

PB82-117524



**NATIONAL  
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SAFETY  
BOARD**

WASHINGTON, D.C. 20594

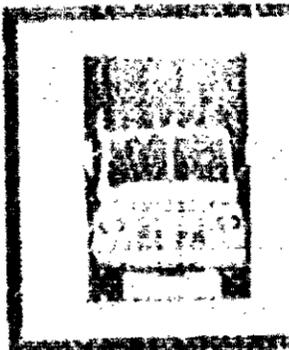
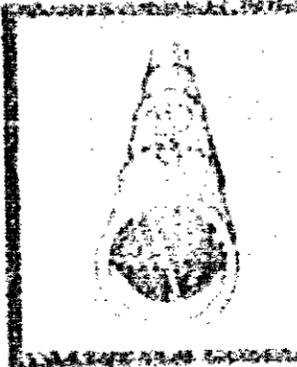
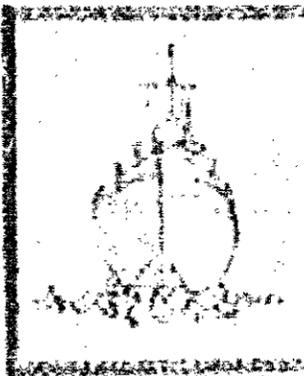
**HIGHWAY ACCIDENT REPORT**

**CONTINENTAL TRAILWAYS, INC.  
SCHEDULED INTERCITY BUS/  
MULTIPLE-VEHICLE COLLISION AND FIRE  
INTERSTATE ROUTE 95  
NEAR BELTSVILLE, MARYLAND  
APRIL 20, 1981**

NTSB-HAR-81-5

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16. Abstract About 5:55 p.m. on April 20, 1981, a scheduled intercity bus with 34 passengers onboard was southbound on Interstate Route 95 (I-95) en route to Washington, D.C., via Silver Spring, Maryland. As the bus approached the Interstate Route 495 (Capital Beltway) interchange, the traffic ahead in the right lane slowed and came to a stop. The bus failed to stop, crashed into the rear of the automobile ahead of it, and precipitated a four-car, front-to-rear-end collision. Two of the automobiles burst into flames which quickly spread to and engulfed the bus after it had been evacuated. Three occupants of the automobile struck by the bus were killed. The drivers of the other three automobiles, the busdriver, and the 34 bus passengers received minor injuries.  The National Transportation Safety Board determines that the probable cause of this accident was the failure of the busdriver to maintain a safe stopping distance between the bus and the automobile ahead as traffic ahead slowed and came to a stop during the peak traffic period. Contributing to the cause and severity of the fires was the separation of the filler pipes from the fuel tanks of two of the automobiles.					
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**NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C. 20594**

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**Adopted: September 15, 1981**

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INTERSTATE ROUTE 95, NEAR BELTSVILLE, MARYLAND  
APRIL 20, 1981**

**SYNOPSIS**

About 5:55 p.m. on April 20, 1981, a scheduled intercity bus with 34 passengers on board was southbound on Interstate Route 95 (I-95) en route to Washington, D.C., via Silver Spring, Maryland. As the bus approached the Interstate Route 495 (Capital Beltway) interchange, the traffic ahead in the right lane slowed and came to a stop. The bus failed to stop, crashed into the rear of the automobile ahead of it, and precipitated a four-car, front-to-rear-end collision. Two of the automobiles burst into flames which quickly spread to and engulfed the bus after it had been evacuated. Three occupants of the automobile struck by the bus were killed. The drivers of the other three automobiles, the busdriver, and the 34 bus passengers received minor injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the busdriver to maintain a safe stopping distance between the bus and the automobile ahead as traffic ahead slowed and came to a stop during the peak traffic period. Contributing to the cause and severity of the fires was the separation of the filler pipes from the fuel tanks of two of the automobiles.

**INVESTIGATION**

**The Accident**

About 1:05 p.m. on April 20, 1981, a Continental Trailways, Inc. bus, assigned to a scheduled passenger route, departed the Port Authority Bus Terminal in New York City en route to Washington, D.C. The busdriver said that he performed a pretrip inspection of the bus and found nothing wrong. Passenger stops were scheduled in Baltimore, Maryland, at 4:40 p.m.; in Laurel, Maryland, at 5:15 p.m.; and in Silver Spring, Maryland at 5:45 p.m. The bus was due to arrive in Washington at 6:25 p.m.

The busdriver stated that the bus arrived in Baltimore about 20 minutes behind schedule because of traffic delays encountered at toll booths and arrived in Laurel about a half hour late. At about 5:50 p.m., the bus left Laurel and was southbound in the far right lane of Interstate Route 95 (I-95) en route to Silver Spring. The weather was clear, visibility was good, and the highway was dry. According to the busdriver, the bus was traveling at 50 mph in moderate to heavy traffic when, about a mile from the exit ramp leading into westbound Interstate Route 495 (I-495), traffic in the right lane slowed and came to a stop. The busdriver said he was approximately 100 feet behind an automobile when the traffic stopped. The bus, however, failed to stop and crashed into the rear of a 1981 Chevrolet Chevette. The Chevette was pushed into the rear of a 1978 Dodge Colt, which in turn was pushed into the rear of a 1978 Dodge Aspen, which in turn struck the rear bumper of a 1980 Ford Mustang.

When the vehicles came to rest, the right front of the bus was on the right shoulder, and the Chevette, which was occupied by three persons, was crushed against the left front of the bus and was engulfed in flames. (See figures 1 and 2.) The left front of the bus also was on fire and, after about 10 minutes, the fire spread throughout the interior of the bus. The Colt, occupied only by its driver, came to rest on its left side about 15 feet south of the burning Chevette. The Colt also was on fire. The Aspen, with four occupants, was pushed forward, struck a Mustang, and came to a stop about 285 feet south of the Colt. Its front seat was tipped rearward at impact causing the driver to temporarily lose control of the vehicle. The Aspen's gas tank was punctured and leaked fuel, but there was no fire. The Mustang, which was slightly damaged, was driven onto the right shoulder and parked by its driver, the sole occupant.

After the crash, the 34 passengers immediately evacuated the bus. Most of the passengers exited through the front door, while others evacuated through the side emergency window exits. After all the passengers had exited, the busdriver left the bus with a fire extinguisher. He said he first went to the Chevette, but it was burning too severely for him to help anyone in it. The three Chevette occupants died in the fire. He then used the extinguisher on the Colt fire. When the fire extinguisher was empty, he and another person rescued the Colt driver.

A person who had been driving immediately behind the bus for about a mile prior to the impact said that the bus was traveling at 55 to 60 mph and that he did not see the brakelights illuminate on the bus at any time. He said that just before the accident, he looked in his rear-view mirror and saw a van behind him begin to reduce speed. The vehicles had just started around a right curve, so he looked around the right side of the bus and saw brake lights illuminating on vehicles in a line of traffic in the right lane in front of the bus. The witness said he applied his brakes about the time that the bus hit the car. He said he pulled onto the right shoulder and stopped to avoid being struck from the rear. The witness said he had driven by the accident site daily within 45 minutes of the time of the crash and that traffic in the right lane often slowed but usually did not come to a halt.

None of the bus passengers reported anything unusual about the bus, the driver, or the driver's action before the accident. They said that except for being behind schedule, the trip had been uneventful. One of the bus passengers stated that just before the accident he felt the bus lunge suddenly. He said it felt like the driver had applied the brakes hard, and a second later there was a crash and a fire erupted at the driver's side of the windshield. He said there was no gradual slowing before the impact.

The busdriver gave conflicting statements about braking before the crash. He told Maryland State Police that "the brakes did not respond as they should" when he "applied the brakes to the maximum." He later told a Safety Board Investigator that he had had no brake problems during the trip and that he did not remember whether he applied his brakes or not at the time of the crash.

The busdriver said he was familiar with the area and had driven this route at least 20 times since February 1981. He said that in that area "most times the traffic backs up, but it generally doesn't come to a dead stop." The busdriver said that the bus company's policy about being behind schedule was "drive safely and not take chances for the sake of making up time." He said that the company did not want a driver to speed "under any circumstances."

