

NATIONAL TRANSPORTATION SAFETY BOARD

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HIGHWAY ACCIDENT REPORT

AIRPORT TRANSPORT BUS -

AUTOMOBILE COLLISION

DULLES AIRPORT ACCESS ROAD

JUNE 9, 1970



NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C. 20591

REPORT NUMBER NTSB-HAR-71-2

SS-H-11

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Adopted: DECEMBER 30, 1970

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FOREWORD

This accident was determined to be a "major accident" within the definition of the National Transportation Safety Board because of the technical problems illustrated by the following issues: (1) the lack of appropriate signs to deter wrong-way entry on a Federally controlled and maintained highway; (2) the absence of occupant restraint systems in passenger-carrying buses; (3) the nonutilization of installed seat belts by the driver of the bus; and (4) alcohol involvement and its relationship to wrong-way traffic movements and fatal accidents. The Board recognizes that other issues were present in the accident; this abbreviated report addresses itself only to the four issues inasmuch as they represent areas of immediate priority.

The report is based upon information independently gathered by the Safety Board, data supplied by the Bureau of Motor Carrier Safety, Federal Highway Administration, and assistance from the Dulles International Airport Police Branch of the Federal Aviation Administration. The recommendations herein are those of the Board.

TABLE OF CONTENTS

<u>CHAPTER CONTENTS</u>	<u>PAGE</u>
Foreword	i
Table of Contents	ii
List of Diagrams	iii
I. <u>Synopsis</u>	1
II. <u>Facts</u>	3
The Accident	3
The Road	3
Accident Site	5
Weather	6
Traffic Control	6
The Vehicles	7
Bus	7
Automobile	8
Van	8
The Drivers	8
Bus	8
Automobile	9
Van	9
Witnesses	9
Vehicle Damage	10
Bus	10
Automobile	11
Van	11
Passenger Injuries	12
III. <u>Analysis</u>	13
The Bus	13
Crash Injuries	14
Evacuation	15
The Automobile	15
The Van	19
Traffic Controls	19
IV. <u>Conclusions</u>	20
V. <u>Probable Cause</u>	23
VI. <u>Recommendations</u>	24

TABLE OF CONTENTS
Cont'd

	<u>PAGE</u>
VII. Appendices	26
1. Stages of Acute Alcoholic Influence/Intoxication	27
2. Bus Occupant Injury List	28
3. Photographs.	29
Bus.	30
Automobile	31
Van.	32
Highway.	33
Southbound I-495 (left) off-ramp terminus gore area. .	34

LIST OF DIAGRAMS

<u>Figure</u>		<u>Page</u>
1	Accident Diagram	4
2	Dulles Access Road - I-495 Interchange Diagram	16

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I. SYNOPSIS

On June 9, 1970, at 4:40 p.m., a 1965 Mercury two-door hardtop sedan, operated by a man under the influence of alcohol, driving west (wrong way) in the inside (left) lane of the eastbound portion of the Dulles Airport Access Road, crashed head-on into the right front of an eastbound 41 passenger 1967 G.M.C. Model 4107 Greyhound Airport Service Bus, 584 feet east of the Virginia Route 7 overpass. Both vehicles were traveling at the speed limit, 65 m.p.h., prior to impact.

After striking the bus, the automobile was driven back 130 feet to the east, pivoted counterclockwise 180°, and struck an eastbound 1969 Ford Econoline Van on the left front side. Just preceding contact, the van, in the outside (right) lane, took evasive action by braking and veering onto the paved, right shoulder of the road.

The bus driver, in the process of overtaking the slower moving van, observed the automobile approximately 1,200 feet to his front, coming towards him in a head-on configuration. The bus driver turned towards the median on his left and applied brakes.

With a closure rate of 130 m.p.h., or 190 feet per second, the bus was not able to complete its evasive maneuver before being struck by the wrong-way automobile.

After disengagement, the bus skidded eastward on the pavement, entered the median, and came to an upright, final position, 278 feet from the point of impact. No fire ensued. Damage to the bus was extensive in the right front corner area and the automobile was destroyed. The operator of the automobile was killed, 14 occupants of the bus and van were injured. One bus passenger died from his injuries 20 days after the accident.

The three accident-involved vehicles were equipped with lap-type seat belts for the driver. The bus driver and automobile driver, however, were unbelted. No passenger restraint system was installed within the bus.

Twelve ambulances, several police units, and two fire trucks responded within 20 minutes. Bus passengers were assisted in climbing out of the vehicle through an open windshield space located at the right front of the bus.

There were no mechanical or tire failures on the bus. There was no evidence of any mechanical or tire failures on either the automobile or van.

The bus driver and driver of the van were sober, awake, and reportedly in good physical condition. Toxicology performed on the automobile driver, during a post-mortem examination, revealed a blood-alcohol content of .21 percent.

The weather was clear and dry. Traffic volume on the road was moderate.

The Safety Board determines that the probable cause of this accident was driver error in that an automobile was driven the wrong way on a dual highway by a driver under the influence of alcohol.

Contributing causes were:

1. The severe impairment of the driver's sensory and motor processes, judgment, and overall driving ability due to the influence of alcohol.
2. The absence of wrong-way traffic control devices at all possible wrong-way entry points to the Dulles Airport Access Road east of the accident site.
3. The bus driver's failure to fasten an available seat belt which increased the severity of his injuries.
4. The nonavailability of a seat belt in the front row of passenger seats of the bus which resulted in severe injury to an ejected passenger.

II. FACTS

The Accident

The bus, making a regularly scheduled passenger trip from the Dulles International Airport terminal to 12th and K Streets, N.W. in Washington, D. C., was carrying eight passengers. Traveling east on the four-lane-divided Dulles Airport Access Road at 65 m.p.h., the bus (headlights on) was in the process of passing a slower moving van when an automobile, 1,200 feet to its front, approached from the opposite direction in a head-on configuration.

The bus was steered slightly towards the left (median area) and the driver made a maximum foot brake application. Tire marks on the pavement indicated that the bus skidded approximately 11 feet prior to impact with the wrong-way automobile. One bus passenger was ejected through the front windshield space. There was no evidence to indicate that the wrong-way automobile attempted any evasive action preceding the head-on collision with the bus.

The van avoided major contact with either of the other two vehicles by turning 45° to the right, entering the paved shoulder, and coming to a gradual stop--at which point it received a glancing blow on its left front corner from the right front of the deflected wrong-way automobile.

The wrong-way automobile was driven back 130 feet, rotated 180° in a counterclockwise direction, and it struck the van as it stopped.

The bus angled slightly to the left, continued forward, leaving approximately 80 feet of tire marks on the roadway. It then entered the grassy median, traveled 198 feet, and came to rest in an upright position.

At final rest, the driver immediately switched off all operating electrical systems within the bus. The engine continued to run until turned off in the rear engine compartment. There were no fires, smoke, or noxious fumes to create panic, or intensify the situation for the passengers. Passengers remained in the bus until they were assisted in evacuation by the driver, motorists, and rescue units.

