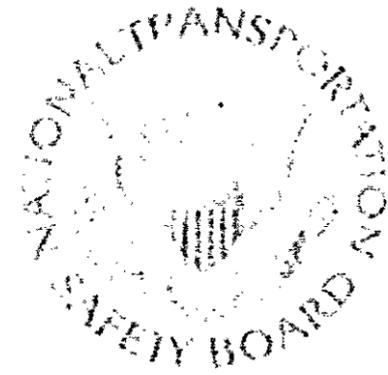


PBB4-916205



NATIONAL  
TRANSPORTATION  
SAFETY  
BOARD

WASHINGTON, D.C. 20584

HIGHWAY ACCIDENT REPORT

COLLISION OF  
G & D AUTO SALES, INC.,  
TOW TRUCK TOWING AUTOMOBILE,  
BRANCH MOTOR EXPRESS COMPANY  
TRACTOR-SEMITRAILER  
TOWN OF REHOBOTH SCHOOLBUS  
REHOBOTH, MASSACHUSETTS  
JANUARY 10, 1984

NTSB/HAR-84/05

UNITED STATES GOVERNMENT

REPRODUCED BY  
NATIONAL TECHNICAL  
INFORMATION SERVICE  
U.S. DEPARTMENT OF COMMERCE  
SPRINGFIELD, VA. 22161

**TECHNICAL REPORT DOCUMENTATION PAGE**

1. Report No. NTSB/HAR-84/05		2. Government Accession No. PB84-916205		3. Recipient's Catalog No.	
4. Title and Subtitle Highway Accident Report — Collision of G&D Auto Sales, Inc., Tow Truck Towing Automobile, Branch Motor Express, Company Tractor-Semitrailer, Town of Rehoboth Schoolbus, Rehoboth, Massachusetts, January 10, 1984.				5. Report Date September 5, 1984	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No.	
9. Performing Organization Name and Address  National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594				10. Work Unit No. 4004	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address  NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594				13. Type of Report and Period Covered Highway Accident Report January 10, , 1984.	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract At 11:45 a.m., on January 10, 1984, a G & D Auto Sales, Inc., tow truck was turning right from the company's driveway onto westbound State Route 44 in Rehoboth, Massachusetts, when the rear-facing passenger car in tow, a 1931 Oldsmobile, was struck by an eastbound tractor-semitrailer operated by Branch Motor Express Company. The 76, 950-pound tractor-semitrailer continued eastbound, crossed the centerline of the damp, two-lane, two-way roadway, and struck the left front of a westbound Town of Rehoboth schoolbus carrying 15 students, ages 5 and 6. The 1979 schoolbus overturned and came to rest on its roof off the roadway. The driver of the tractor-semitrailer, the driver of the schoolbus, and one student were killed; 12 students were injured. The driver of the tow truck was not injured.  The National Transportation Safety Board determines that the probable causes of the accident were (a) unsecured steering axle wheels of the vehicle being towed by the rear, (b) excursion of the towed vehicle over the highway centerline into the path of the oncoming tractor-semitrailer, (c) loss of directional control by the driver of the tractor-semitrailer, and (d) entry of the uncontrolled tractor-semitrailer into the opposing traffic lane where it struck the schoolbus.					
17. Key Words  Tow truck, schoolbus, seating, seatbelts, tractor-semitrailer, head-on collision, Schoolbus Crashworthiness				18. Distribution Statement  This document is available through the National Transportation Technical Information Service, Springfield, Virginia, 22161	
19. Security Classification (of this report) UNCLASSIFIED		20. Security Classification (of this page) UNCLASSIFIED		21. No. of Pages 33	22. Price

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NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: September 5, 1984

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COLLISION OF  
G & D AUTO SALES, INC., TOW TRUCK TOWING AUTOMOBILE,  
BRANCH MOTOR EXPRESS COMPANY TRACTOR-SEMITRAILER,  
AND TOWN OF REHOBOTH SCHOOLBUS,  
STATE ROUTE 44  
REHOBOTH, MASSACHUSETTS  
JANUARY 10, 1984

SYNOPSIS

At 11:45 a.m., on January 10, 1984, a G & D Auto Sales, Inc., tow truck was turning right from the company's driveway onto westbound State Route 44 in Rehoboth, Massachusetts, when the rear-facing passenger car in tow, a 1981 Oldsmobile, was struck by an eastbound tractor-semitrailer operated by Branch Motor Express Company. The 76,950-pound tractor-semitrailer continued eastbound; crossed the centerline of the damp, two-lane, two-way roadway; and struck the left front of a westbound Town of Rehoboth schoolbus carrying 15 students, ages 5 and 6. The 1973 schoolbus overturned and came to rest on its roof off the roadway. The driver of the tractor-semitrailer, the driver of the schoolbus, and one student were killed; 12 students were injured. The driver of the tow truck was not injured.

