the hood upward approximately 12 inches at the back edge. The right front fender was distorted outward 2 inches.

The left A-pillar showed horizontal abrasions from about midway of the windshield to the roofline, and showed some distortion inward (to the right). The left front corner of the roof showed a severe abrasion, the corner distorted slightly downward and rearward.

The windshield had a clean vertical break 8 to 10 inches to the right of the left edge of the windshield glass. There was no evidence that the hood had come in contact with the windshield.

Abrasion marks and indentations on the left side of the body sheet metal extended to the extreme end of the left rear fender, being more pronounced at the A-, B-, and C-pillars, and termination at the left rear bumper with a heavy deformation of the sheet metal just forward of

the rear bumper horn. The rear bumper was deformed 3 inches rearward.

The left front wheel had been forced rearward approximately 8 inches and inward at the top between 10° and 15°, distorting the left front suspension downward.

Along the right side, the outward displacement of the right front fender caused a partial jamming of the right front door.

With the exception of the windshield, all glass in the automobile remained unbroken and in place.

Interior damage to the automobile consisted only of a slight dent in the chrome covering of the left A-pillar.

The automobile rebounded in a southerly direction, coming to rest on its wheels 110 feet from the point of impact. The automobile left no discernible indications of its path of travel from the point of impact to its final resting position.

L. Post Accident Activities

Notification of the accident to the Indiana State police at Jasper, Indiana, was given by a resident of the area by telephone at 5:17 a.m. The State police at Jasper notified all emergency units. Assistance at the scene was rendered almost immediately by a nearby resident. The first State police unit arrived within 25 minutes of the time the accident occurred, as did the first of five ambulances, the last of which arrived at 6 a.m. All survivors from the bus and the automobile driver were taken by ambulance to a county hospital approximately 20 miles north on Indiana Route 57. Response by the police and emergency rescue vehicles, both to the scene and then to the hospital, was considerably delayed by the heavy fog conditions. The injuries were handled by the hospital without any special problems.

III. ANALYSIS

A. General

Several obvious factors contributed in a causal way to this collision and rollover and subsequent

AUTOMOBILE DEFORMATION

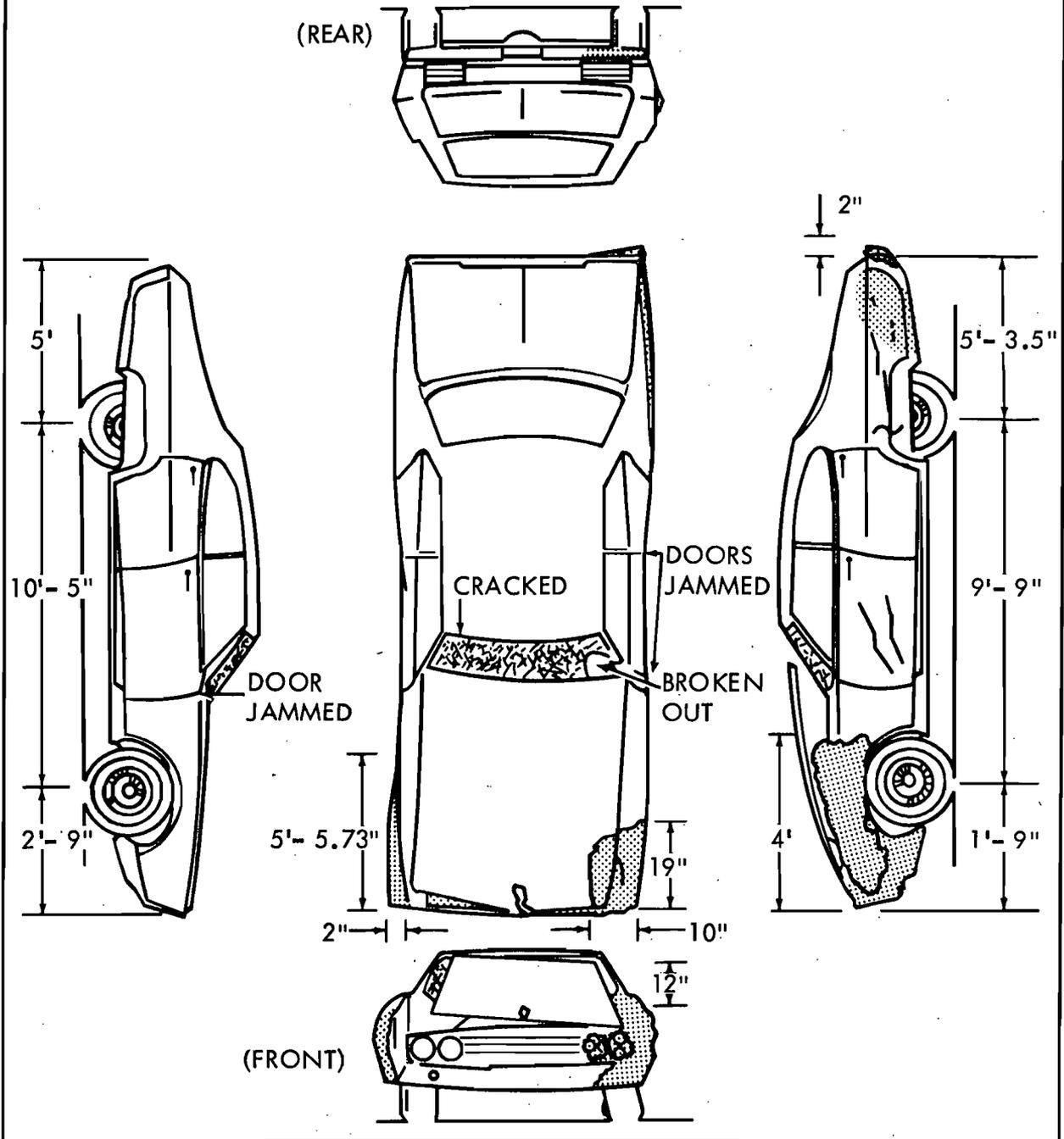


Figure 4

fatal and nonfatal injuries. In order to provide a full understanding of the facts and circumstances of this accident, it is necessary to identify all of the significant factors and their relationship to each other and to the accident. This analysis concentrates on those factors that are most pertinent in explaining the accident and which are related to the corrective measures set forth in the recommendations.

B. Pre-Crash

1. Limited Visibility and Limited Speed:

When the bus passed through Petersburg, Indiana, at about 5 a.m., 15 minutes before the accident, the bus was about 25 minutes late from its normal schedule. While the busdriver stated that he was not concerned because he was behind schedule, it is believed that his speed between 40 and 45 m.p.h., on the wet pavement in a dense, freezing fog, and in total darkness, indicates his attempt to maintain his schedule. During the 4-hour trip from Indianapolis to Petersburg, the bus was only 25 minutes late despite heavy fog experienced during most of that 4 hours. Further evidence of excessive speed lies in the testimony of the investigating police officer who stated that a safe speed in the dense fog was not more than 25 m.p.h., and in the testimony of a witness who stated that he could not drive safely in the vicinity of the accident at more than 20 m.p.h.

2. **Automobile:** An analysis of the evidence (skidmarks and gouge marks) at the accident scene established that the automobile was stopped to the left of the center of Oatsville Road, with the front of the car protruding 2 to 3 feet into Route 57. The gouge marks on Oatsville Road were determined to have been made by the downward distortion of the left front suspension of the automobile when struck by the bus. (Figure 2 and Appendix 4.) The lack of a painted centerline and painted stop line at the intersection deprived the driver of guidelines for positioning his vehicle.

3. **Observations by Witnesses:** Generally, the passengers were able to provide very little information about this precrash situation. How-

ever, two passengers reported that they had observed some of what occurred. The passenger seated in the right front aisle seat 1-C (Appendix 2) said that he was dozing but awakened in time to see a white car which appeared to be on the road in front of, and coming toward, the bus. The passenger seated in the fourth row in the right aisle seat 4-C (Appendix 2) said she saw the lights of the automobile in front of the bus and thought it was entering the highway and coming toward the bus.