The Road^{1/}

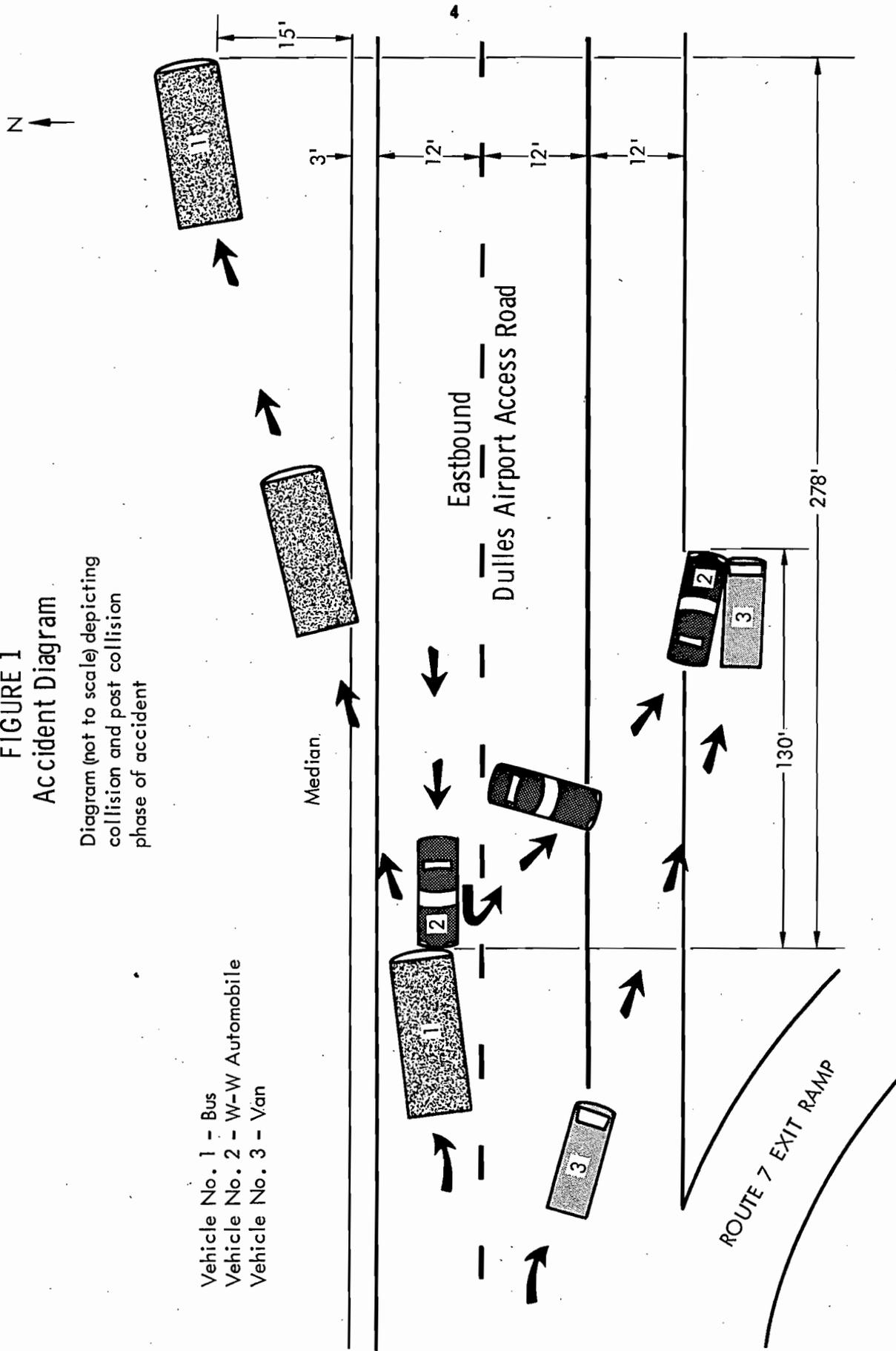
The Dulles Airport Access Road, opened to traffic in 1962, is a four-lane-divided, controlled-access highway running generally east and west, extending 14.3 miles from the Dulles International Airport

^{1/} Data obtained from the Federal Highway Administration, U.S. Department of Transportation.

FIGURE 1
Accident Diagram

Diagram (not to scale) depicting collision and post collision phase of accident

- Vehicle No. 1 - Bus
- Vehicle No. 2 - W-W Automobile
- Vehicle No. 3 - Van



to Virginia Route 123, near McLean, Virginia. It is operated and maintained by the Federal Aviation Administration, U.S. Department of Transportation.

The horizontal and vertical alignment meets current highway design criteria, there being no curves greater than $1^{\circ} 30'$ and no grades greater than 3 percent. At the accident site, the curve is $1^{\circ} 30'$ to the right eastbound, and the grade measures plus 2 percent.

The east and westbound lanes are divided by a 64-foot median employing a V-bottom ditch design with 6 to 1 side slopes. Several crossover locations are provided for official use only and these are controlled by padlocked chains and signed to prohibit use by the general public. The crossover located five-tenths of a mile east of the accident site is left uncontrolled and is unofficially utilized by the general public. No guardrail is in place at the accident site, nor is any required.

There are seven interchanges, six of which are partial interchanges, that allow westbound entry and eastbound exit only. The left off-ramp, southbound on I-495, is the only ramp allowing entry to the eastbound roadway other than at the airport itself.

The roadway pavement is constructed of asphaltic concrete. The surface is moderately worn, free of holes and ruts, and dotted with repair patches.

The outer and inside shoulders are paved and clearly delineated by a painted, white line on each edge of the roadway.

Accident Site

The accident site is 12 miles east of the airport. The accident occurred in the inside (left) lane of the eastbound traffic-way -- 548 feet east of the Virginia Route 7 overpass.

The stopping sight distance, looking east from the Route 7 overpass, is approximately 1,200 feet. Farther stopping sight distance is prevented by a group of trees on an earth embankment located on a curve east of the accident site. The design minimum stopping sight distance on this road is 498 feet (dry pavement).

"Minimum stopping sight distance is the sum of two distances: one, the distance traversed by a vehicle from the instant the driver sights an

object for which a stop is necessary, to the instant the brakes are applied; and the other, the distance required to stop the vehicle after the brake application begins. "2/

The nearest point of entrance or exit east of the accident site is 1 1/2 miles, located at the I-495 interchange.

Traffic volume was reportedly moderate at the time of the accident. Peak traffic usually occurs between the hours of 4 p.m. and 7 p.m. The eastbound average daily traffic count is 3,838 vehicles.

Weather

No precipitation was reported just before or during the accident. The pavement was dry, and visibility clear.

Traffic Control

The posted speed limit is 65 m.p.h. Pavement markings on the eastbound roadway consist of a 4-inch white skip centerline and solid white, 4-inch lines marking the inside (left) and outside (right) edges of the roadway.

At the time of the accident, traffic control devices (signs, signals, markings) indicating one-way traffic which could be interpreted as regulatory, cautionary, or warning, were nonexistent at the I-495 interchange or on the roadway in that vicinity.

A Bureau of Public Roads Instructional Memorandum (21-6-67, 47-54.1), Subject: Signs and Pavement Markings to Avert or Redirect Wrong-way Traffic Movements, states,

"... it is necessary to emphasize and broaden signing and marking in view of the serious nature of the wrong-way problem, it is concluded that the Bureau should take steps to implement the installation of signs and pavement markings with no unreasonable delay."

The Federal Highway Administrator's November 18, 1970, "Notice of Determination of Applicability of Highway Program Standard to Federally Administered Areas," states,

2/ "Policy on Geometric Design on Rural Highways," ASHO, 1965.

"Notice is hereby given that, in accordance with the provisions of section 403(a) of title 23, United States Code, the Federal Highway Administrator pursuant to authority delegated to him, hereby determines that Highway Safety Program Standard 13 (Traffic Control Devices) (23 CFR 204.4) is applicable to highways open to public travel in federally administered areas where a Federal department or agency controls the highway or supervises traffic operations."

Discussions with traffic engineers revealed they uniformly agree that wrong-way signing is not necessary on ramps linking two or more expressways. That interpretation is based on the fact that such ramps are geometrically designed to deter inadvertent wrong-way entry. The ramps linking I-495 and the Dulles Airport Access Road are so designed and constructed.

Soon after this collision, appropriate signs to deter wrong-way entry were placed at several locations situated within the I-495 interchange and in the vicinity of the accident site.

The Vehicles

The Bus

The bus, a 1967 G.M.C. 41-passenger coach, Model PD 4107, is a 2-axle vehicle with single tires on the front and dual tires on the rear. It is powered by an 8-cylinder, rear-mounted diesel engine, and is equipped with air-operated brakes.

This model bus has four long-type side windows on each side, hinged at the top and latched on the bottom. The latter are of "pushout" design, with emergency exit capability. The two-piece windshield is designed to "pop out" in the advent of impact.

The bus is designed to seat 41 passengers: one to a seat, two seats to a section, in two rows of nine sections, and one to a seat, five seats to a section, in one row located at the rear of the vehicle. The driver's seat is equipped with a lap belt, anchored to the seat frame, but it was not in use at the time of the collision. There was no company policy in effect requiring the driver to utilize the installed belt. No other occupant restraint system was installed.

Overhead package racks are located on each outboard side of the bus interior. The ceiling consists of plastic panels with a transom window between the center and lower front area. The flooring is plywood bolted

to the understructure and is tiered with two steps between the raised floor level. A single entrance/exit door is manually operated and opens outward.

The Automobile

The automobile, a 1965 Mercury 2-door hardtop model, was equipped with a V-8 gasoline-powered engine, automatic transmission, power steering, power brakes, and front lap-type seat belts. The driver was found, after the collision, in the automobile and unbelted.

This automobile was owned by the driver and registered in Maryland.

The Van

The van, a 1969 Ford Econoline was equipped to carry eight passengers. Front shoulder and lap-type seat belts were installed; the seat belts were in use by the driver and front seat passenger.

This vehicle is owned by the driver and registered in the State of Texas.