BUS  
LEFT DUAL WHEEL  
SKIDMARK

BUS  
RIGHT FRONT  
WHEEL  
& SKIDMARK

CHEVETTE  
COLLISION SCRUB  
SKIDMARK

0

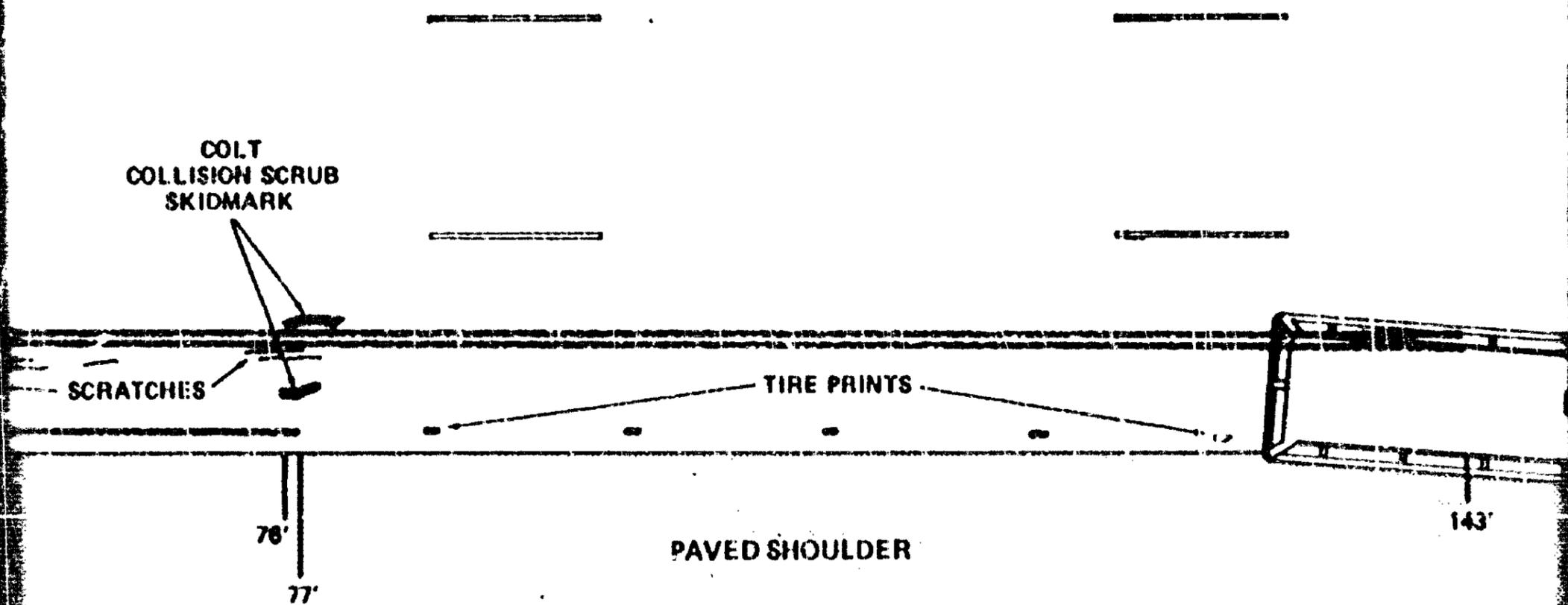
1'

44'

PAVED SHOULDER



— Southbound Lanes —>



Pages 3 thru 5

Figure 1. --Plan drawing of accident site.



ASPEN  
TIRE SCUFFMARKS

BUS  
LEFT FRONT  
WHEEL  
SKIDMARK

SCORCHED AREAS

Colt

LANE LINES

Bus

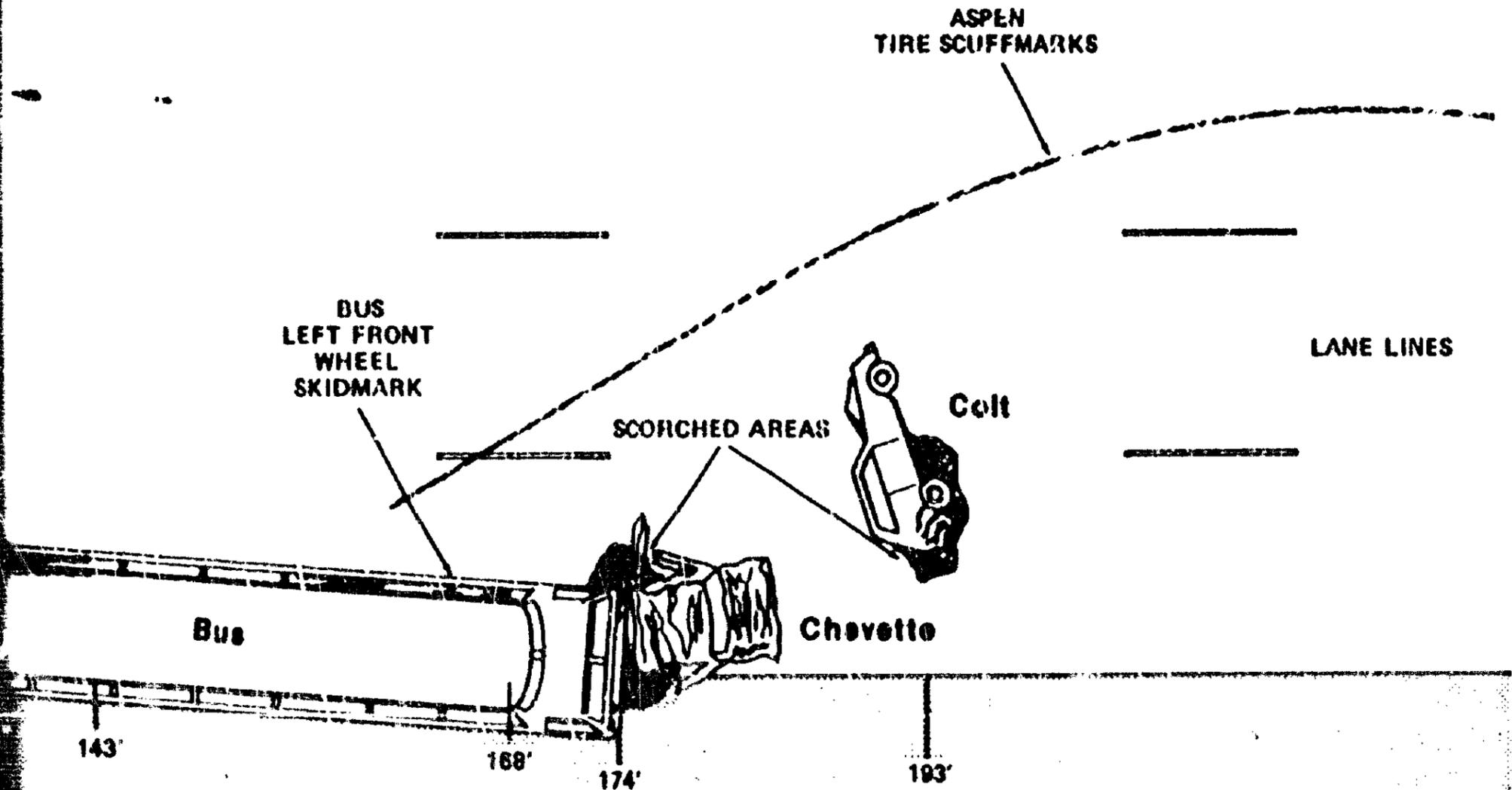
Chevette

143'

168'

174'

193'