C. Crash

1. **Crash Sequence:** A detailed evaluation of the marks on the left front bumper and left side of the bus, and on the left side of the automobile indicated the following impact sequence:

- The left front bumper of the bus impacted the rearmost left side of the automobile.
- The front of the automobile then swung to the left while the rear of the bus was sliding toward the automobile.
- The left front of the automobile was impacted by the left side of the bus.
- The left lower frame of the bus impacted the left front wheel area of the automobile above the center of the axle. This forced the top of the left front wheel to its right and deflected the left front suspension (A-frame) down into the pavement.
- As the left rear of the automobile rebounded from impact with the left front of the bus, in a counterclockwise rotation, the left front of the automobile was forced into the left rear baggage door of the bus, knocking the door loose.
- As the two vehicles were momentarily locked and sliding south, the left suspension and bumper support bracket of the automobile scraped the pavement, leaving the gouge marks shown in Figure 2 and Appendix 4.
- The left front of the automobile then engaged the left rear vertical pillar of the bus baggage compartment.
- As the bus continued to slide and rotate clockwise, the automobile was impelled in

a generally southerly direction, rear end foremost, back into Route 57. It came to rest 110 feet south of the gouge marks.

- The lower frame and side panels of the bus acted as an underride guard, preventing deeper penetration of the automobile under the bus and moderating the amount of damage to the automobile and injuries to the driver.

Following the reasoning set forth in the analysis of the impact marks on the bus and automobile and the skid and gouge marks on the road, scale outlines of the bus and automobile were superimposed onto the diagram in Figure 2. The results show the probable relation of the two vehicles at the moment of first impact, and the probable position of the automobile as it stood on Oatsville Road just before the collision.

2. **Busdriver's Misperception:** The 68° angle of Oatsville Road to the alignment of Route 57, the skewed position of the automobile as it stood in the intersection, the right curve, and the illusionary effect of the fog on the bus driver's visibility were the primary contributing factors leading to the bus driver's misperception of the automobile and induced him to take the faulty evasive action which directly caused this collision.

A possible explanation for the visual confusion experienced by the busdriver has been advanced by a well-known expert in visual factors as they relate to highway safety, Dr. Merrill J. Allen of the Indiana University Department of Optometry. From the busdriver's point of view, Indiana Route 57 curved around behind the automobile. Thus, a line drawn from the busdriver's eye through the automobile would, if extended, finally intersect again with Indiana Route 57. In extremely foggy conditions, when it is not possible to see the other vehicle clearly, and its relation to the roadway and topography in general, the observer becomes totally dependent upon his depth perception in placing the vehicle along his line of vision. If the busdriver perceived the automobile to be farther away

than it was in fact, this would tend to make the automobile appear to be out in his roadway in the manner indicated above (Figure 5). Several factors may have tended to make the busdriver perceive the automobile as being farther away than it was in fact. First, he was not viewing the automobile's headlamps head-on, although he assumed he was. When viewed from an angle, the distance separating the headlamps would be the same as for a more distant vehicle viewed head-on. Also, the intensity of the lights viewed from an angle (especially from the left) would be the same as for lights viewed head-on from some greater distance. Finally, Dr. Allen reports that under foggy conditions, people generally err on the side of perceiving things to be farther away than they actually are. There are, no doubt, other possible explanations for the busdriver's misperception of the automobile, but the above is submitted as the most probable.

3. **Effect of Excessive Speed:** The bus was approaching the automobile, which appeared to be farther away than it really was, at 60 to 66 feet per second (40 to 45 m.p.h.). The busdriver did not have sufficient time to perceive, recognize, and properly evaluate the hazard, select from the alternatives, and execute the proper evasive action. If he had more time, he may not have made the decision which led to the collision. If the bus had been traveling at a slower speed, the driver may have been able to maintain control, and stop the bus without skidding into the automobile.

4. **Bus Rollover:** After the bus separated from the automobile, it continued to slide sideways, to its left, until the left wheels went off the improved surface of Oatsville Road. When the left wheels contacted the shoulder, they dug in and caused the bus to roll over counterclockwise. The bus made a three-quarter rollover, coming to rest on its right side and facing in a northwesterly direction, approximately 32 feet beyond the initial rollover point.

5. **Occupant Kinematics:** There was no readily discernible pattern in the injuries sustained which would support any firm statement of impact force directions and sequences. In gen-

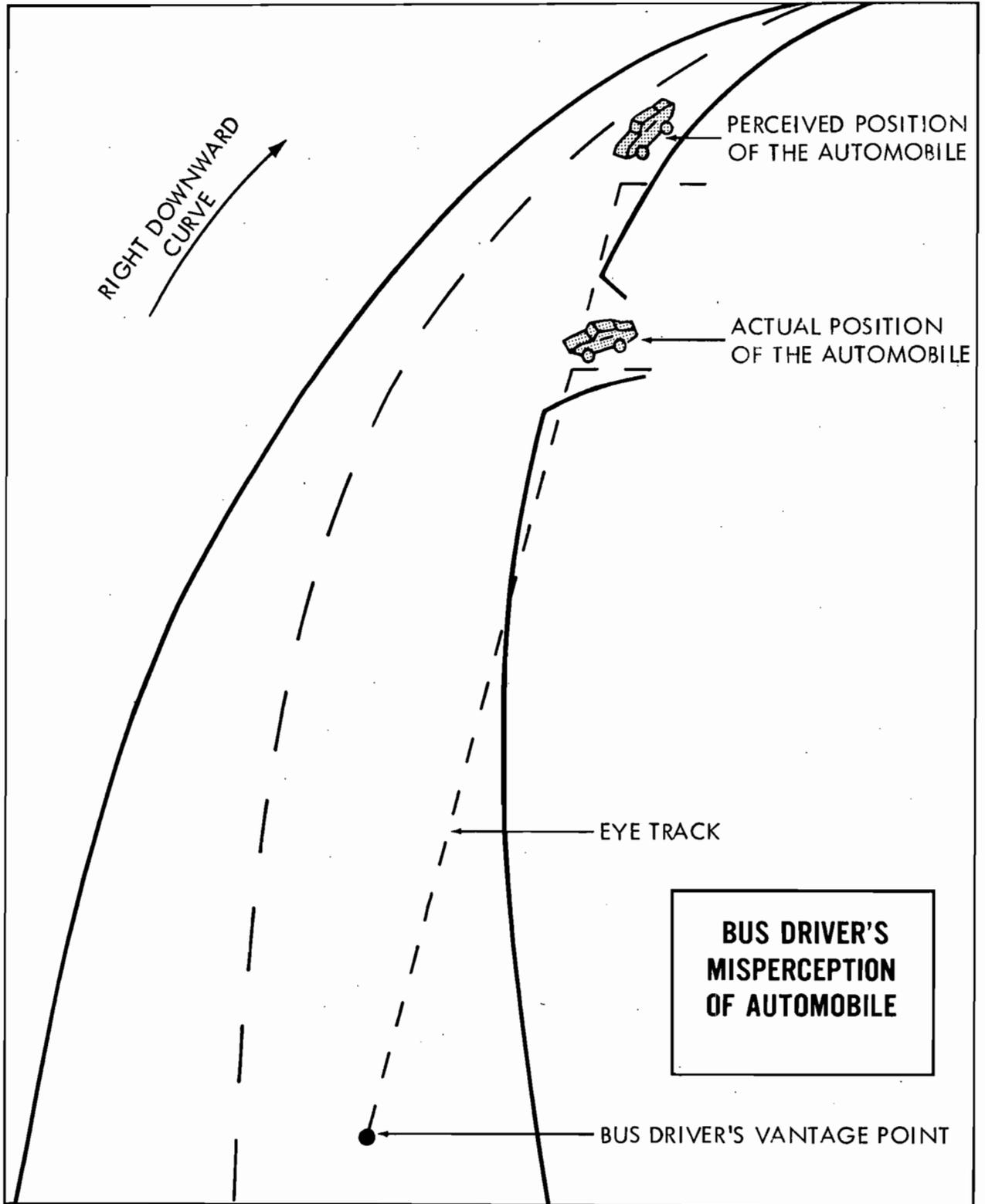


Figure 5

eral, it is apparent that as the bus slid broadside and decelerated, the bus occupants must have been thrown toward the left relative to the bus. Upon impact with the automobile, this left side loading became greater. As the bus rolled onto its left side, the occupants were accelerated up out of their seats and toward the upper left side of the bus. Finally, as the bus came to rest on its right side with its bottom somewhat elevated, the occupants fell toward the upper right portion of the bus. During the rollover, the upper left rear corner of the bus sustained a crushing force downward and to the right. During application of this force, occupants in this part of the bus must have been accelerated toward the upper left rear area. There is little indication from the kinematics of the bus as to what forces may have been applied tending to move occupants toward the front of rear. In fact, some occupants came to rest considerably forward of where they were originally seated, while others came to rest considerably to the rear of their original seat locations.