The Drivers

Bus

The bus driver, a male, aged 35, held a current State of Virginia chauffers license and BMCS doctor's certificate, dated September 27, 1967.

He was employed as a driver by Airport Transport, Inc., October 4, 1967, and retained by the present carrier when they assumed management of the operation on January 1, 1969. Prior to October 4, 1967, he was employed as a commercial truck driver, and had no experience operating buses. On November 27, 1968, he assumed full-time bus driving duties after being road-tested and receiving driver training. His personnel record indicates he has had a total of eight accidents during his 33 months of employment with this carrier, both as a part-time and full-time driver. Seven of the eight were recorded as being "non-preventable," the other as "preventable." His record does not include any traffic violations and the National Drivers Register has no record of him.

His pre-crash hours of service were checked and found to be within the allowable limits set forth in BMCS Regulation 395.3--a total of 31 hours on duty in 7 days, and approximately 35 minutes on the day of the accident. He was sober and in good health.

He suffered lacerations to the face and hands, a fractured vertebrae (hairline), a fracture in the left arm, chest and abdomen injuries during the crash, and was hospitalized.

The Automobile

The driver of the automobile, a male, aged 48, held a current Pennsylvania operator's license, although he had been a working resident of the State of Maryland for the past 3 years. His driving experience spanned 30 years. The National Driver Register has no record of this driver.

He was a carpenter. According to his wife, he was unemployed at the time of the accident occurrence, but had left his home in good spirits that day at 7:30 a.m. to seek employment.

His wife also stated that they were not in financial trouble, nor were they experiencing domestic problems. Further, she indicated that her husband was a moderate beer drinker, and at no time did he allow drinking to interfere with his work or home life.

This driver's trip plan on the day of the accident is not known. Attempts to locate persons possibly possessing such information have been unsuccessful.

The medical cause of death was officially listed by the Fairfax (Virginia) County Medical Examiner as "a compound comminuted fracture of the skull with evulsion of scalp, boney calvarin and brain." Toxicology performed on a blood sample taken from the driver's pulmonary vein revealed a blood-alcohol content of .21 percent, and a carbon monoxide level within normal limits. The Medical Examiner recorded on the death certificate the official cause of death as "suicide."

The Van

The driver of the van, a male, aged 33, had a current and valid Texas operator's license, with no restrictions noted.

He has been driving for the past 18 years; however, his driving history is unknown.

His injuries included a fractured right hand and minor lacerations.

Witnesses

A westbound motorist told of first noticing the wrong-way vehicle approximately one-half mile west of the I-495 interchange, and about 1 mile east of the accident site. Separated by a 64-foot median, he drove

parallel with the wrong-way vehicle for a distance of approximately one-half mile attempting to warn the driver by blowing his horn and waving his left arm. The wrong-way driver appeared to be "oblivious" to his efforts and continued westbound at a speed of about 65 m.p.h.

An eastbound motorist stated that he was traveling in the outside (right) lane and first observed the wrong-way vehicle as it came out of the curve located approximately one-tenth of a mile east of the accident site. He blew his horn and waved his left arm as the wrong-way vehicle passed him in the inside (left) lane. The wrong-way driver was observed to be sitting upright and looking straight ahead. The witness' actions were ignored as he watched (through his rear view mirror) the bus and wrong-way vehicle collide. He stated that the brake lights on the wrong-way vehicle did not light up prior to, or during, the collision.

A second westbound motorist, the operator of a U.S. Army vehicle, stated that he noticed a car going the wrong way on Dulles Road. A few seconds later, a bus came over a hill heading straight for the car. The bus swerved but could not avoid hitting the car in the right front.

Vehicle Damage

The Bus

The right front of the bus was damaged in increasing severity from the middle front through the right corner. The corner collapsed approximately 1 foot inward and the door was crushed.

The right front windshield and transom were ejected outward during impact; the left front windshield broke into three pieces. The window to the immediate left of the driver's seat was shattered, and the window to its rear was cracked. The window to the immediate rear of the door was cracked, and the window to its immediate rear was missing. All other windows maintained their integrity.

The first two rows of seats on the left side of the bus were deformed, but not dislodged from their floor anchorages. The right front outboard seat was bent forward, also remaining secured to its floor anchorage. All other seats in the passenger compartment maintained their normal configuration.

The driver's seat revealed no obvious signs of deformation, other than a slight twisting to the left. A lap-type seat belt is anchored to this seat by swivel mountings on the seat frame. A part of the belt was found wedged between the seat and the left wall of the bus.

The roof and most of the floor area showed no evidence of any breaks or deformation. The floor area in the right front corner (impact area) of the bus was crushed inward.

The steering wheel and column displayed no indication of crash damage. The steering system, the front suspension, and the front and rear axles were all damaged.

Fuel tanks remained intact and there was no fire.

A post-crash inspection of the bus disclosed no evidence of mechanical failure. Maintenance records indicate that the bus was regularly inspected and serviced. Brakes were relined, diaphragms changed, and a new brake relay valve installed on January 19, 1970. The tires showed no excessive wear and were above BMCS tread depth minimums.

The Automobile

The right front half of the automobile was crushed inward approximately 3 feet, causing frame deflection to the left. There was severe buckling of the hood, right front fender, roof, and right side.

The right door assembly was deformed, protruding out and downward. The left door, including its glass, maintained its integrity. Both windshield and rear window were disintegrated.

The right front tire was ruptured and the right rear tire split. The left rear wheel was turned inward, but its tire showed no damage. The left front tire revealed no damage.

The steering wheel and column were distorted and the dashboard was buckled. Both the front and rear seats were dislodged from their anchorages. The partition separating the trunk area and passenger compartment was down, and the spare tire was lying in the rear passenger compartment. An empty gin or vodka bottle was observed lying on the floor of the passenger compartment.

No post-crash mechanical inspection was made. The automobile was reputed to be in good mechanical condition with no noticeable defects.

The driver was the sole occupant of this vehicle.

The Van

An on-site inspection of the van was not conducted due to its unavailability. A study of available photographs taken at the accident site indicates that this vehicle suffered minor damage to its left front door area.

Passenger Injuries

All passengers aboard the bus were injured to some degree. One passenger died 20 days after the accident occurrence from a blood clot which developed as a result of a leg broken in the collision. Most of the passenger injuries consisted of lacerations and bruises to the extremities. The ejected passenger was hospitalized and treated for a fractured spine and several fractured ribs. (See Appendix 2.)

The five passengers and driver in the van suffered minor injuries, mainly lacerations and bruises.

III. ANALYSIS

Several relevant factors contributed in a causal way to this accident and the ensuing fatal and nonfatal injuries. This analysis focuses on those causal factors that are most relevant to the explanation of the accident, and are pertinent to the corrective measures outlined in the recommendations contained in this report.

The bus, traveling east on the Dulles Airport Access Road, overtook the slower moving van and moved into the inside (left) lane preparing to execute a passing maneuver. When abreast of the van, the bus driver reached a location on the road representing his point of possible perception to the danger of the wrong-way automobile, approximately 1,200 feet to his front. The wrong-way automobile, traveling west on the Dulles Airport Access Road, reached a location on the road representing his point of possible perception to the danger of the oncoming bus, approximately 1,200 feet to his front. Farther sight distance for both drivers was restricted by a horizontal curve and lateral obstruction (clump of trees on right side of eastbound roadway). Both the bus and wrong-way automobile were proceeding at the legal speed limit of 65 m.p.h. providing a closure rate of 190 feet per second.

Using a base of 1,200 feet (stopping sight distance), and a closure rate of 190 feet per second, each driver had 6.3 seconds in which to respond before impact.

During that time, the drivers would have to (1) evaluate the situation, (2) decide on what evasive action to take, (3) take action and avoid the oncoming vehicle.

A. The Bus

(1) Evaluate the Situation:

Due to the abnormal situation and surprise created by an oncoming vehicle traveling in the wrong direction on a one-way divided highway, it is likely that the bus driver expended more time in this phase than would be expected under other circumstances.

The bus driver's delay in realizing that the automobile was a danger to him as a wrong-way vehicle, and with his attention to the front being somewhat diverted by the task of passing a slower moving vehicle, shortened his evasive action decisionmaking time as he drove beyond the point of possible perception to the point of impact, the last 11 feet with brakes locked. Computing from the latter figures, it is estimated that the bus driver expended 5.4 seconds (573 feet) during the perception and reaction stages of the pre-impact sequence.

Based on available data, and considering the extraordinary traffic condition created by a wrong-way automobile, it is not practical to present any "average" perception, and "typical" reaction time values in comparison with estimated perception and reaction times as they ensued in this collision.