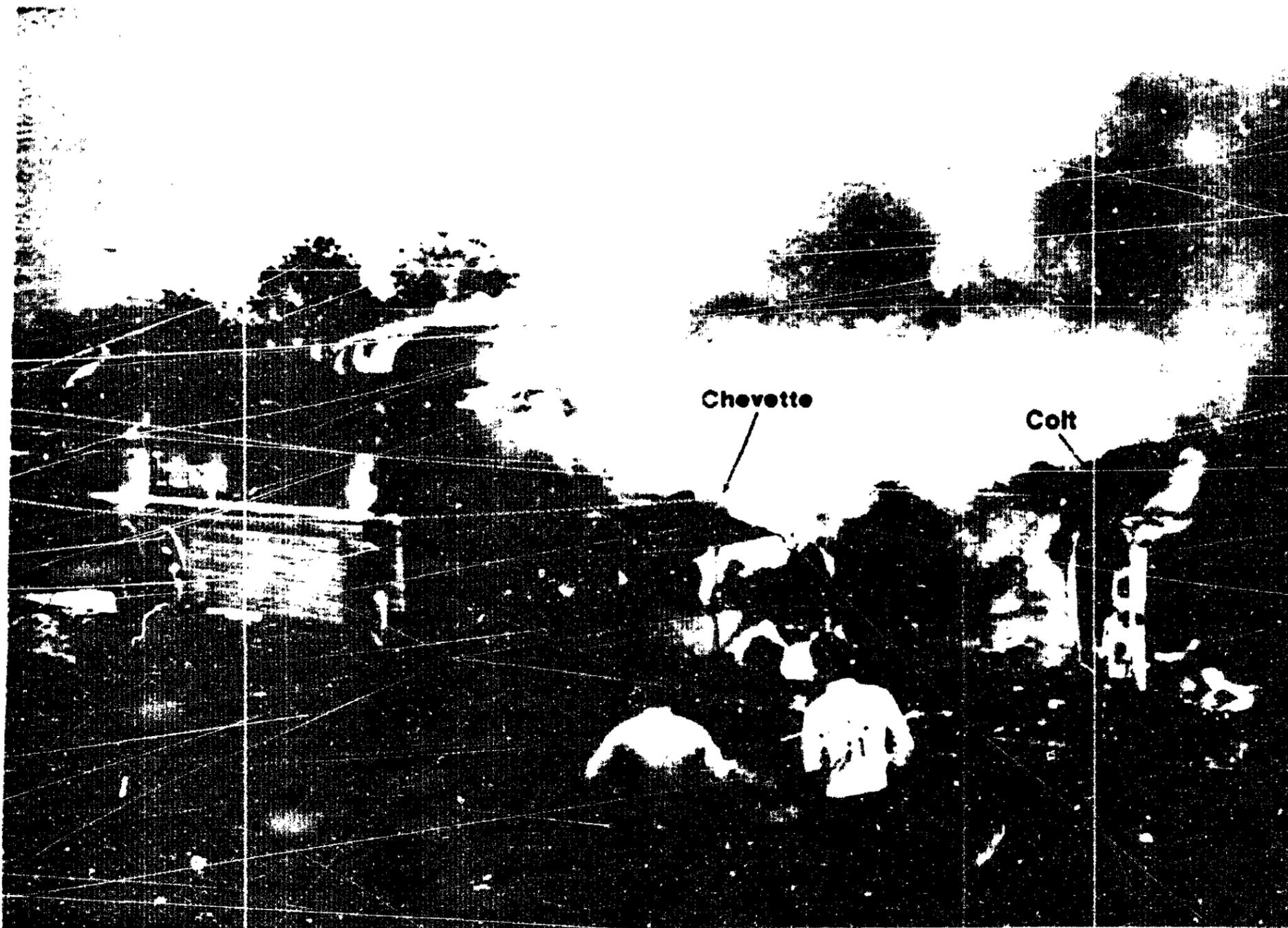


Figure 2.--Bus, Chevette, and Colt burning after impact.

Injuries to Persons

<u>Injuries</u>	<u>Drivers</u>	<u>Passengers</u>	<u>Total</u>
Fatal	1	2	3
Nonfatal	1	0	1
Minor/none	3	37	40
Total	5	39	44

Vehicle Information and Damage

The Bus.-- The bus was a 1974 Silver Eagle, three-axle model 05 which had been owned, since new, by American Buslines, Inc., a subsidiary of Continental Trailways, Inc. The vehicle identification number (VIN) was 9268. It was equipped with a 567.4-cubic-inch, V-type, eight-cylinder, General Motors Detroit Diesel Engine; a four-speed manual Spicer Transmission; manual steering; air conditioning; and air-activated drum brakes. The governed engine speed, transmission and rear axle ratio, and rear tire size were such that the maximum attainable road speed was about 62 mph.

The bus had a 46-passenger seating capacity with 11 rows of double seats on the right and 12 rows of double seats on the left, and was equipped with a lavatory which was located at the right rear. A folding entrance/exit door was located at the right front of the bus, and the rear windows and alternate side windows were "push-out type" emergency exits.

The bus was 40 feet long, 8 feet wide, and 11 feet high and weighed 26,000 pounds when empty; its estimated loaded weight at the time of the crash was 31,000 pounds. The bus manufacturer recommended that the trim height of the empty bus be adjusted so that 49 percent of the weight was on the drive axle (rear), 26 percent was on the bogie axle (second), and 25 percent was on the steering axle (front). A Trailways maintenance foreman stated that the bus was in compliance with the manufacturer's axle weight distribution specifications.

A postcrash examination of the bus revealed that there were no tire deficiencies. The tire tread depths of 8/32 to 16/32 inch and tire air pressures of 110 to 120 pounds per square inch were within the manufacturer's recommended limits. The rear brakelights were found to be in operating condition by supplying electrical power from an external source to the brakelight circuit at the rear engine compartment.

Because of fire damage, the brake chamber pushrod travel at each wheel was measured by charging each chamber individually with air from an external source. The measurements were as follows:

<u>Axle</u>	<u>Brake Chamber</u>	<u>Slack Adjustment (inches)</u>		
		<u>Left Wheel</u>	<u>Right Wheel</u>	<u>Readjustment Stroke *</u>
Front	Type 16	1	7/8	1 3/4
Second	Type 12	1 1/4	3/4	1 3/8
Rear	Type 30	1 7/8	2 5/8	2

\*7 The manufacturer's recommended maximum stroke at which these brakes should be adjusted.

The pushrod travel at the right wheel of the drive axle was the only measurement that exceeded the manufacturer's adjustment specifications. It exceeded it to the point where it was at the limit of the stroke capability. The parking brake at this position was inoperative.

The brake linings on all wheels were of adequate thickness and did not exhibit any signs of excessive glazing. The only defect found on the brake linings was at the left side of the second axle where the outer edge of the linings was split in two places. These splits would have had no effect on the braking capability of that wheel. The right front wheel brakedrum was out of round and had two high spots about 180° apart. Also, there were varying degrees of play in the mechanical linkage between the airbrake chambers and the brake shoes on all wheels. However, the degree of play would not have significantly affected the braking efficiency of the bus.

An examination of the bus company's maintenance files revealed that from January 25, 1981, to April 17, 1981, 32 drivers recorded 50 complaints related to defects on the accident bus. Nine of the complaints were brake-related, and eight complaints reported front-end "shimmy"; three of the shimmying complaints stated that it occurred during braking. The balance of the complaints ranged from an inaccurate speedometer to loose baggage doors.

According to the records, the brakes on the accident bus had been adjusted nine times between February 1, 1981, and April 13, 1981; during this period, the bus traveled about 22,000 miles. The drive-wheel brake linings were replaced on February 11, 1981. The front wheels were balanced four times as a result of the shimmying complaints.

The bus was damaged from both the collision and the resulting fire. However, the collision damage was minor compared to the fire damage. The collision damage was limited to the front of the bus where the left side of the bumper and metal trim above the bumper were pushed rearward. (See figures 3 and 4.) Fire destroyed all seat upholstery, leaving only scorched metal seatframes. The interior side and roof panels and portions of the roof were destroyed by the fire. Flooring to the left of the driver's seat and the door entrance platform was burned away; the floor below the passenger seats and aisle was charred but remained intact. All driving controls and instruments were destroyed by fire, as was the spare tire stored in front of the bus below the entrance platform. The left-front tire was scorched but remained inflated; none of the other tires was damaged by fire.