The one fatality resulting from the rollover was a 4-month-old female who was lying on her mother's lap in a plastic infant carrier at the extreme left rear of the bus (seats 10-A and 10-B--see Appendix 2). Her death resulted from a severe blow to the head. This blow may have resulted from contact with the interior of the bus at the upper left rear corner, since the child was free to be accelerated in this direction during the external crushing of the area during the rollover. However, after the accident the empty plastic infant carrier and the infant were found in the concrete drainage ditch near the bus. Thus, the ejection of the infant through the rear window opening seems likely, and the head injury probably resulted from contact with the concrete drainage ditch.

6. Sources of Injuries: Two points of obvious occupant contact were discernable. One of these was the "Watch Step" warning sign assembly on the interior ceiling immediately below the "Astrolite" transom window. There was evidence of contact with this assembly. The upper handrail at the right front of the bus broke free of its two

attachment points on the forward casting which supports it, fracturing in such a way as to leave an extremely sharp projection just to the right of the "Watch Step" sign. However, there was no indication of occupant contact with it. Just to the right of this location, a reading lamp assembly at the forward end of the right side luggage rack showed evidence of contact by a person. Contact at these points could well have been the source of head lacerations suffered by the passenger in seat 1-C.

Many passengers complained of headache, neck pain, shoulder pain, and back pain. Much of this discomfort and injury was probably caused by contact with the overhead luggage racks during the rollover. At several locations, the luggage rack was deformed upward between its supports, and only occupant contact would readily explain this deformation. Of the few occupants who could recall their kinematics, several indicated secondary collisions with the luggage racks.

Rib injuries and pain in the left rib cage area were also common complaints, and several occupants recounted definite contact with the armrests. All of the injuries thus far recounted probably could have been avoided if the occupants had been restrained in their seats. However, such restraints might have increased the difficulty of egress for the left side passengers in light of the final resting position of the bus on its right side, with the bottom portion slightly elevated (which would have left many suspended by their restraints). This would have been significant had the need arisen to evacuate the bus rapidly.

The busdriver generally remained in his seat throughout the rollover sequence and was still in his seat as the bus came to rest on its right side. He then grabbed the steering wheel and swung down toward the ground. He searched around for the interior light switch, and while he does not recall actually reaching up and turning on the lights, somehow the lights did get turned on.

The passengers came to rest both in the aisle, lying against the left side of the right side seats, and farther up against the right side interior of

the bus. Although there was some piling up and intertwining of passengers, one on top of another, there was no indication of any injuries having been sustained during the postcrash movements and egress of the passengers.

7. Bus Window Performance: The fact that the safety windows swing open so easily in the side impact and rollover situation may be desirable from the point of view of facilitating escape. However, the size of these open windows also creates an added danger of occupant ejection. Although it is apparent that no occupants were ejected through these open windows in this case, it could easily happen in the rollover situation. Seat belts would minimize this possibility.

The bus windshield and rear window both popped out upon impact during rollover (as designed), which greatly facilitated occupant egress. Each of the eight emergency escape windows came free at the bottom (as designed), and three of these window and frame assemblies were torn completely free from the bus as the windows swung open and were subsequently torn away from their top hinges by ground contact. Of the safety windows which remained attached, three panes of glass were broken completely out of the frames and two other panes were cracked, one of which was penetrated slightly so that the plastic laminate was exposed. The first of the elevated windows at the right of the bus was popped out, while the corresponding window on the opposite side was cracked severely but did not pop out. The first window behind the driver's position on the left was cracked at a location immediately adjacent to the protective railing behind the driver, probably the result of the bus's left side being distorted to the right in contact with this rail during rollover. The window at the driver's immediate left exhibited the poorest performance. This plastic-laminate type of glass was broken out extensively, exposing sharp edges which could have been quite injurious. These edges might have been the source of a small laceration above the driver's left eyebrow.

8. Other damages: The drive train and running gear of the bus sustained little damage, and the bus was drivable following the collision and rollover, although the power steering was not operable. The treads of both left rear tires were torn away from the tire carcasses around their left-side circumferences, resulting from the unusual loads imposed on them as the bus slid broadside.

The portion of interior metal paneling covering the left rear roof pillar, which broke free and protruded into the left rear seat area, projected approximately 7 inches to the right from the crushed-in body structure. The bus's body at this point had been deformed to the right approximately 8 inches from its normal orientation. The rear edge of the left overhead luggage rack was deformed extensively downward, but is not believed to have caused injury to any of the occupants.

9. Automobile Kinematics: After disengaging from the bus, the automobile continued to rotate clockwise and, in a backward motion, was carried 110 feet south of the point of impact where it came to rest on its wheels facing northeast. It is noteworthy that such an extensive rebound occurred without serious injury to the automobile driver and that the automobile was deflected both in a direction and at a rate which enabled it to escape entanglement during the subsequent rollover of the bus. This limited damage and injury, and the shoving aside of the automobile was primarily due to the design of the bus. The lower frame, baggage compartment floor, and side paneling acted as an underride guard and prevented the override of the automobile by the bus.

Substitute the side of a semitrailer for the side of the bus and one can visualize what could have happened. In all probability, the semitrailer would have overridden the automobile, crushing both the vehicle and its driver.

There was no discernible white paint transfer from the automobile to the side of the bus to indicate any specific point of contact on the latter. However, the bus sustained its greatest

side damage in the area of the luggage compartment doors forward of its left rear wheel-well. This damage probably resulted from contact with the automobile's left front. The bus's rear luggage compartment door was torn from its hinges in the course of the collision and rollover. The battery compartments located immediately in front of the luggage compartment received direct contact damage.

As a result of its left front impact, the automobile's left A-pillar was bent inward and broke the windshield at the left edge. The nature of the breakage observed here was typical of pre-1966, 15-mil laminate windshields. The sharp edges of glass which resulted could have been a source of laceration injury to the automobile driver, who was accelerated toward this left front area during the collision. A dent observed on the interior of the automobile's left upper A-pillar probably resulted from occupant contact but apparently caused no significant injury to the driver. Following impact, the left doors were inoperable, so the driver exited through the right front door after shutting off the engine.

IV. CONCLUSIONS

The following conclusions have been derived from the analysis of the available evidence:

1. The bus was behind schedule some 25 minutes when it left Petersburg.
2. Familiarity with the route had an affect on the busdriver's speed.
3. A proper and safe speed was estimated by the investigating police officer and others at 20 to 25 m.p.h.
4. The bus, traveling at 40 to 45 m.p.h., in dense fog, in total darkness, and on a wet road surface, was traveling at an excessive speed for road and weather conditions.
5. The angle of Oatsville Road to the alignment of Route 57, the skewed position of the automobile at the intersection, the right curve, and the illusory

effect of the fog were contributing factors leading to the busdriver's misperception of the automobile and his miscalculation of appropriate evasive action which directly caused the collision.

6. Passengers' statements support the illusory characteristics of the environment just before the evasive action was taken.
7. The lower frame and side panels of the bus body acted as an underride guard and prevented the automobile from penetrating under the bus, moderating the damage to the automobile, and injuries to the driver.
8. The fatally injured infant female was ejected from the bus through the rear window during the rollover of the bus.
9. Many bus occupants sustained upper body injuries in falling against the overhead parcel shelves during rollover.
10. Rib fractures and bruises to bus passengers were the result of secondary collisions with the armrests of the seats during rollover.
11. Overhead reading lights and/or ceiling-mounted warning signs provided hazardous projections against which passengers were impacted during rollover, producing head lacerations.
12. The installation of occupant restraints and their use by the driver and passengers on the bus would have reduced the number and severity of injuries.
13. The bus windshield and rear windows popped out during rollover and provided adequate exit areas for bus occupants.