(2) Decide on what action to take:

After the evaluation phase, the bus driver had five possible action options available to him; (1) steer sharply to the right and risk a collision with the van; (2) steer to the right and enter the right lane, requiring the van to take evasive action and allow the oncoming vehicle to pass freely in the left lane, anticipating that the van would successfully vacate the right lane and the oncoming vehicle would continue forward in the left lane; (3) steer sharply to the left without braking, and enter the sloped median and chance bus overturn; (4) apply brakes without turning, anticipating that the oncoming vehicle would react similarly; (5) while gradually steering to the left, apply brakes and enter the median at a slight angle at a reduced rate of speed, lessening the probability of bus overturn.

(3) Take action and avoid the oncoming automobile:

The bus driver chose to steer slightly to the left, make a maximum foot brake application, and enter the median at a slight angle at a reduced rate of speed, lessening the probability of bus overturn. However, the time expended during the evaluation phase of the pre-impact sequence narrowed the time parameters available for this maneuver, negating its completion. The bus was steered 5° to the left, skidded 11 feet, and remained on the roadway, slowing down to about 50 m.p.h. as it made contact with the right front of the wrong-way automobile.

(4) Crash Injuries:

On impact, the right section of the bus windshield popped outward, and an unrestrained passenger (right front row seat) was propelled forward at impact-velocity through the windshield space. A second unrestrained passenger (right second row seat) was forced from his seat by deceleration forces and thrown forward down the bus aisle. He, at that point, was intercepted by the bus driver and restrained within the bus. The latter passenger sustained a broken leg during his impact kinematics, and 20 days later died from a blood clot which developed as a result of his collision injury. The ejected passenger received a fractured spine and ribs as he made contact with the pavement. From available injury reports, it appears that the remaining bus passengers, all seated within the first three rows (right and left), were thrown forward. They experienced relatively low injury patterns which were most likely sustained during impact with forward seat backs.

Bus deceleration forces moved the unrestrained driver forward against the steering wheel and then upward into a standing position. During the upward and forward movement of his body, the bus driver experienced further contact with the steering wheel and momentary impact with the windshield, increasing the number of injury points on his upper torso and head. He remained in the upright position until the bus came to rest.

(5) Post-impact:

Although forced into a standing position during the impact, the driver maintained control of the bus and brought it to a slow orderly stop in an upright position on the median, some 278 feet east of the point of impact. He remained in the bus and immediately switched off all electrical systems. He attempted to cut off the bus engine without success. The engine was cut off via the rear engine compartment by two motorists who stopped to assist.

(6) Evacuation:

The only entrance/exit door of the bus was crushed into an inoperable configuration. This factor necessitated the removal of occupants through window space. Although the side windows were intact and could be pushed out for emergency escape, an open space created by the popped out right windshield was chosen as an evacuation route. This effort was accomplished by the bus driver, motorists, and rescue units as they arrived.

The entire evacuation process was orderly, and began after the bus came to rest. The noncritical nature of passenger injuries and absence of fire probability allowed a slow and careful evacuation to be executed.

B. The Automobile

The absence of available details as to the wrong-way driver's pre-crash trip plan makes it necessary to discuss and analyze all the eastbound roadway entry points available to him on the date of the accident occurrence. He could have entered the eastbound roadway:

1. From I-495 via the northbound exit ramp, heading the wrong way.
2. From I-495 via the southbound exit ramp, heading the wrong way.
3. From Virginia Route 123 via the exit ramp, heading the wrong way.

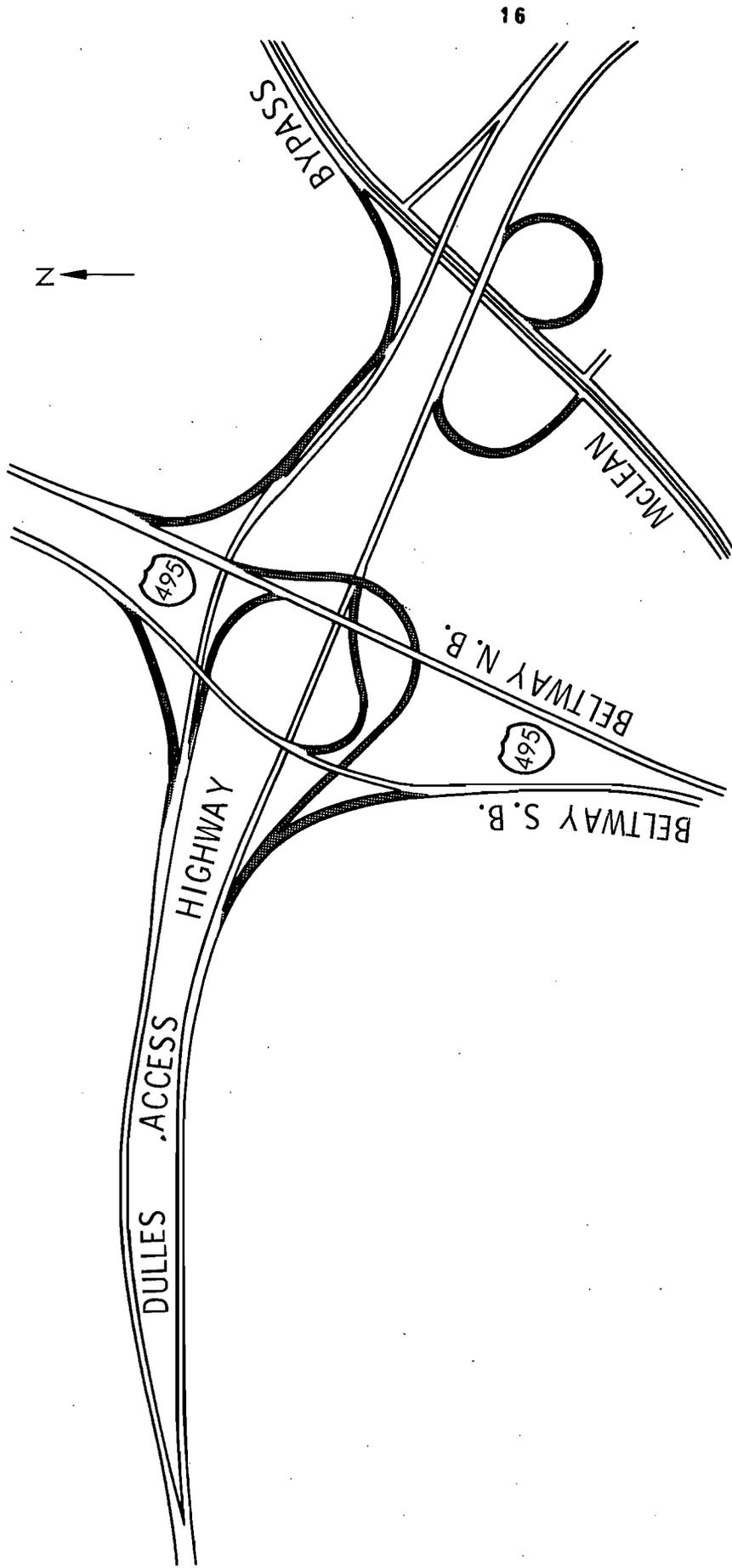


FIGURE 2
 DULLES ACCESS ROAD - I-495 INTERCHANGE
 DIAGRAM

Diagram depicts all ingress and egress ramps of the Dulles Airport Access Road at I-495 and McLean Bypass (Route 123).

4. From an eastbound configuration on the Dulles Airport Access Road, making a "U" turn on the eastbound roadway, heading the wrong way.
5. From a median crossover located at the Route 123 terminus of the road, via a left and right turn, heading the wrong way.
6. From I-495 via the southbound McLean (left) off ramp by executing a left turn across the gore area^{3/} and a left on the eastbound roadway, heading the wrong way.

Entry to the eastbound roadway to proceed westbound (wrong way) can be accomplished at any of the points mentioned above. However, the geometric design of the terminus points of the ramps in question clearly delineate their distinct exit characteristics, and entrance can only be executed by a determined and knowing effort.

A review of all possible actions by the driver suggest that he was southbound on I-495 and desired to reverse direction to proceed toward his home in a northbound direction on I-495. Under that premise, it is probable that he completed the following maneuvers: (1) exited from southbound I-495 via the McLean (left) off ramp; (2) drove down the ramp; (3) as he approached the tapered ramp terminus, found his vehicle parallel with the eastbound portion of the Access Road; (4) in an alcohol-induced state of confusion, he could have executed a left turn (90°) over the flat, uncurbed gore area; and (5) completed the remainder of a 180° turn on the eastbound roadway, placing him in a westbound configuration. Driving in the inside (left) lane (his right), he proceeded westbound, possibly seeking a route which would place him in a northbound direction.