The Chevette.--The 1981 Chevrolet Chevette was a subcompact, four-door, hatchback sedan, VIN-G1AB689BY129539, whose curb weight was about 2,100 pounds. The vehicle, which was owned by the driver, was severely damaged by both impact and fire. The collision damage resulted from two impacts: one in the rear when struck by the bus, and the other one in the front when the Chevette was pushed into the Colt. As a result of being "sandwiched" between vehicles, the Chevette was compressed to 99 inches on the right side and 110 inches on the left; its original length was 164 inches. The rear and passenger compartments of the Chevette were displaced forward to the B-pillar, and the entire front end was displaced rearward. (See figure 5.) The rear axle was separated from the vehicle and found lodged underneath the front end of the bus. The fuel tank, which was located at the rear of the vehicle, was displaced and deformed. The filler pipe was separated from the left side of the tank leaving an opening about 2 inches in diameter and there was a small puncture hole, about 1/4 inch in diameter, in the bottom of the tank. (See figure 6.)

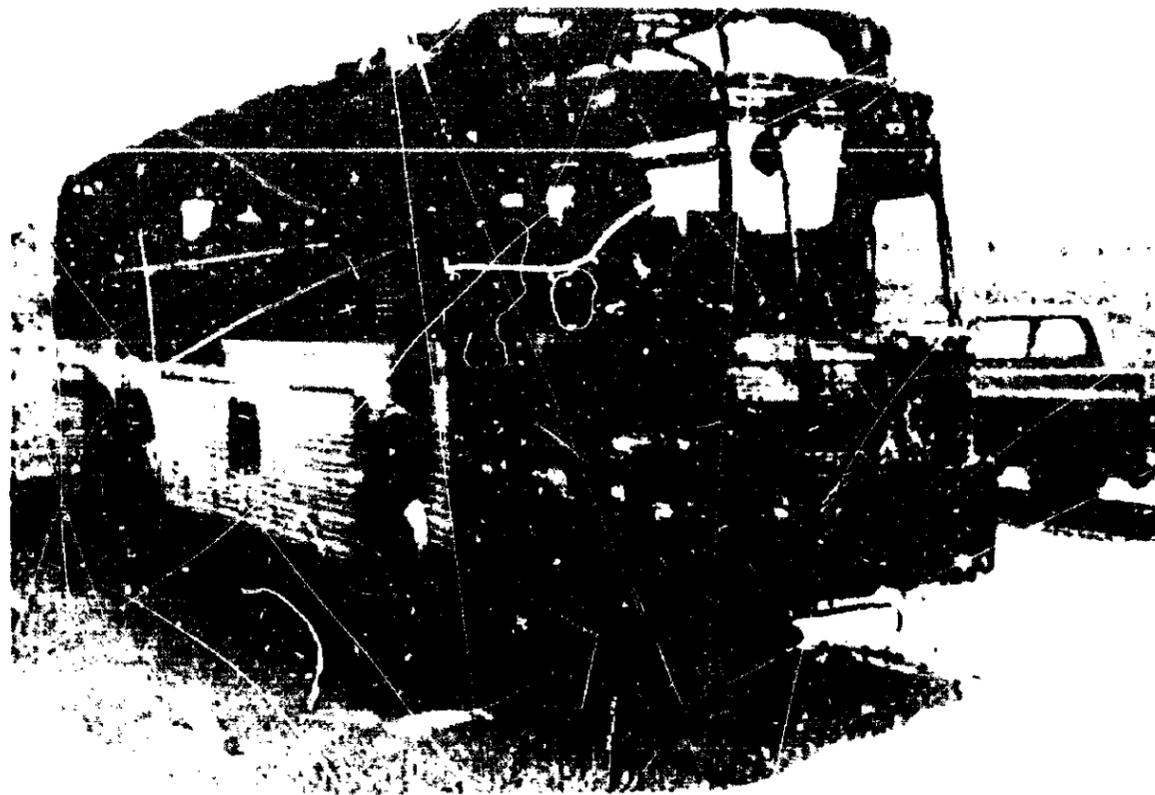


Figure 3 --View of front and right side of bus.

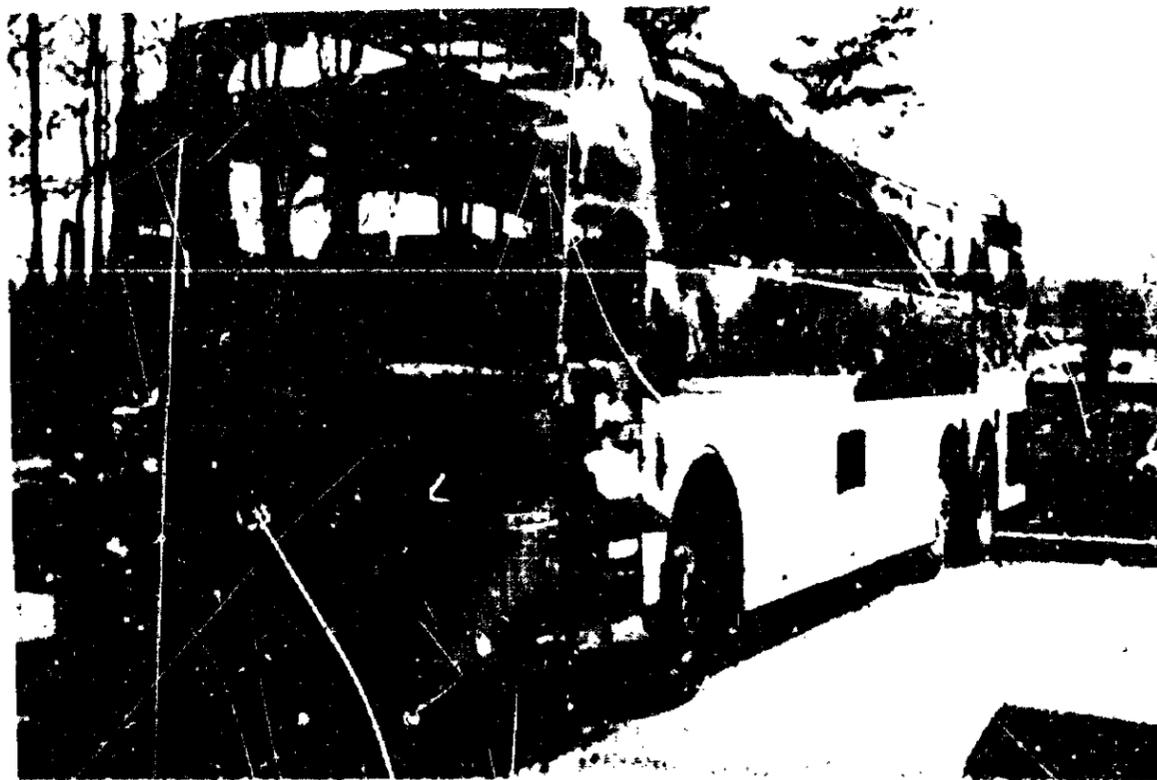


Figure 4.--View of front and left side of bus.



Figure 5.--View of Chevette crushed against left front of bus.

The Colt.--The 1976 Dodge Colt was a subcompact, two-door sedan, VIN-6S23K67500300. This vehicle, which was owned by the driver, was also damaged by both impact and fire. Impact damage to the rear of the vehicle displaced both fenders, the bumper, and trunk compartment forward and downward. The rear bumper was rotated downward about 90°. (See figure 7.) Although the gas tank was displaced and dented, there were no visible punctures; however, the filler pipe, as in the Chevette, was separated from the fuel tank but remained attached to the body at the filler cap. (See figure 8.) This permitted an undetermined quantity of gasoline to spill and provided additional fuel for the fire. The impact damaged the front of the vehicle and buckled and deformed both fenders. The front bumper was bent upward on the left side, and the hood was buckled and had a large dent in the forward right side.