V. PROBABLE CAUSE

The Safety Board determines that the probable cause of this accident was that the busdriver misjudged the location of the automobile because of the illusion created by the fog. Contributing factors were the excessive speed of the bus in dense fog on a wet road and the geometrics of the intersection which compounded the illusory effects of the fog.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Highway Administration (FHWA) expand its rulemaking concerning section 393.93 (seat belts) of the Motor Carrier Safety Regulations in Part 393 of Title 49, Code of Federal Regulations to require in all interstate buses the installation of occupant restraints, active or passive, that conform to the Motor Vehicle Safety Standard 209. The Board recommended this in its accident report released December 31, 1968—entitled “Interstate Bus-Auto Collision near Baker, California,” and recommended it again in its accident report released March 19, 1970, entitled “Chartered Interstate Bus Crash Interstate I-80S near Beaver Falls, Pennsylvania.”
In the Board’s view, a decision to make available suitable restraints which would reduce injuries is not dependent upon a showing that all passengers would use them, nor should it be limited by the fact that past bus passenger seat designs do not accommodate the lap belt type of restraint.
2. The National Highway Safety Bureau, in the development of its rulemaking related to Docket 2-11, Bus Seats, include the requirement for the installation of seat belt assemblies as well as seat belt anchorages for interstate buses.
3. The Federal Highway Administration and the National Highway Traffic Safety Administration, in their rulemaking as recommended above, include the requirement that occupants of interstate buses be advised, both by a “Fasten Seat Belt” illuminated sign and by notification by the driver, to fasten seat belts.
4. The National Highway Traffic Safety Administration study the feasibility and practicality of a standard for passenger buses requiring that overhead surfaces which include roof linings, moldings, parcel or luggage shelves, edges, and support hardware be designed so as to reduce or prevent direct contact injuries in rollover and upset accidents, and that such areas resist separation or fracture of a type which would expose edges to passengers. Such protection is of particular importance in the absence of passenger restraints not currently required.
5. The National Committee on Uniform Traffic Laws and Ordinances set a high priority on the development of more definitive criteria in the Basic Speed Rule (11-801 BASIC RULE) of the Uniform Vehicle Code to provide a guide for motorists: (1) as a basis for evaluating the degree of hazard presented by adverse environment factors (such as fog, smoke, ice, rain, traffic), and (2) to determine what is the appropriate (safe) vehicle speed under conditions present.
6. The International Association of Chiefs of Police use its influence and professional resources to redirect the attention of law enforcement agencies to the basic speed law (as it is set forth in the 1964 IACP Resolution D-19-20, of the Highway Safety Policies for Police Executives). The Association urge an aggressive enforcement program against violators of speed-limit laws, with special emphasis on the basic speed law.
7. The National Association of Motor Bus Owners use its influence and professional resources to urge its members to adopt, and disseminate in writing, a policy concerning the operation of buses during inclement weather such as stressing safety over the maintenance of schedules. Busdrivers should be instructed to drive their buses at a speed that is appropriate and safe, as dictated by the environmental conditions, even though it means that schedules cannot be maintained.
8. The Indiana State Highway Commission install traffic control signs and markings corresponding with the standards set forth in the “Manual of Uniform Traffic Controls and Devices for Streets and Highways” on

County Road 125-S (Oatsville Road), at both its east and west approaches to the intersection of Indiana State Route 57, as well as all other county roads.

9. The National Highway Traffic Safety Administration and the Bureau of Motor Carrier Safety of FHWA study the circum-

stances of this accident and consider the desirability of adding the requirement for side underride protection. Reference is made to NHTSA proposed rulemaking on Rear Underride Protection, Trucks and trailers (Docket No. 1-11, Notices 5 and 6), and to BMCS Safety Regulation 393.86, Rear End Protection.

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

Member

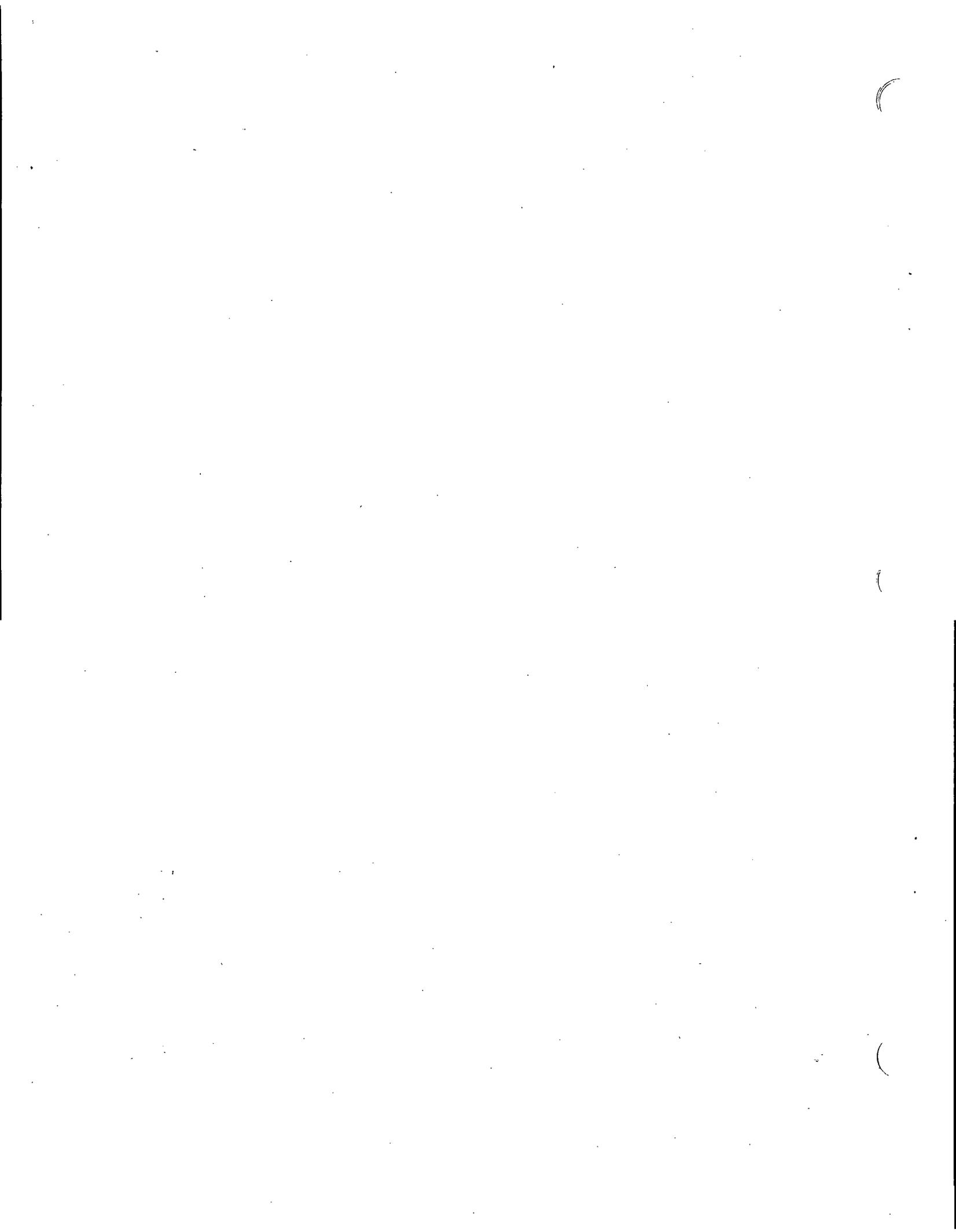
/s/ ISABEL A. BURGESS

Member

February 10, 1971

VII. APPENDICES

1. Synopsis of bus occupant injuries.
2. Seating arrangement on bus.
3. Aerial photograph of terrain in vicinity of accident scene, Indiana Route 57 and County Road 125-S.
4. Photograph of gouge and skidmarks on Oatsville Road at intersection with Indiana Route 57.
5. Diagram of intersection of Indiana Route 57 and Oatsville Road charting path of bus travel, point of impact, and final resting places of vehicles.
6. Photograph of left front and side of bus, showing damage and deformation.
7. Photograph of left rear of bus showing damage and deformation.
8. Photograph of interior of left rear of bus showing deformation of roof, ceiling liner material, and parcel shelf in vicinity of seats 10A and 10B.
9. Closeup photograph of fracture damage to ceiling liner material in vicinity of seats 10A and 10B.
10. Photograph showing damage and deformation of left front and side of automobile.



Synopsis of Bus Occupant Injuries

Driver of the Automobile: Age 18, male, 5' 10", 130 pounds; only occupant of the automobile. Seat belt provided but not in use.

Injuries: Minor laceration to the head. Complained of neck pain, although X-rays of the cervical spine were within normal limits.

Driver of the Bus: Age 43, male, 6' 1", 205 pounds.

Injuries: Four centimeter laceration extending vertically above the right eyebrow, as well as a contusion of the left knee.

Occupant of Bus, Row 1, Seat C: Age 34, male, 6' 1", 200 pounds.

Injuries: Laceration to the left chin two centimeters in length; severe laceration to the left forehead at the hairline; a small laceration over the left eyebrow; ecchymosis on the lateral aspect of the left eye with swelling; bruise to the left thigh; diagnosed as having minor concussion; skull films were negative.

Occupant of Bus, Row 2, Seat D: Age 18, female, 5' 4", 108 pounds; asleep.