A westbound witness, driving parallel with the wrong-way automobile, first observed the vehicle approximately 1 mile east of the accident site. The accident occurred approximately 1 1/2 miles from the wrong-way driver's probable entry point onto the eastbound roadway.

The wrong-way driver had the same sight distance available to him as did the other two involved drivers. He had three evasive action options: (1) steer sharply to his left and enter the outside right shoulder area, chancing a collision with the van; (2) apply brakes without turning anticipating that the oncoming bus would react similarly; and (3) apply brakes, steer sharply to his right and enter the median. Under the existing conditions, the latter option was most feasible. The median embankment side slope (6:1) could be negotiated by a decelerating vehicle with an excellent chance of recovery,^{4/} consequently offering the wrong-way automobile a probable collision-free path.

^{3/} ASHO defines the "gore" as the area immediately beyond the divergence of two roadways, bounded by the edges of those roadways.

^{4/} FHWA, "Handbook of Highway Safety Design and Operating Practices," U.S. Department of Transportation, May, 1968.

However, the wrong-way driver did not execute any of the three previously mentioned evasive action options. It is suggested that he was either preoccupied by his confusion and/or in an alcohol-induced state of indifference. Both are evidenced by his failure to acknowledge the warnings of other motorists and take evasive action. This, however, does not necessarily indicate that the wrong-way driver had, in fact, completely lost all of his sensory and motor functions, and was driving blind to the danger, and physically incapable of responding to it.

It has been fairly well documented that, generally, human sensory and motor processes are depressed by the intake of alcohol. (See Appendix 1) Fields of vision perception, distance, judgment, and reaction functions are degraded in proportion to the amount of alcohol consumed. The percentage of alcohol (.21) found in the blood of the wrong-way driver in relation to his body weight indicates that he had a minimum of 9 ounces of 100-proof liquor, or nine 12-ounce bottles of beer remaining in his system at the time of his death. This concentration is likely to seriously degrade the sensory and motor processes in most individuals.

A post-crash examination of the driver's seat belt revealed no evidence of crash failure, which indicates that the belt was not fastened during the collision. At impact, the unbelted driver was thrown into the steering wheel and column with sufficient force to fracture four of his ribs on the right side and seven on the left side, as well as his pelvis. His automobile was stopped instantly from a speed of about 65 m.p.h., then driven back in the opposite direction 130 feet as it rotated counterclockwise 180°. During the latter kinematics, the driver's head and torso were propelled forward and to the right, his forehead striking the center of the dashboard (radio) causing fatal injury. After the immediate post-collision activities were stabilized, the bus driver discovered the wrong-way driver in the automobile lying across the front passenger compartment with his face resting on the center dashboard (radio) and his feet in the area of the foot control pedals.

Although the autopsy performed on the wrong-way driver revealed no pre-death organic disorders or evidence of the chronic use of alcohol, the official death certificate recorded "suicide" as the manner of his death. That finding was based on his blood-alcohol content (.21 percent) and wrong-way movement on the highway. It is agreed that automobile accidents include a certain number of suicides or suicidal attempts; nevertheless, a review of the wrong-way driver's background, health, financial situation, home life, and drinking habits does not indicate suicidal motivation or tendencies.

C. The Van

The driver of the van, immediately upon perceiving the wrong-way automobile, steered to his right and entered the paved shoulder area of the road.

His evasive action option was clearly singular and did not require the time-consuming decisionmaking process necessary in the case of the bus driver.

The evasive maneuver of the van was successful and the vehicle only received a minor glancing blow from the wrong-way automobile as that vehicle came to rest after being driven backward by its collision with the bus.

Traffic Controls

It is possible that the wrong-way driver would have noticed appropriate signs on the ramp and roadway, if they had been in place at that time. On the other hand, it is also possible that his reaction to such signs, had they been in place, would have been negative and would not have retarded his westward movement on the eastbound roadway. This, however, does not rebut the overall effectiveness of appropriate signing to prevent wrong-way entry by all motorists onto multilane divided highways, as pointed out in a California research project, dated June, 1965.

"Since many of the at-fault drivers in wrong-way accidents, especially the more severe accidents, have been drinking, and since it is generally assumed that the drinking driver is more difficult to influence, there was some concern that the preventive measures might not be too effective in reducing wrong-way driving by drinking motorists. The rate of wrong-way driving, however, was decreased to almost the same degree at night for the sober and for the drinking driver. During daylight hours, however, the drinking driver incident rate was decreased to a substantially greater degree (70 percent vs. 57 percent)."^{5/}

^{5/} State of California Department of Public Works Interim Report No. 2 on Wrong-way Driving (Phase III).

IV. CONCLUSIONS

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

1. The bus was operating at 65 m.p.h. and slowed down to approximately 50 m.p.h. prior to impact. (Pages 3, 13, 14)
2. The wrong-way automobile was operating at 65 m.p.h. There is no evidence to indicate that it slowed down prior to impact. (Pages 3, 10, 13)
3. The bus driver's attention to his front was somewhat distracted by the task of passing a slower moving vehicle. (Pages 3, 13)
4. The evasive action, decisionmaking process time frame for the drivers (bus and automobile) was 6.3 seconds--the vehicles closing at a rate of 190 feet per second. (Pages 3, 13)
5. The van driver took proper evasive action by gradually entering the right (paved) shoulder of the road, thereby gradually reducing deceleration forces and preventing serious injuries to the occupants of that vehicle. (Pages 3, 19)
6. The experience in this case indicates that the placement of appropriate traffic control devices on multilane divided highways is essential to prevent wrong-way entry. (Pages 6, 7, 19)
7. The 1,200 feet of stopping sight distance (point of possible perception) available to both the bus driver and the wrong-way driver was above the minimum stopping distance of 489 feet (dry pavement) as recommended for this highway design. (Page 5)
8. The bus driver's evasive action options were few and all virtually impossible to execute effectively without causing damage and/or injury to the bus and its occupants. (Pages 3, 12, 13, 14)
9. The evasive action chosen by the bus driver prevented bus overturn. (Pages 3, 14)
10. The wrong-way driver's evasive action options consisted of three possible maneuvers. All could possibly have prevented the collision. There is no indication that he chose to execute any of them. (Pages 3, 17, 18)

11. The presence and use of passenger restraints in the bus could have reduced the severity of injuries suffered in that vehicle. Such restraints would have contained the ejected passenger and the fatal passenger in their seats, reducing the severity of their injuries. (Pages 3, 7, 12, 14)
12. The bus driver was not wearing the seat belt provided for his use, increasing the severity of his injuries. (Pages 7, 9, 10, 15)
13. The bus carrier did not have a written company policy requiring the fastening of seat belts by drivers operating buses equipped with such restraining devices. (Page 7)
14. The bus driver was qualified to operate a passenger motor carrier and possessed all the credentials required by BMCS regulations. (Page 8)
15. The bus driver, at the time of the collision, was in good health, and sober. (Page 8)
16. The wrong-way driver was driving on a current Pennsylvania driver's license, even though he was a resident of the State of Maryland. (Page 9)
17. The wrong-way driver, at the time of the collision, was driving while under the influence of alcohol; his judgment, reactions, and overall driving ability were impaired. (Pages 9, 10, 18)
18. The flat uncurbed gore area at the terminus of the I-495 southbound McLean (left) off ramp offers wrong-way turn-around opportunity for confused motorists. (Pages 5, 17)
19. The failure of the automobile driver to realize his wrong-way entrance into the eastbound roadway of the Dulles Access Road was partially a result of his being under the influence of alcohol. (Pages 9, 10, 18)
20. The deceleration forces on the wrong-way automobile created loads within that vehicle, making it unlikely that the driver would have survived even had his seat belt been fastened. (Pages 3, 9, 11, 18)
21. The background information available on the wrong-way driver, and an analysis of the accident facts gave no evidence that the collision was motivated by a self-destructive act. (Pages 9, 18)

22. The bus was in satisfactory mechanical condition. (Page 11)
23. The wrong-way driving phenomenon requires more research, development, and implementation in the area of remedial measures: traffic control devices, highway design, alcohol involvement, and enforcement.

V. PROBABLE CAUSE

The Safety Board determines that the probable cause of this accident was driver error in that an automobile was driven the wrong-way on a dual highway by a driver under the influence of alcohol.