The Aspen.--The 1978 Dodge Aspen was a four-door sedan, VIN-NL41D8F128176, which was owned by its driver. Damage to this vehicle resulted from impact; there was no fire damage. The rear bumper, trunk compartment, lower edge of the trunk lid, and right-rear fender were deformed forward. (See figures 9 and 10.) The left-rear fender was buckled and the front seatbacks were collapsed rearward. A trailer hitch attached to the rear bumper was pushed forward and punctured the fuel tank, causing a fuel leak. No fire resulted from the leak, however. Although the Aspen struck the rear of the Mustang, there was no visible damage to the front of the Aspen.

The Mustang.--The 1980 Ford Mustang was a two-door sedan, VIN-0F02A160839, and was owned by the driver. This vehicle was driven from the scene by its driver and was not examined by the Safety Board's investigator. The driver stated that there was some damage to the rear bumper.



Figure 6.--View of Chevette fuel tank. Note hole in tank where filler pipe had been attached.

#### Driver Information

The 46-year-old busdriver had been employed continuously by Trailways, Inc., as a driver since 1970. He held a valid Maryland chauffeur's license with no restrictions. A check of his Maryland State driving record revealed that since April 1978, he had one traffic violation conviction on June 28, 1980, for "following too close;" the violation was committed while driving a bus in Maryland on I-95.

The busdriver held a current medical certificate required by the Federal Motor Carrier Safety Regulations (FMCSR). His vision was reported as 20/20 in both eyes. The driver's daily logs were current, and an examination of the logs revealed that the busdriver was in compliance with the FMCSR regarding hours of service.

The busdriver said that on the day before the crash, April 19, 1981, he had a good night's sleep. He awoke at 10:30 a.m. and left for work about 5:45 p.m., in Washington, D.C. He went on duty at 7:45 p.m. and began driving at 8:15 p.m. when he departed for New York City; the bus arrived there at 1:45 a.m. on April 20, 1981. After eating, the



Figure 7.--View of left rear of Colt.

busdriver slept from about 3 a.m. until about 10:30 a.m. After breakfast, he went to the bus dispatcher office and was assigned a bus for the return trip to Washington. He departed New York City at 1:05 p.m.; the crash occurred about 5:55 p.m.

The 47-year-old Chevette driver was a resident of Maryland. She held a valid Maryland driver's license with no restrictions. The 23-year-old Colt driver was a resident of Virginia. She held a valid Pennsylvania driver's license with the restriction of wearing glasses. The Aspen driver was 58 years old and a resident of Vermont. He held a valid Vermont driver's license with the restriction of wearing glasses.

#### Highway Information

Interstate 95 is a north/south, Federal-aid, primary highway that traverses Maryland from the northeast corner of the State to the Washington, D.C., area where it joins the Capital Beltway system encircling the District of Columbia before continuing south into Virginia. Although I-95 was originally planned to extend south, past the Beltway, into the District of Columbia, the plan was abandoned and construction of I-95 was discontinued at the Capital Beltway. As a result, southbound I-95 traffic is channeled onto the Capital Beltway. Eastbound traffic is designated as a continuation of I-95 and westbound traffic is designated as I-495. The continuation of I-95 traffic exits from I-95 onto two ramps; westbound traffic uses a one-lane cloverleaf design and the eastbound traffic uses a diamond-type exit ramp with access to a U-turn area. (See figure 11.)

In the vicinity of the accident site, I-95 is an eight-lane, Portland cement concrete, divided highway and has a posted 55-mph speed limit. The opposing lanes, four southbound and four northbound, are separated by a grass median that is about 100 feet wide. The through lanes in each direction are 12 feet wide and are delineated by broken



Figure 8.--View of right side of Colt's fuel tank.  
Arrow points to hole where filler pipe had been attached to tank.

white lines. The outer edge of the roadway is delineated by a solid white edgeline and the inner edge by a solid yellow line. Paved asphalt shoulders border both the inner and outer edges of the roadway. There were no significant pavement irregularities.

At the crash site about 1.4 miles north of the Capital Beltway, the southbound lanes of I-95 curved right 1°3' (5,447 foot radius) with a 0.03 foot per foot superelevation and descended at a 1.4 percent grade. The length of the curve was 2,518 feet; the crash occurred 1,280 feet into the curve. The horizontal sight distance facing south on the approach to the crash site was about 1,300 feet. Just south of the crash site, the far left lane merged to the right, reducing the southbound travel lanes from four lanes to three.

Signs posted for the southbound lanes within a half mile north of the crash site consisted of two regulatory signs, one on each side of the road 0.5 mile north of the crash site that stated, "Warning - Trucks Right Lane Only - 1/2 Mile." About 1,500 feet south of these signs, two warning signs were also posted on each side of the road; the one on the left side stated, "Left Lane Ends 200 Feet" and the one on the right stated, "Expressway Ends 2 Miles." Actually, the left lane did not end for another 1,100 feet. About 500 feet north of the crash site, there were two overhead advance guide signs; one stated, "95 South Exit - 1 1/2 Mile" the other, "495 Beltway Jct. - 1 Mile."

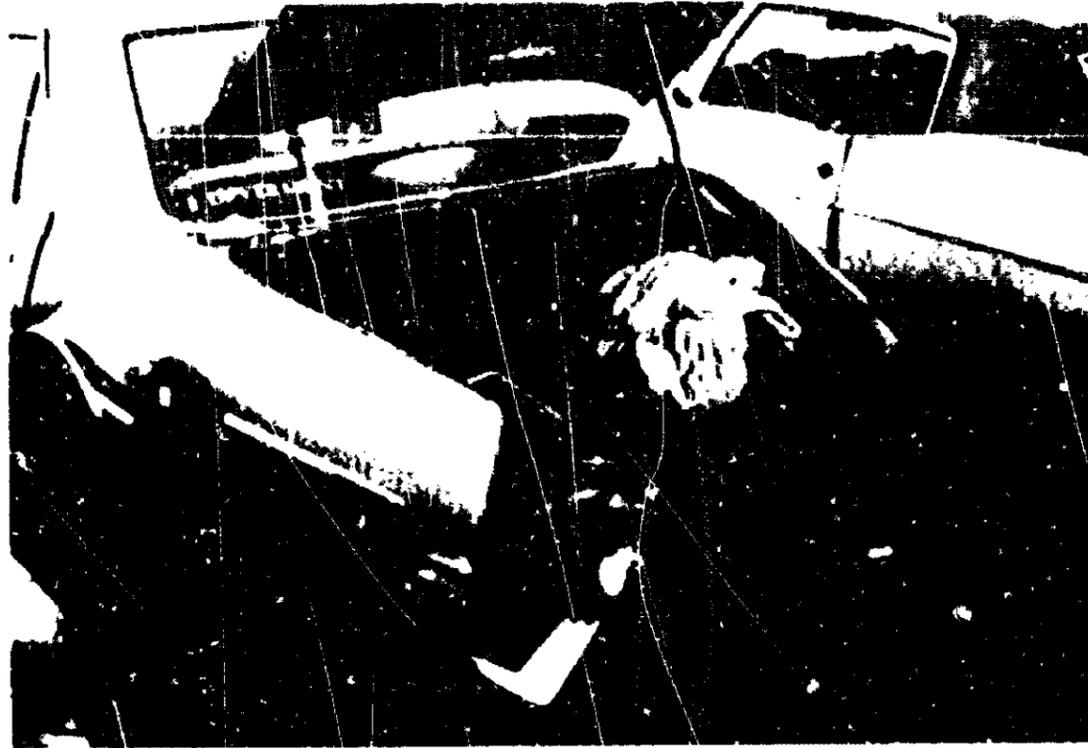


Figure 9.--Left rear view of Aspen.