Injuries: No injuries except for severe back pain which, on X-ray, were revealed to be secondary to a small compression fracture of the anterior cortex at the anterior superior margin of lumbar spine No. 1.

Occupant of Bus, Row 3, Seat A or B (unknown whether seated by aisle or window): Age 32, female, 5' 6", 135 pounds.

Injuries: There was a question of concussion; also, an inequality of the pupils was noted, with the left being larger.

Occupant of Bus, Row 4, Seat C: Age 65, female, 5' 3", 160 pounds; diabetic history; presently on diabetic medications as well as on a medication for congestive heart failure.

Injuries: A comminuted fracture of the scapula directly below the glenoid fossa, extending immediately and superiorly to the scapular spine; a fracture at ribs eight and ten on the left of the mid-axillary line; a question of some dislocation of the left shoulder, but no reduction necessary.

Occupant of Bus, Row 5, Seat B: Age 60, female, 5', 260 pounds.

Injuries: A comminuted impacted colle's fracture of the distal radius and of the ulner styloid process on the left; slight abrasion below the left elbow and a questionable fracture of the left scapula; laceration directly above the left lip, with a laceration on the inside of the lip at the same level; slight erythema above the right eye and an area of induration.

Occupant of Bus, Row 7, Seat A: Age 60, female, 5' 6", 155 pounds; asleep.

Injuries: Severe pains in the left shoulder girdle and over the chest; X-rays revealed a comminuted mid-shaft fracture on the left clavicle, as well as fracture of the fifth and sixth ribs on the right at the midaxillary line.

Occupant of Bus, Row 7, Seat B: Age 72, female; no direct interview due to her being under intense treatment for congestive heart failure; cardiac history and has been on very heavy medication for congestive heart failure.

Injuries: Head injuries of unknown severity which involved a large hemotoma over the frontal area and some constriction of the pupils; no basilar skull fracture and nothing further on x-rays.

Occupant of Bus, Row 9, Seat A: Age 29, male, 5' 11", 215 pounds.

Injuries: Slight abrasion directly above the right elbow; severe contusion of the right hip; generalized pain in the pelvic region and thoracic area; x-rays taken were negative.

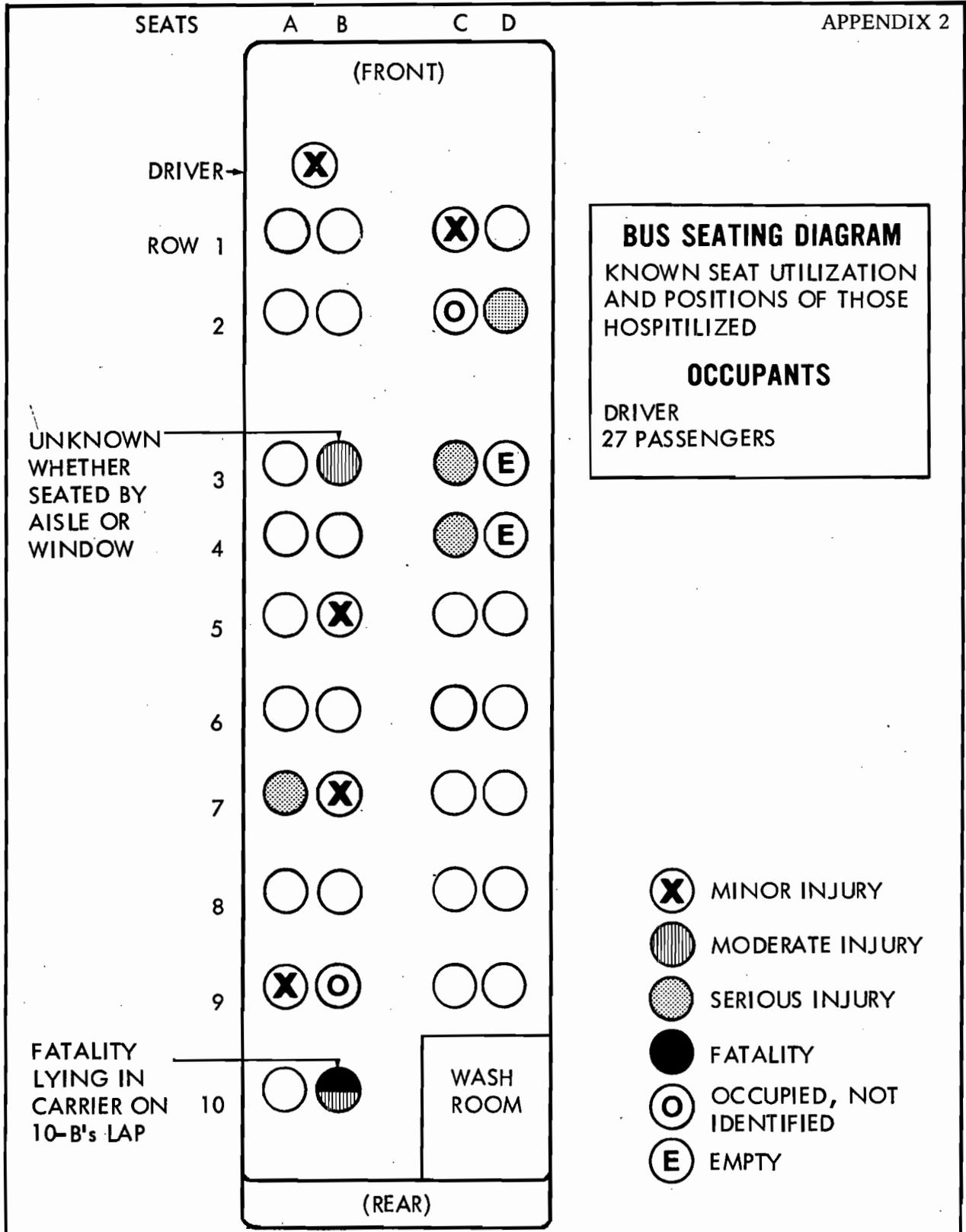
Occupant of Bus, Row 10, Seat B: Age 33, female, 5' 3-1/2", 152 pounds. She was seated with her back toward the aisle and her left leg bent and up on the seat, right leg on the floor, holding a 4-month old baby in her lap, in a carrier. She was dozing at time of the accident; heard screaming and glass crashing; was thrown forward and to the right about three seats; lost track of the baby; not sure if she recovered the baby before or after exiting bus.

Occupant of Bus, Row 10, Seat B, on lap of 10-B above: Age 4 months, female infant.

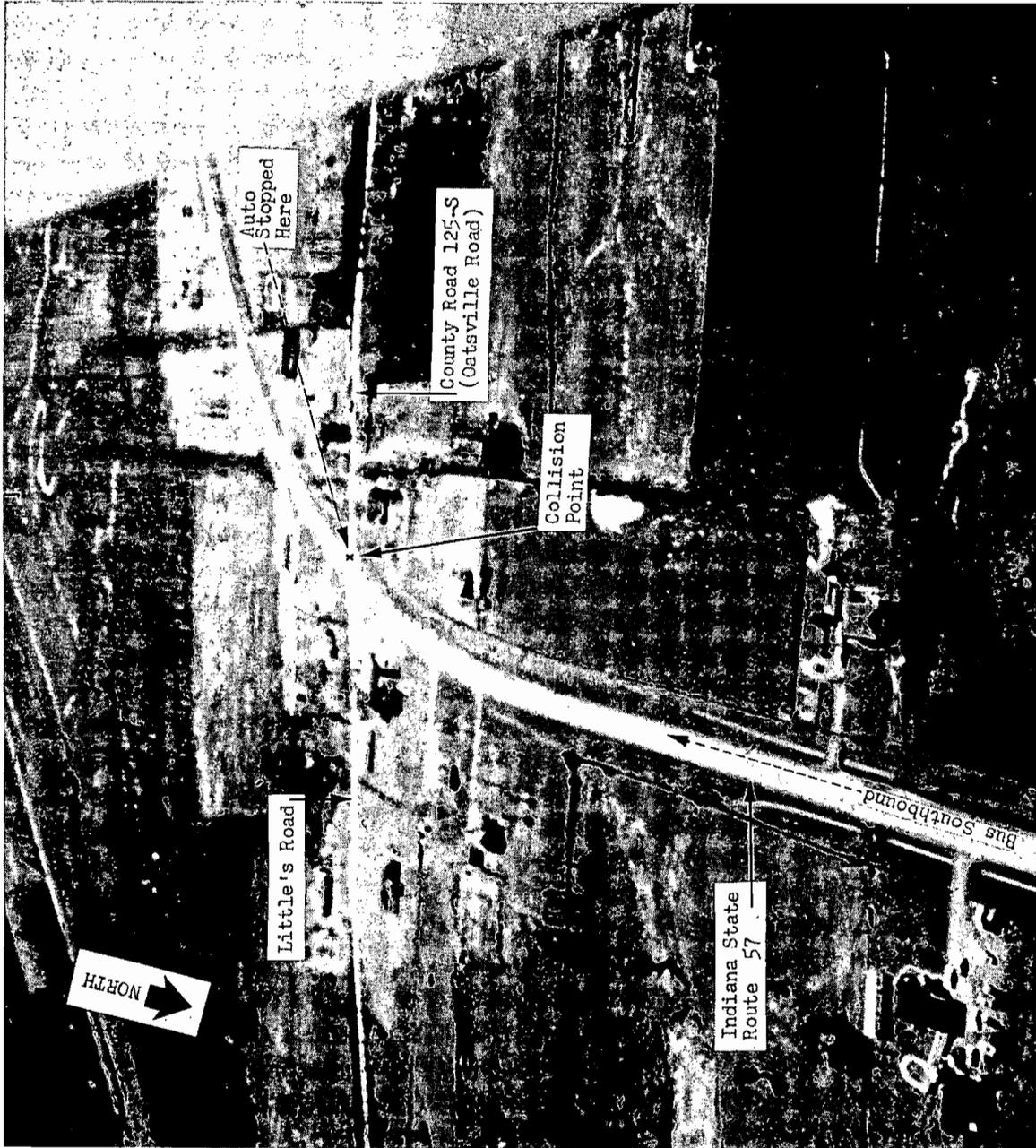
Injuries: Fatal (Details of injuries on file with National Transportation Safety Board).