Contributing causes were:

1. The severe impairment of the driver's sensory and motor processes, judgment, and overall driving ability due to the influence of alcohol.
2. The absence of wrong-way traffic control devices at all possible wrong-way entry points to the Dulles Airport Access Road east of the accident site.
3. The bus driver's failure to fasten an available seat belt which increased the severity of his injuries.
4. The nonavailability of a seat belt in the front row of passenger seats of the bus which resulted in severe injury to an ejected passenger.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Highway Administrator, in the implementation of his notice of November 18, 1970, "Notice of Determination of Applicability of Highway Program Standard to Federally Administered Areas," should review all current operational and experimental procedures, and urge implementation of those found to be most effective in preventing wrong-way traffic movements.
2. The Federal Highway Administration, as the Safety Board recommended in its accident report, Interstate Bus-Auto Collision near Baker, California, March 7, 1968, continue to stimulate and support individual State demonstration projects in the application of remedial measures to avert or redirect wrong-way traffic movements on multilane divided highways.
3. The Bureau of National Capital Airports, the Federal Aviation Administration, in cooperation with the Virginia Department of Highways, implement remedial measures on the Dulles Airport Access Road by installing appropriate signing at all possible wrong-way entry points.
4. The Bureau of National Capital Airports extend the left guard-rail on the southbound I-495 (McLean) left off-ramp to the east end of the gore, and curb the same area to prevent "short cutting" across the gore and subsequent wrong-way entry to the Dulles Airport Access Road.
5. The Federal Highway Administration expand its rulemaking concerning Section 393.93 (seat belts) of the Motor Carrier Safety Regulations in 49 CFR 393.93 to require in all buses, the installation of occupant restraints, active or passive, that conform to the Motor Vehicle Safety Standard 209 and will retain the passengers, as well as the driver, in their seats during collision and rollover.

The Board has recommended in its accident reports, Interstate Bus-Auto Collision near Baker, California, March 7, 1968, and Chartered Interstate Bus Crash near Beaver Falls, Pennsylvania, December 26, 1968, that the FHWA consider its rulemaking and pending dockets on the subject of the installation of seat belts for bus occupants. The present regulation (Section 393.93) requires seat belts for drivers but none for passengers. 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. The retention of passengers in their seats during the crash phase is clearly desirable, as indicated by this case and others, and making restraints available is a first step in obtaining their use.

6. The National Highway Traffic Safety Administration 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 intercity buses.
7. The National Association of Motor Bus Owners urge its membership to install, without delay, driver seat belts in all buses and secure their utilization.

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

December 30, 1970.

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VII. APPENDICES

1. Stages of Acute Alcoholic Influence/Intoxication
2. Bus Occupant Injury List
3. Photographs
 - (1) Bus
 - (2) Mercury
 - (3) Econoline
 - (4) Highway
 - (5) Southbound I-495 (left) off-ramp terminus area.

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APPENDIX I

STAGES OF ACUTE ALCOHOLIC INFLUENCE/INTOXICATION

BLOOD ALCOHOL LEVEL (Percent)	STAGE OF ALCOHOLIC INFLUENCE	CLINICAL SIGNS/SYMPTOMS
0.01-0.05	Sobriety	No apparent influence Behavior nearly normal by ordinary observation Slight changes detectable by special tests.
0.03-0.12	Euphoria	Mild euphoria, sociability, talkativeness. Increased self-confidence; decreased inhibitions. Diminution of attention, judgment, and control Loss of efficiency in finer performance tests.
0.09-0.25	Excitement	Emotional instability; decreased inhibitions Loss of critical judgment Impairment of memory and comprehension Decreased sensory response; increased reaction time. Some muscular incoordination.
0.18-0.30	Confusion	Disorientation, mental confusion; dizziness Exaggerated emotional states (fear, anger, grief, etc.) Disturbance of sensation (diplopia, etc.) and of perception of color, form, motion, dimensions Decreased pain sense Impaired balance; muscular incoordination; staggering gait, slurred speech.
0.27-0.40	Stupor	Apathy; general inertia, approaching paralysis Markedly decreased response to stimuli. Marked muscular incoordination; inability to stand or walk Vomiting; incontinence of urine and feces. Impaired consciousness; sleep or stupor.
0.35 -0.50	Coma	Complete unconsciousness; coma; anesthesia. Depressed or abolished reflexes. Subnormal temperature Incontinence of urine and feces Embarrassment of circulation and respiration. Possible death.
0.45	Death	Death from respiratory paralysis

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Council.

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APPENDIX 2
BUS OCCUPANT INJURY LIST

Bus Driver: Male, aged 35.

Diagnoses: Chest and abdomen injuries,
fractured vertabrae, hairline
fracture in left arm, and lacerations.

Right Side, front row, inboard: Male, aged 60.

Diagnoses: Fractured spine and fractured ribs.
Ejected.

Right side, second row, inboard: Male, aged 53, fatal.

Diagnoses: Broken right leg, dislocated
right little finger, lacerations.
Died of injury complications (blood clot),
20 days after accident.

Right side, third row, inboard: Male, aged 70.

Diagnoses: Bruised left knee and nose.

Right side, third row, outboard: Female, aged 66.

Diagnoses: Bruises and lacerations.

Left side, behind driver, inboard: Male, aged 37.

Diagnoses: No physical complaints.

Left side, third row, outboard: Male, age unknown.

Diagnoses: Bruises left leg and hand.

Location unknown: Male, aged 45.

Diagnoses: Mouth area bruises.

Location unknown: Male, aged 43.

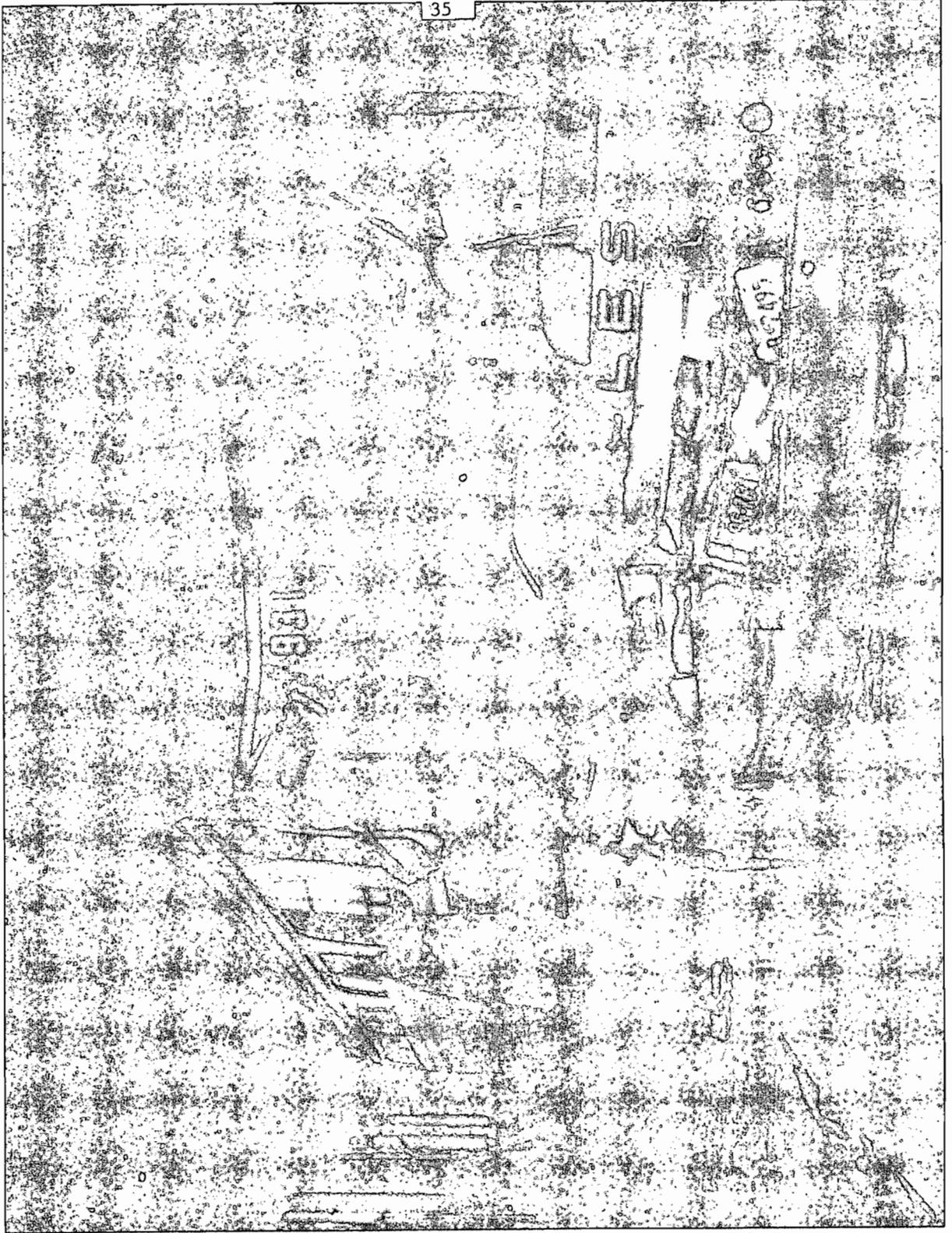
Diagnoses: Fractured nose and
lacerations.