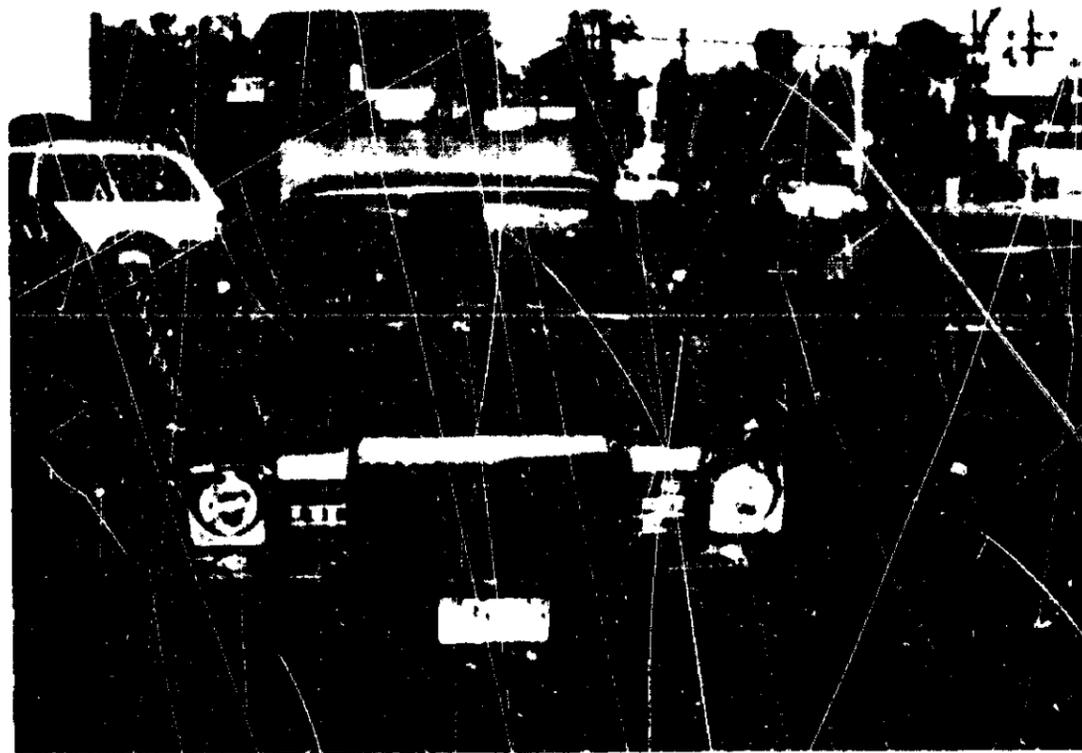


Figure 10.--Front view of Aspen.

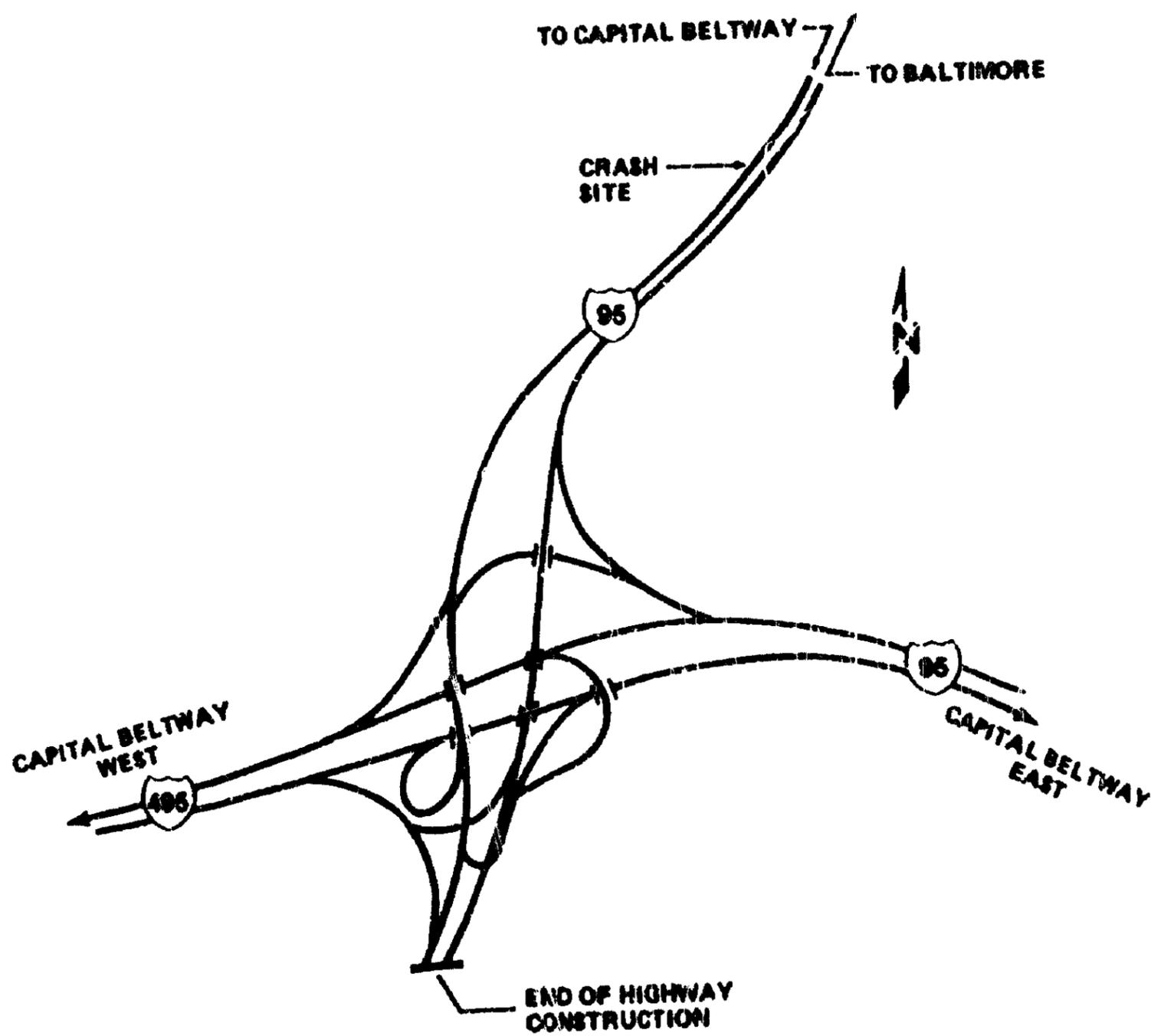


Figure 11.--I-95/495 Interchange.

An hourly traffic volume count taken by the Maryland Department of Transportation (DOT) on the date of the crash between 5 p.m. and 6 p.m. on I-95 about 12 miles north of the crash site disclosed that there were 3,870 southbound vehicles, which was a 53-percent increase over the 1980 average count for that time and place. Accident statistics for a 1.3-mile section of southbound I-95, which included the crash site, revealed that from 1977 through 1979 there were 32 traffic accidents. Twenty-three of these were property damage accidents and 9 were personal injury accidents; there were no fatal accidents. Rear-end collisions accounted for 7 of the 32 accidents. An analysis of the accidents on this section of the highway by the Maryland DOT indicated that they were not abnormal in number or severity when compared to the accident rates of similar type highways within the State.

Maryland State Police familiar with this section of I-95 said that there were often traffic delays and backups during peak traffic hours, especially in the right lane of southbound I-95. These delays and backups apparently resulted from an inability of the interchange ramp from southbound I-95 to westbound I-495 to accommodate the volume of vehicles traveling through this location.

A design study report <sup>1/</sup> prepared by the Maryland DOT, which proposed future improvements at the I-95/495 interchange, stated, "the existing interchange is not adequate to serve the resulting traffic movements and volumes. The turning movements to travel east and west (and return) on the Capital Beltway have greatly increased over prior forecasts . . . ."

The study proposed the following improvements: (1) construction of a directional connecting ramp from southbound I-95 to the eastbound roadway of the Capital Beltway (I-95); (2) widening of ramps from southbound I-95 to westbound I-495, and from eastbound I-495 to northbound I-95; (3) elimination of the U-turn at the end of I-95; and (4) the construction of a park-and-ride facility for commuters.

The Maryland DOT received design approval on March 23, 1981, for the proposed improvement from the U.S. Department of Transportation, Federal Highway Administration (FHWA). The FHWA indicated that the project is in the State's consolidated transportation program for FY 1981-86 as a project under development and evaluation. It appears unlikely that the project will be built in the near future. <sup>2/</sup> The FHWA has indicated that the project will be 2 years in the design stage before a priority will be assigned.