Occupant of Bus, Row 3, Seat C: Age 50, female, 5' 9", 200 pounds; asleep.

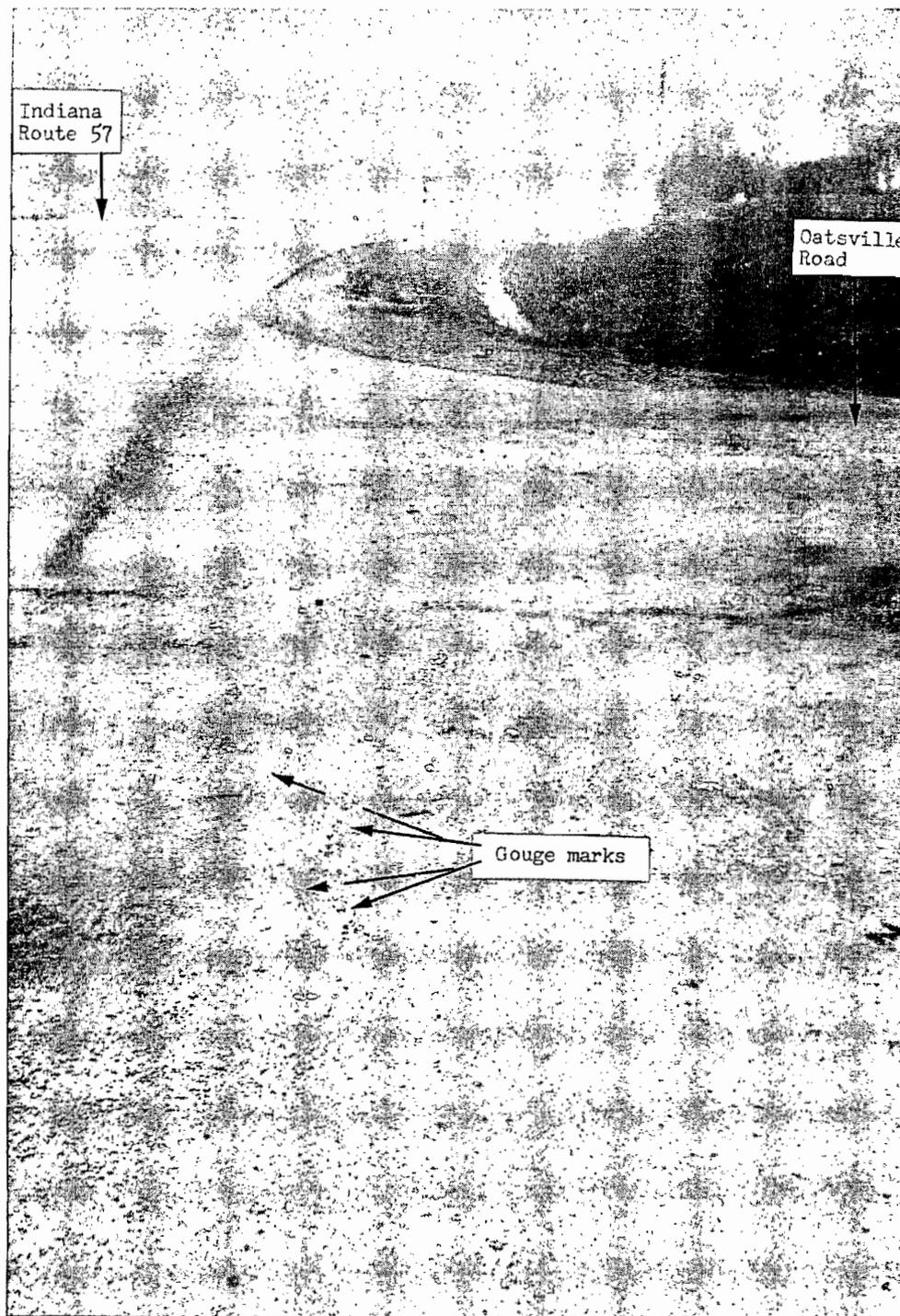
Injuries: Fracture of the humerus right below the level of the head, and a sprain to the right forearm.