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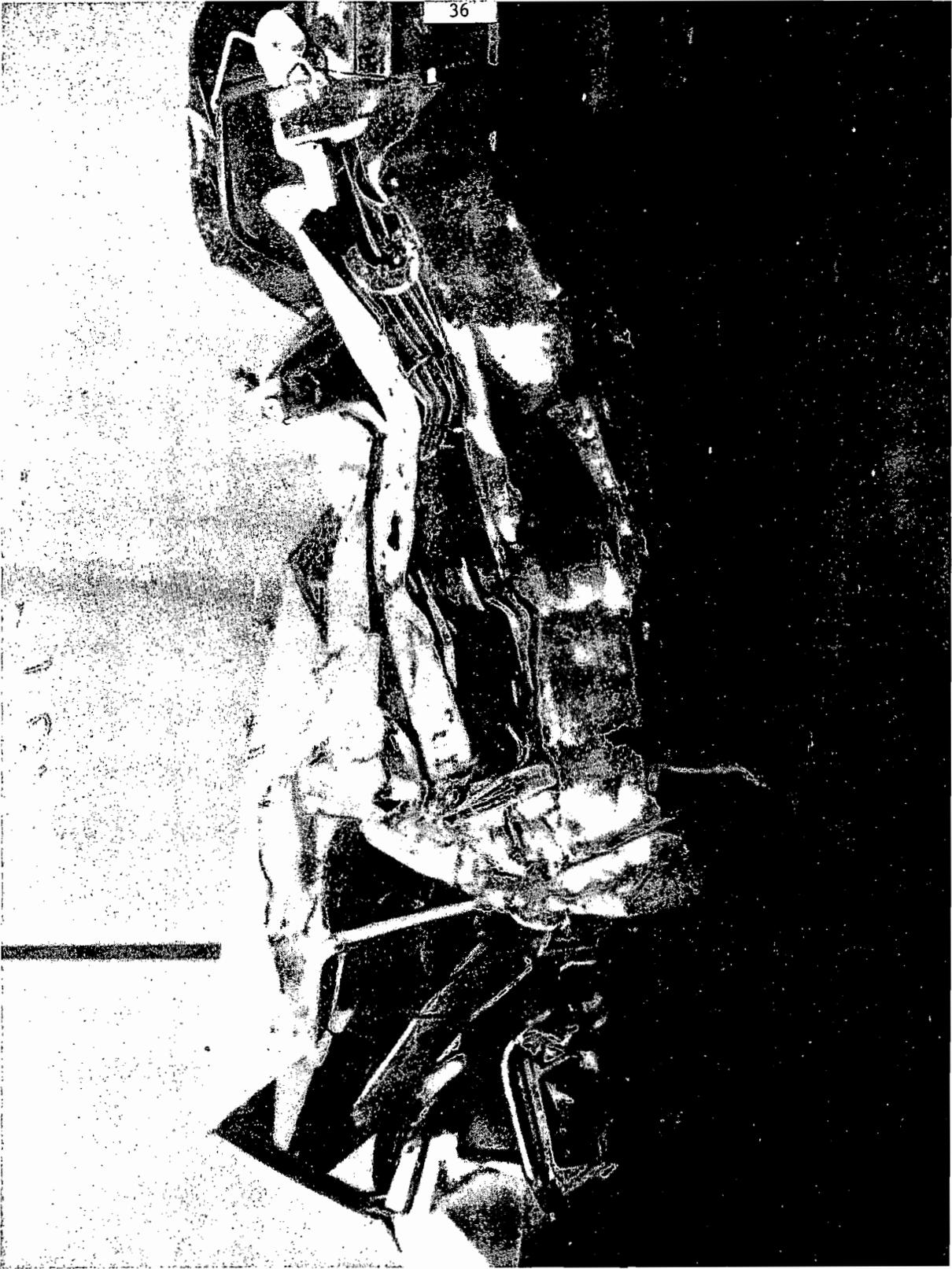
APPENDIX 3Photographs