Evidence found on the roadway at the crash site consisted of tire marks, gouges and scratches, and two patches of scorched pavement. (See figure 1.) Marks attributed to the bus consisted of three locked-wheel braking skidmarks and a series of tire prints. The skidmarks varied considerably in length. The left-rear dual tire left a skidmark that was 143 feet long, the right-front wheel left a skidmark that was 77 feet long, and the left front wheel left a mark that was at least 11 feet long. The right-front wheel skidmark began about 168 feet before the bus came to a halt, but the wheel ceased sliding after 77 feet and then began to roll. As the tire rolled, it left a tire print each time the "hot spot," which was created on the tire when it was sliding, came in contact with the road surface.

<sup>1/</sup> "Design Study Report, FAP I-95-3 (64)6 I-95/495 Interchange Reconstruction and Park and Ride Facility," Maryland Department of Transportation, State Highway Administration, June 1980.

<sup>2/</sup> Letter from FHWA Division Administrator, Region 3, to NTSB Investigator in Charge, received May 9, 1981.

No visible precrash or postcrash braking skidmarks were made by the four passenger cars involved in the crash. However, there were two sets of collision scrub skidmarks <sup>3/</sup> in the right lane south of where the bus skidmarks began. One was attributed to the Chevette and the other to the Colt. A tire scuffmark <sup>4/</sup> that followed a curved path from the right lane to the third lane and back, attributed to the Aspen, began in the area where the bus came to rest and faded away as it proceeded in a curved scutherly direction.

#### Pathological Information

Autopsies of the driver and the two passengers of the Chevette were performed by the Prince George's County Medical Examiner's Office. The autopsy reports revealed that the driver died as a result of thermal burns and other injuries; there was no alcohol present in her blood. The 15-year-old male passenger died of thermal burns and a fractured skull, and the 13-year-old male passenger died of thermal burns.

#### Survival Aspects

Two Maryland State Police officers, who were assigned to patrol on I-95, were notified of the crash by a passing motorist. They responded to the scene immediately and called for the fire department and police assistance. They were unable to rescue the persons in the Chevette because of the intensity of the fire.

#### Tests and Research

At the request of the Maryland State Police and the Safety Board, the Maryland DOT conducted both wet and dry locked-wheel skid trailer tests at the crash site on April 24, 1981. The locked-wheel skid trailer measures the longitudinal friction coefficient developed between the pavement and a standard test tire that is braked and slides in the direction of travel of the trailer. The locked-wheel braking test simulates and measures the ability of friction between the tires and pavement to stop or slow a vehicle when the brakes lock the wheels. The standard test tire is constructed with automobile tire rubber compounds and has been found to be representative of average automobile tires in terms of frictional quality. However, large truck and bus tires are constructed with harder rubber compounds that wear better but have lower frictional quality than automobile tire compounds. Therefore, trailer tests using a standard test tire obtain higher test values than tests using truck or bus tires. <sup>5/</sup> The tests were performed at 40 mph in the far right, southbound lane of I-95. The dry coefficient readings resulting from these tests ranged between 0.85 and 0.88. Coefficients of friction between 0.80 and 1.00 are typical for clear, dry, rough textured pavement under optimum operating conditions. These test results indicated that the road surface had adequate friction qualities.

<sup>3/</sup> Tire skidmarks made by wheels that are locked due to collision rather than by braking.

<sup>4/</sup> A tire mark on the pavement made by a tire which is both rotating and skidding.

<sup>5/</sup> "Truck Tire Cornering and Braking Traction Study," Enesco, Inc. for the U.S. Department of Transportation, 1979 (NHTSA-9-6227); "Initial Tests on Stopping Distance and Spin-Out Characteristics of Regrooved Tires on Euses," Texas Transportation Institute, 1967.



Figure 12.--View of southbound I-95 from right shoulder.  
Arrow indicates accident site.

#### Other Information

Each passenger car manufactured on or after September 1, 1976, is required to meet the fuel system integrity standards set forth in Federal Motor Vehicle Safety Standard (FMVSS) 301-75 (49 CFR Part 571). This standard, developed by the National Highway Traffic Safety Administration (NHTSA), requires that a vehicle be able to withstand a front or rear impact at 30 mph in which spillage from the fuel system does not exceed 1 ounce from the impact and a total of 5 ounces in the 5 minutes following cessation of motion following the impact. However, since the collision speeds were above the 30-mph performance requirement of the standard, compliance with the standard was not applicable in this accident.

#### **ANALYSIS**

##### The Accident

The marks left on the road surface as a result of the crash were instrumental in establishing the spatial relationship of the bus, the Chevette, and the Colt, and were also used in estimating the precrash speed of the bus. The braking skidmarks made by the bus showed the path of the bus before, during, and after the collision. They indicated that the bus was steered right and braked before impact. The distance between the beginning of the braking skidmarks of the bus and the first collision scrub skidmarks, which were made by the Chevette when its body sheet metal was crushed against its rear wheels locking them, revealed that the bus was being braked for at least 42 feet before it crashed into the Chevette. The bus skidmarks continued past this point to where the bus came to rest, 168 feet from where the skidmarks began.

The collision scrub skidmarks made by both the Chevette and Colt identified their location at impact and showed that the rear of the Colt was about 10 to 12 feet in front of the Chevette at the time of the collision. The scorched patches of pavement marked the location at which the burning vehicles came to rest after impact. The Chevette came to rest about 175 feet from where it was struck, and the Colt about 115 feet. Although tire scuffmarks made by the Aspen showed part of its postimpact path of travel, there were no visible marks locating the positions of the Aspen and the Mustang at impact. The absence of preimpact braking skidmarks from any of the passenger cars involved in this crash indicated that these vehicles probably had decelerated gradually and had not skidded to a halt as in a panic or sudden emergency stop.

After adjusting the skid-trailer test results for the differences between the test tire and the bus tires and after making further allowances to compensate for the probable lack of braking capability of the right-rear drive wheel and the incomplete skid at the right-front wheel, the Safety Board calculated that the speed of the bus at the point where skidmarks first appeared was at least 50 mph, and its speed at impact was at least 45 mph. Because the computed speeds are minimum speed estimates, and considering the witness statements and the computations, the Safety Board concludes that the travel speed of the bus, before braking, was about 55 mph.

Based on the estimated speed of the bus and the 42-foot distance between the start of its skid and impact with the Chevette, the Safety Board concludes that the busdriver began braking too late to avoid impact. This could have been due to either the busdriver's failure to establish a safe stopping distance or to a delay in perception, or both. The busdriver should have maintained at least a 3-second following distance; at 50 mph this distance would be at least 220 feet and at 55 mph it would be at least 240 feet. According to FMVSS 121, "Air Brake Systems" (49 CFR 571.121), which establishes minimum stopping distance requirements for trucks and buses, a bus traveling at 50 mph must be able to stop in 203 feet, and at 55 mph, in 246 feet. The 100-foot distance which the busdriver said he was maintaining between the bus and the car ahead was insufficient to permit stopping the bus before striking the traffic stopped ahead. Although the 1974 bus was built before the standard became effective in 1975, the minimum stopping distances established by the standard are being used in this report as guidelines for minimum stopping distances for the bus.

#### Brake Maintenance

The evidence indicates that the bus brakes were out of adjustment. The manufacturer of the brake chambers stated in its maintenance manual that for a proper brake adjustment, all chamber strokes must be adjusted to approximately the same stroke and that the adjustments must be made so that the stroke was as short as possible without the brake dragging. When the bus brakes were examined after the crash, the adjustments did not conform to either of the above criteria for proper brake adjustment. The chamber strokes on each axle were not adjusted to approximately the same stroke. The pushrods were not adjusted to as short a stroke as possible; the pushrod stroke at the right-rear drive wheel was not only beyond the point where it should have been readjusted, but was at the limit of its travel and probably provided only limited braking torque. This condition reduced the effective braking capacity of the bus. The pushrod stroke at two other wheels, the left-second axle wheel and the left-front axle wheel were within 1/8 inch of the point where they should have been readjusted. However, since the first visible evidence of braking started only 42 feet before impact, the Safety Board concludes that the degraded condition of the bus brakes did not contribute to the cause of this crash.