APPENDIX 3

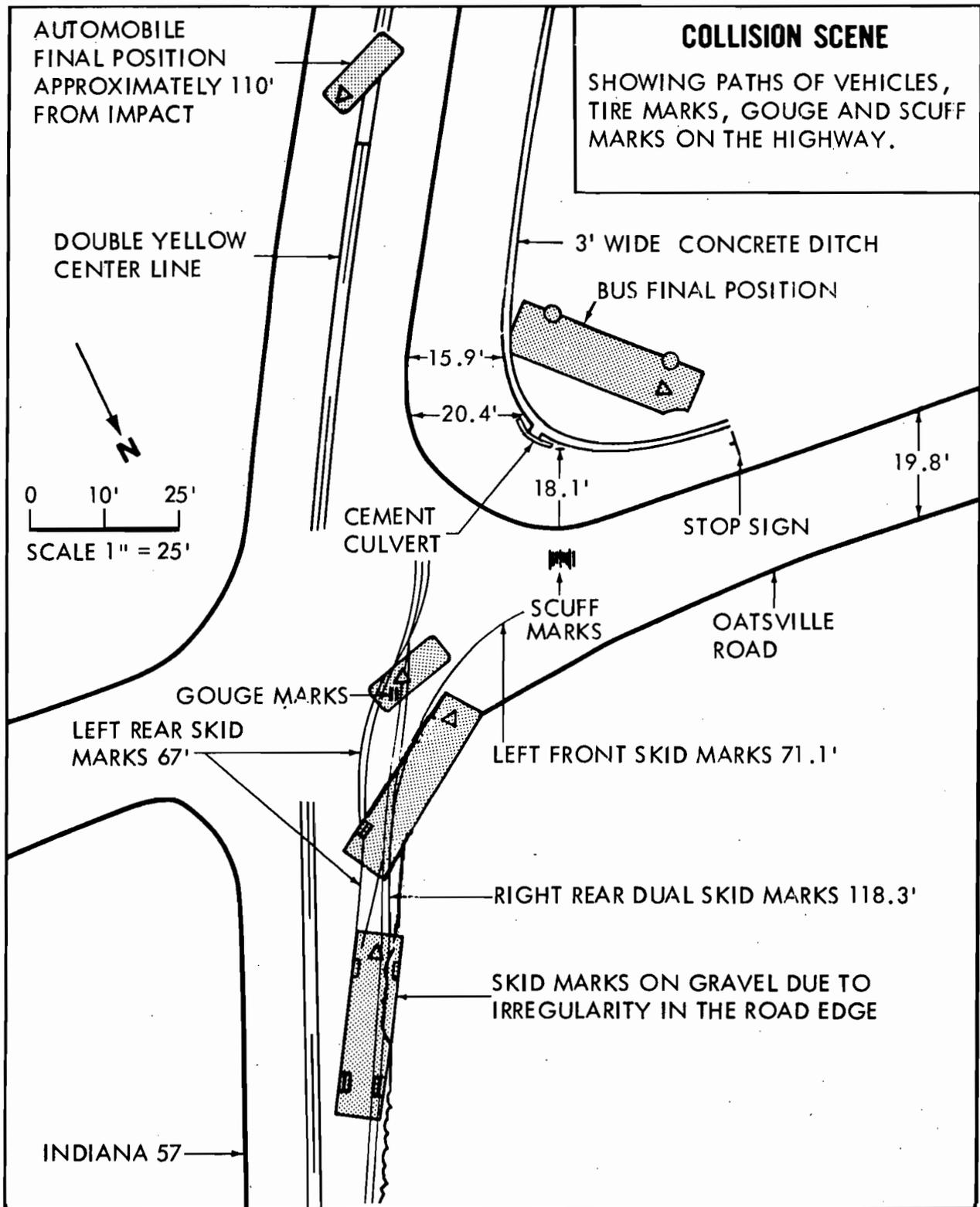


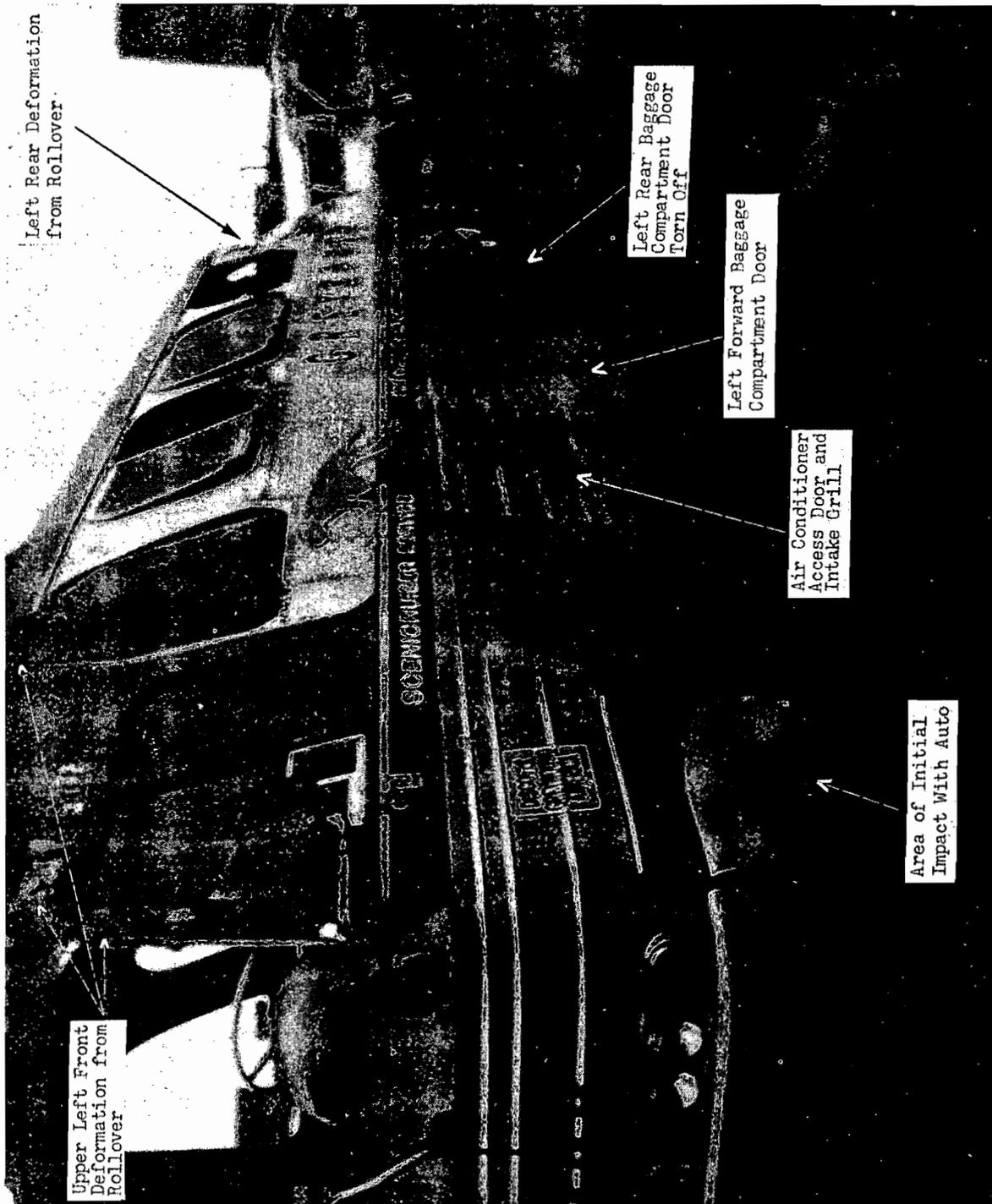
Terrain in Vicinity of Accident Scene.



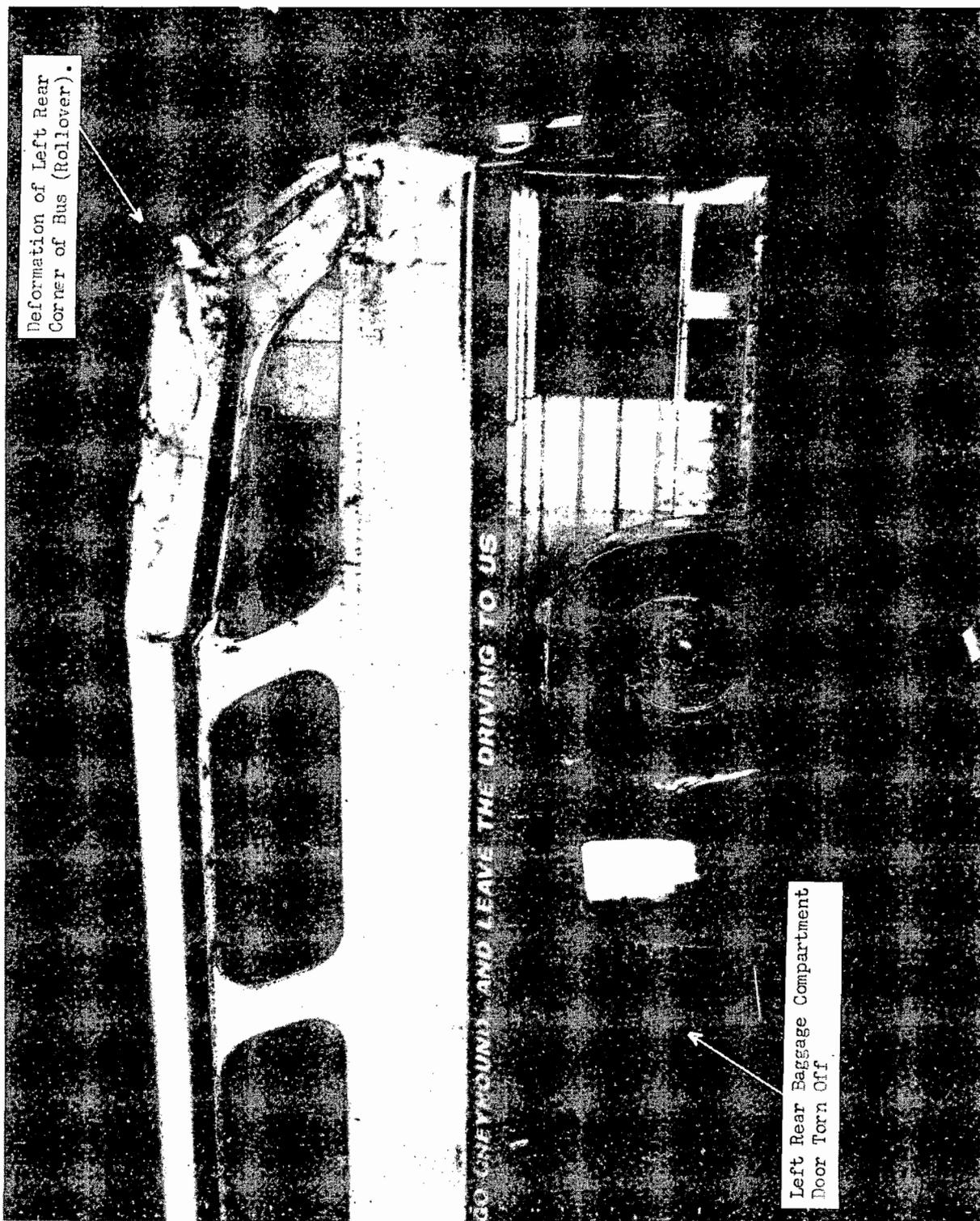
**Gouge Marks from Downward Distortion
of Left Front Suspension of Auto.**

APPENDIX 5





Bus Deformation from Initial Impact with Automobile and Rollover.