1. Bus
2. Mercury
3. Econoline
4. Highway
5. Southbound I-495 (left) off-ramp terminus area

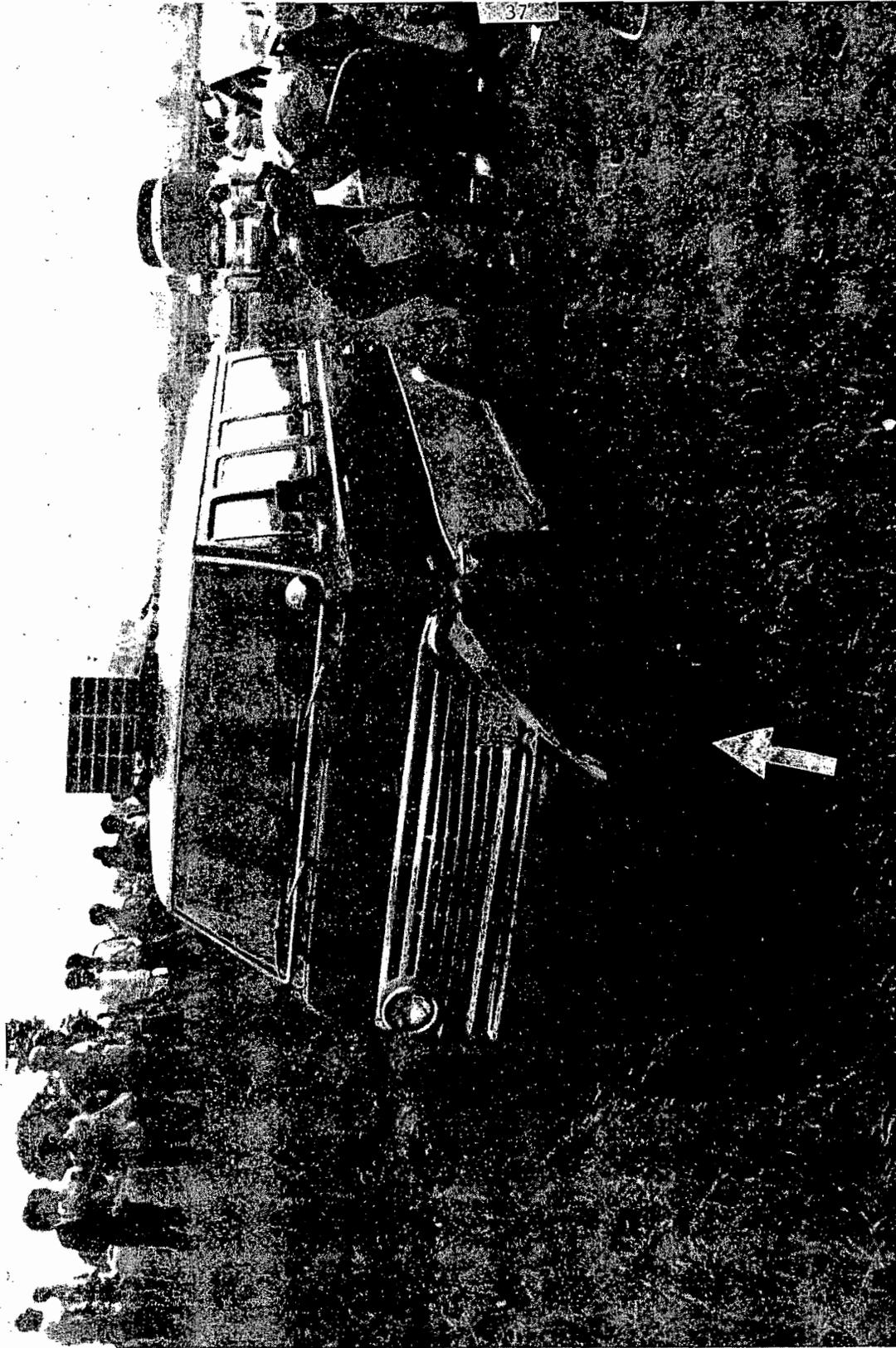
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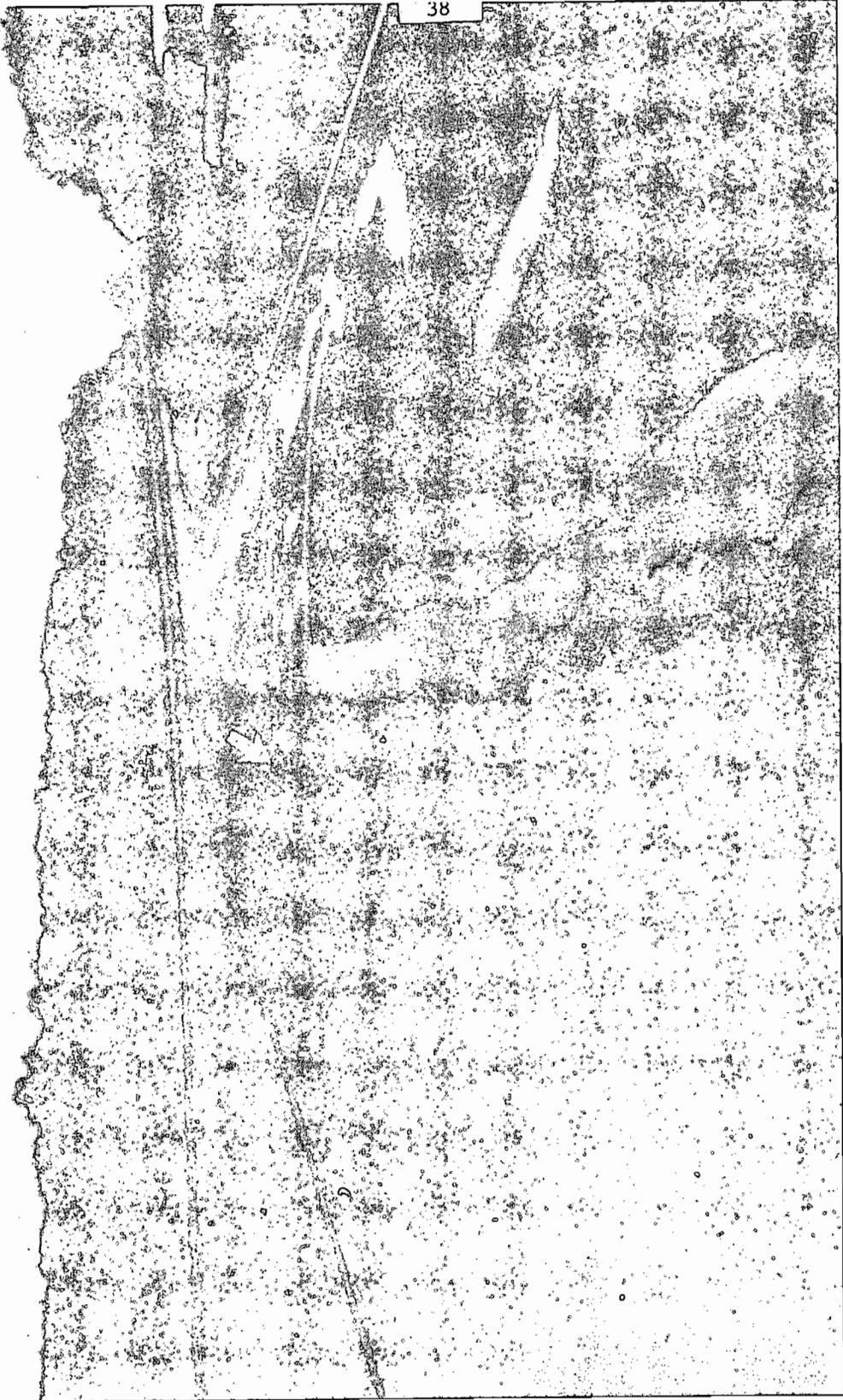
Photograph of the bus taken after removal from the accident scene showing right front and corner damage.



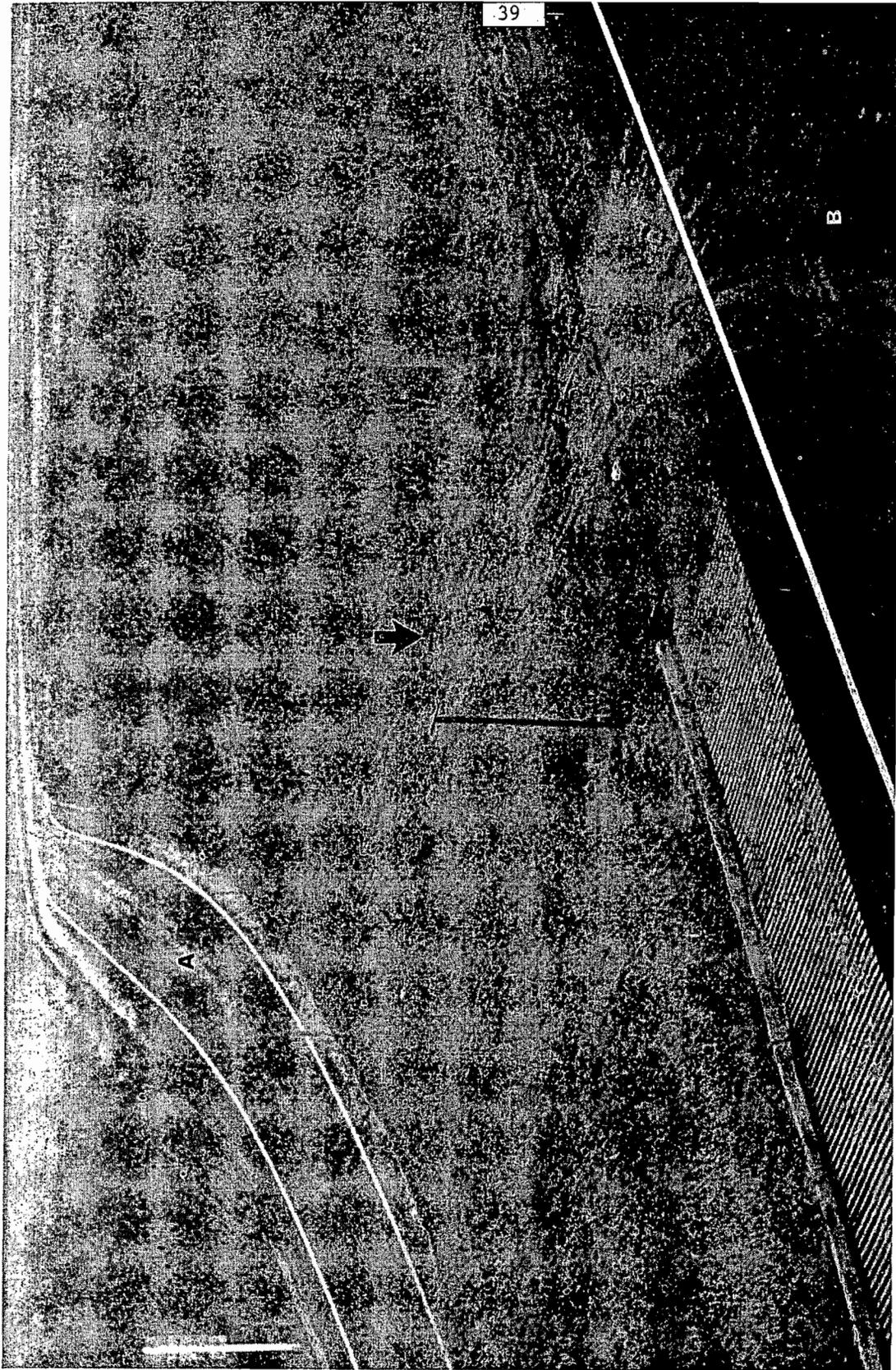
Photograph of the automobile taken after removal from the accident scene showing front, right side, and roof damage.



Photograph of the van taken at the accident scene showing left front side damage and section (arrow) of the automobile's right front fender.



Photograph of the accident site looking east on the Dulles Airport
Access Road. Arrow indicates point of impact.



Photograph of the gore area between the southbound I-495 McLean (left) off ramp (A) and the Dulles Airport Access Road (B) showing tracks (arrow) made by construction vehicles crossing the flat, uncurbed gore.