The maintenance records for the bus indicated that the brakes were adjusted only 7 days before the crash and that since then the bus had been driven an estimated 2,400 miles. It is unlikely that brake lining wear during this period would have increased the pushrod stroke to any appreciable degree. Therefore, the pushrod stroke measured after the crash should have been approximately what it was 7 days earlier, after the brakes were allegedly adjusted. Accordingly, the Safety Board concludes that on April 13, 1981, the brakes either were not adjusted or were improperly adjusted.

The front wheels of the bus had been balanced four times in the 2 months before the accident after the driver reported a "shimmy during braking." This condition could have resulted from the high spots discovered on the right-front wheel brakedrum which could have caused uneven braking at that wheel when the high spots "grabbed" intermittently on the brake linings during braking and may have caused the wheel to vibrate and possibly cause the bus to pull to the right when the brakes were applied.

#### The Driver

There was no evidence to indicate that the busdriver's physical ability to perform the driving task was impaired. Further, the Safety Board was unable to determine whether the driver's tactics were affected by the fact that he was already about one-half hour behind schedule and faced a further delay at the I-95/495 interchange.

#### The Highway

The I-95/495 interchange was designed and constructed under the assumption that I-95 would extend south of the Capital Beltway into Washington, D.C., and that the interchange would be part of a continuing north/south highway system rather than the termination point of southbound I-95. Since it was not built to accommodate a large flow of through traffic from I-95, the traffic flow on the exit ramp from southbound I-95 to westbound I-495 increases beyond the ramp's capacity during peak hours of traffic and causes the flow of southbound I-95 traffic in the right lane to be disrupted either by forcing it to come to a complete stop or to a significantly reduced speed. To what degree and at what distance upstream this condition manifests itself depends on the traffic density, but wherever this condition exists, it increases the probability of traffic accidents and is clearly undesirable. Because the crash probably would not have occurred if the traffic had not come to a halt in the right lane of southbound I-95, and since this traffic backup was caused by the inadequacy of the interchange to accommodate the volume of southbound I-95 traffic exiting to westbound I-495 during a peak traffic hour, the Safety Board concludes that the inadequate interchange was a factor in this accident. The already planned safety improvements at the interchange should eliminate the traffic backups, and the Maryland DOT should expedite these improvements.

#### Fire

The fuel tanks of both the Chevette and Colt, which were located behind the rear axles, were displaced during the collision. Although the fuel filler pipe on both vehicles remained attached to the body at the capped end inside the fuel access door, both pipes separated from the left side of the fuel tank, leaving an opening of about 2 inches in diameter. Since the fuel tanks were not designed to restrict or prevent fuel spillage in the event of a filler pipe separation, an uncontrolled flow of fuel gushed from the opening during the collision sequence and was ignited. The Safety Board was unable to determine the source of fuel ignition, but the most likely sources were sparks from shorted electrical wiring, sparks from metal vehicle components scraping the concrete, or hot filaments of bulbs from brakelights that were illuminated when broken during the crash.

According to witnesses, the vehicles began to burn seconds after impact. The large volume of fuel spillage from the Chevette caused the vehicle to be immediately engulfed in flames, which prevented rescue of its occupants. The Colt fire was initially less severe and did not interfere with the rescue of its driver. If the filler pipe of the Chevette had remained in place, the gasoline would then have escaped only through the impact induced 1/4-inch diameter hole which was 64 times smaller in area than the 2-inch diameter opening left by the filler pipe. The reduced flow of fuel might have fed a less intense fire and the occupants of the Chevette might have been rescued. In the case of the Colt, if the filler pipe had not separated, there would have been no leakage and probably no fire.

Fuel filler pipe separation resulting from rear-end collisions has occurred in the last seven highway accidents involving fire investigated by the Safety Board. The probability of fire could be reduced and deaths and injuries prevented if fuel tanks were designed to prevent fuel from spilling uncontrollably from the fuel tank in the event of a filler pipe separation. This might be accomplished by a design change adding a simple back-flow check valve inside the fuel tank at the filler pipe connection.

### CONCLUSIONS

#### Findings

1. The location of braking skidmarks made by the bus and collision scrub skidmarks made by the Chevette indicate that the bus was being braked for at least 42 feet before it struck the Chevette.
2. The minimum total braking distance of the bus was 168 feet.
3. The absence of braking skidmarks from the passenger cars indicate that they probably were not braked to a sudden stop before they were struck.
4. Calculations indicated that the maximum speed of the bus at the beginning of the skidmark was at least 50 mph, and its speed just before impact was at least 45 mph.
5. There was insufficient stopping distance between the bus and the Chevette when the bus began braking. This was probably due to either the busdriver's failure to establish an adequate stopping distance or his delayed perception.
6. The degraded condition of the bus brakes was not a contributing factor in this crash.
7. Although maintenance records indicated that the bus brakes were adjusted 7 days before the crash, analysis of the evidence indicated they either were improperly adjusted or were not adjusted at that time.
8. There was no evidence to indicate that the busdriver's physical ability to perform the driving task was impaired.
9. Traffic delays caused by the inadequacy of the I-95/495 (Capital Beltway) interchange to accommodate the volume of southbound I-95 traffic exiting to westbound I-495 during peak traffic periods were a factor in this crash.
10. If the filler pipe had not separated from the fuel tank of the Colt, there would have been no gasoline leakage and probably no fire in that vehicle.

11. If the filler pipe had not separated from the fuel tank of the Chevette, the fuel leakage would have been 64 times less in volume and the fire might have been less intense, permitting the rescue of the vehicle's occupants.
12. The probability of fire due to fuel spills could be reduced by designing fuel tanks that will not permit fuel to spill uncontrollably from the tank when the filler pipe is detached.

**Probable Cause**

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the busdriver to maintain a safe stopping distance between the bus and the automobile ahead as traffic ahead slowed and came to a stop during the peak traffic period. Contributing to the cause and severity of the fires was the separation of the filler pipes from the fuel tanks of two of the automobiles.

**RECOMMENDATIONS**

As a result of its investigation of this accident, the National Transportation Safety Board recommended:

--to the Maryland Department of Transportation:

Review conditions at the I-95/495 interchange and determine if the planned safety improvements should be expedited. (Class II, Priority Action) (H-81-71)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JAMES B. KING  
Chairman

/s/ ELWOOD T. DRIVER  
Vice Chairman

/s/ G. H. PATRICK BURSLEY  
Member

PATRICIA A. GOLDMAN, Member, filed the following concurring and dissenting statement:

I concur in the adoption of this report and the probable cause of the Beltsville, Maryland accident. However, I do not believe recommendation H-81-71 is justified.

Our investigation disclosed that the safety improvement project for the I-95/495 interchange is part of the State of Maryland's consolidated transportation program and is "under development and evaluation." I support the completion of this project as soon as practical.

Our investigation did not include an evaluation of Maryland's system for reviewing projects and establishing priorities. Therefore, it seems inappropriate to second guess the State's plans for the project since they are apparently well aware of the problem.

/s/ PATRICIA A. GOLDMAN  
Member

FRANCIS H. McADAMS, Member, did not participate.

September 15, 1981

**APPENDIX**  
**INVESTIGATION**

The National Transportation Safety Board was notified of this accident by the Maryland State Police at 6:15 p.m. on April 20, 1981. An investigator from the Highway Accident Division of the Bureau of Accident Investigation in Washington, D.C., was on the accident site at 8 p.m. The Investigator-in-Charge from the New York City field office was on scene at 9 a.m., on April 21, 1981. The Investigator-in-Charge was assisted during the investigation by representatives of the Maryland State Police, the Federal Highway Administration, and the FHWA's Bureau of Motor Carrier Safety.

There were no depositions taken or hearings held during this investigation.