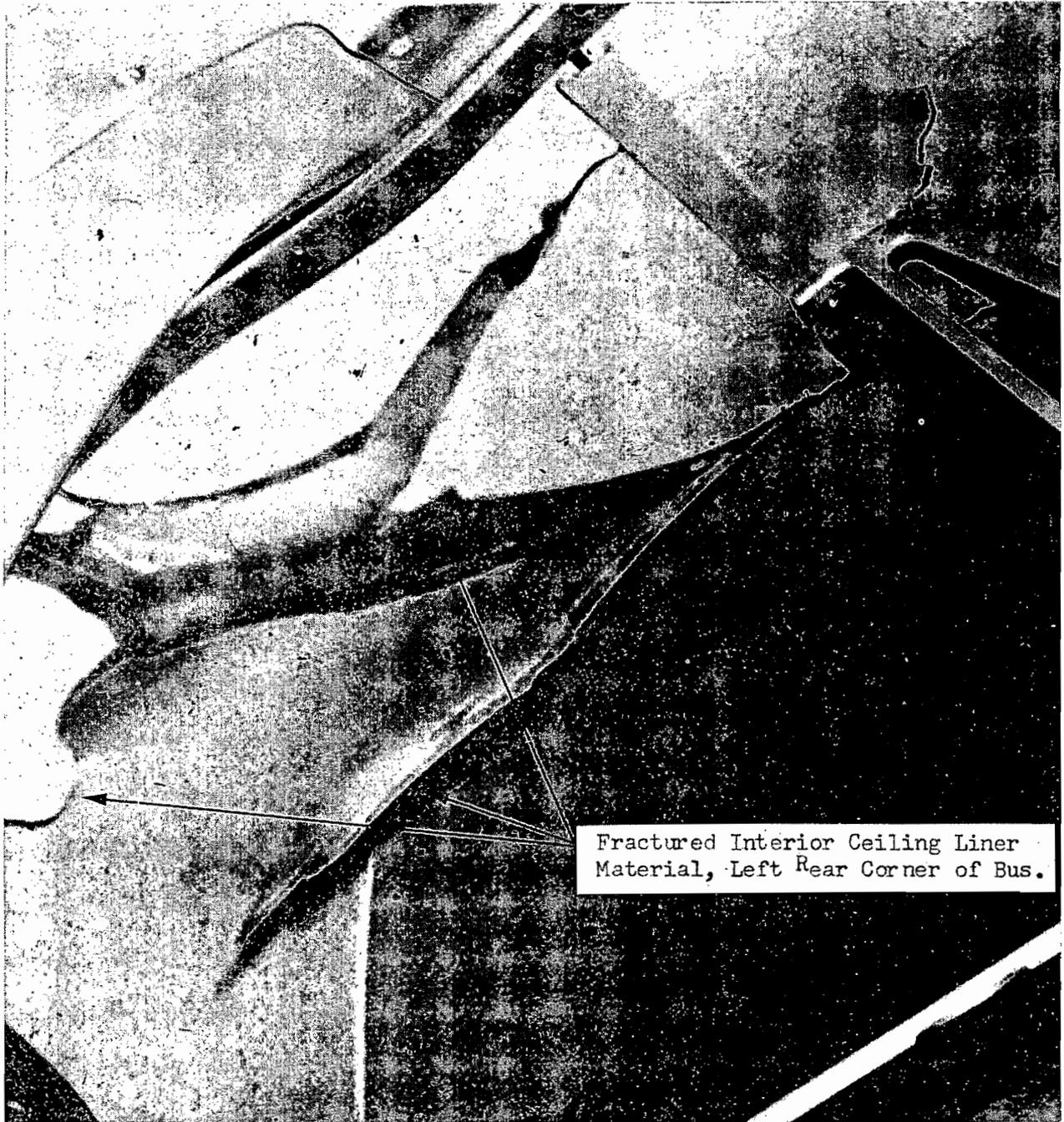


Deformation to Left Rear of Bus.

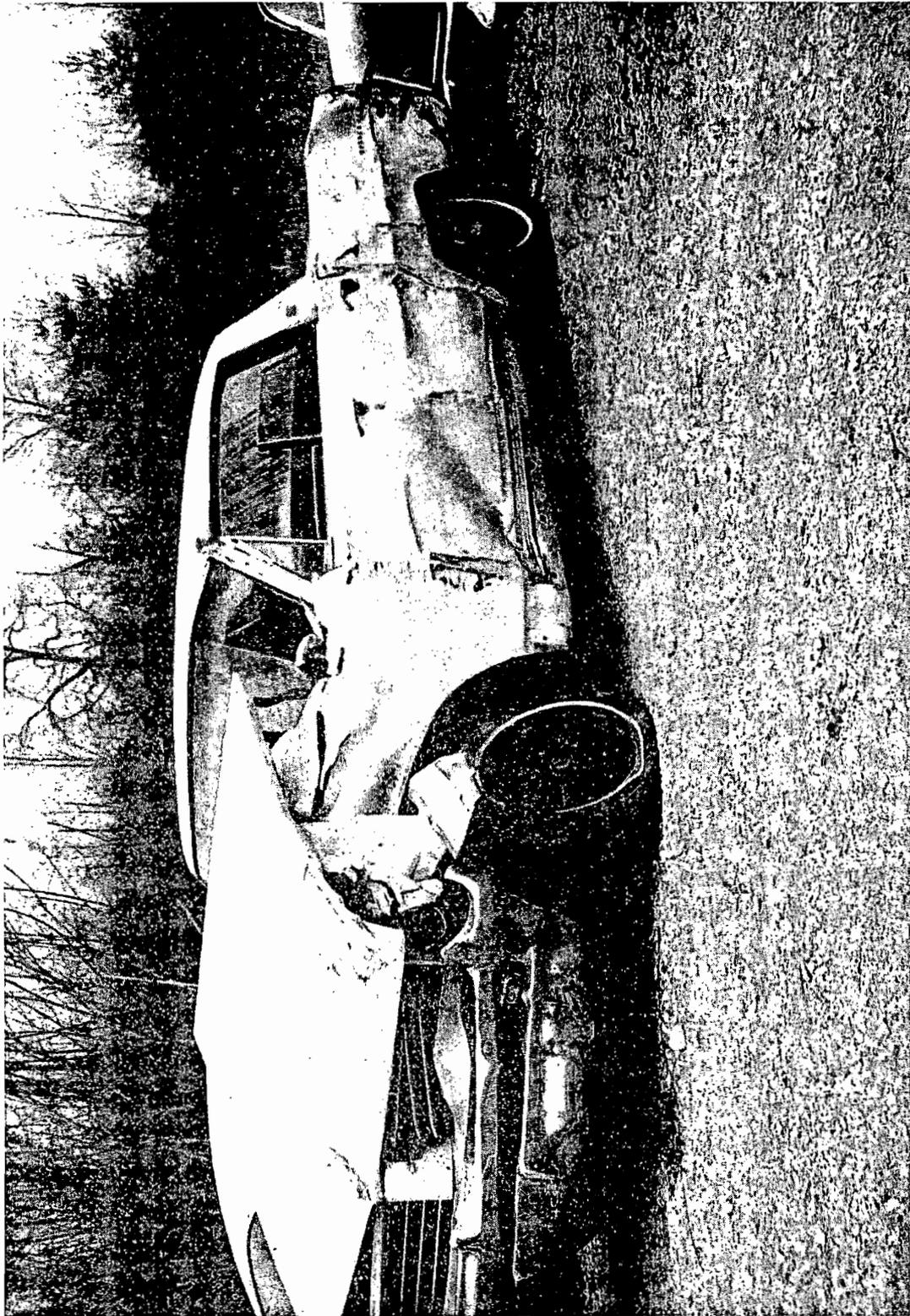


Bus Left Rear Interior Deformation.

APPENDIX 9



Close up of Fractured Ceiling Liner Material
Over Seats at Left Rear of Bus.



Front and Left Side of Automobile.