The National Transportation Safety Board determines that the probable causes of the accident were (a) unsecured steering axle wheels of the vehicle being towed by the rear, (b) excursion of the towed vehicle over the highway centerline into the path of the oncoming tractor-semitrailer, (c) loss of directional control by the driver of the tractor-semitrailer, and (d) entry of the uncontrolled tractor-semitrailer into the opposing traffic lane where it struck the schoolbus.

INVESTIGATION

Events Preceding the Accident

On January 5, 1984, a 1981 Oldsmobile Cutlass, which had been reported stolen on January 4, 1984, was found abandoned on a rural road in Rehoboth, Massachusetts. G & D Auto Sales, Inc. <sup>1/</sup> was contacted by the Rehoboth Police Department to tow the vehicle to G & D's storage lot on State Route (S.R.) 44 in Rehoboth.

The Rehoboth and Seekonk, Massachusetts, police officers involved in the recovery of the stolen Oldsmobile reported that the notch on the ignition switch was aligned with an arrow and the word "Lock" embossed on the right side of the steering column, and that the left side of the steering column had been broken away by the thieves. (See figure 1.) Both police officers stated that there was no key in the ignition, but that they could turn the steering wheel which caused the steering axle wheels to turn. The mechanism which caused the steering wheel and gear selection lever to lock when the ignition key was removed had been disabled.

<sup>1/</sup> Hereafter referred to as G & D.



Figure 1.—View of left side of Oldsmobile's  
damaged steering column.  
(Photo courtesy of Rehoboth Police Department)

The Seekonk police officer stated that when the employee for G & D arrived at the car abandonment site either he or the Rehoboth officer, or both, told the G & D employee that the steering axle wheels were free to turn. The Seekonk officer also stated that he observed the G & D employee holding a length of manila rope in his hand while the car was being prepared to be towed, but that he did not see what the G & D employee did with the rope. The G & D employee later denied that he had any rope on his tow truck or that he used any rope to prepare the vehicle for towing.

The G & D employee installed two tires and rims onto the steering axle of the car, hooked his tow truck to the rear of the car, and towed it to G & D's storage lot. The Seekonk officer reported that he saw the Oldsmobile being towed by the rear and that he observed no errant tracking as the vehicle was being towed.

### The Accident

After the 3,200-pound Oldsmobile was recovered, arrangements were made with the vehicle's owner to have the vehicle towed to Providence, Rhode Island. At 11:45 a.m., on January 10, 1984, the tow truck, with the Oldsmobile in tow by the rear with the front steering axle on the road, turned right from the G & D's company driveway onto westbound S.R. 44. (The tow truck driver was not the same person who had towed the abandoned vehicle to G & D on January 5.) The Oldsmobile was struck by an eastbound tractor-semitrailer operated by Branch Motor Express Company. The tow truck driver stated that he felt a "bang" about 30 yards after leaving the G & D driveway, and that the Oldsmobile was struck by the truck after the truck traveled across the highway centerline. He stated that he then drove the tow truck with the Oldsmobile still in tow onto the westbound shoulder of S.R. 44. He also stated that he thought the steering axle wheels of the Oldsmobile were "locked" to prevent it from tracking outside the turning radius of the tow truck.

The tractor-semitrailer continued eastbound on the two-lane, two-way roadway and struck the left front of a westbound schoolbus, which was carrying 15 students (ages 5 and 6), partially separating the schoolbus body from the frame. The schoolbus had turned right from River Street onto S.R. 44 about 375 feet east of the point of collision. The truck tractor then separated from the semitrailer, rotated to the left, struck the left side of the schoolbus near the bus's drive axle, and came to rest off the roadway behind the schoolbus. The schoolbus overturned and came to rest on its roof about 50 feet north of the westbound lane of S.R. 44. The semitrailer rotated almost 180° to the left, overturned, and came to rest blocking the westbound shoulder of S.R. 44. (See figures 2 and 3.) As a result of the three-vehicle collision, the tractor-semitrailer driver, the schoolbus driver, and one student were killed, and twelve students were injured.

### Emergency Response

The tow truck driver stated that after the accident he ran back to the schoolbus and saw smoke coming from the engine compartment of the schoolbus. He returned to the tow truck, removed his fire extinguisher, and then returned to the schoolbus where he and a local resident with a fire extinguisher extinguished the fire.

A female motorist who had stopped at the accident site shortly after the accident stated that a man was already inside at the front of the schoolbus as she approached it. The man inside the bus passed four or five children out of the damaged windows on the left side of the bus to the female motorist who then placed the children on a nearby

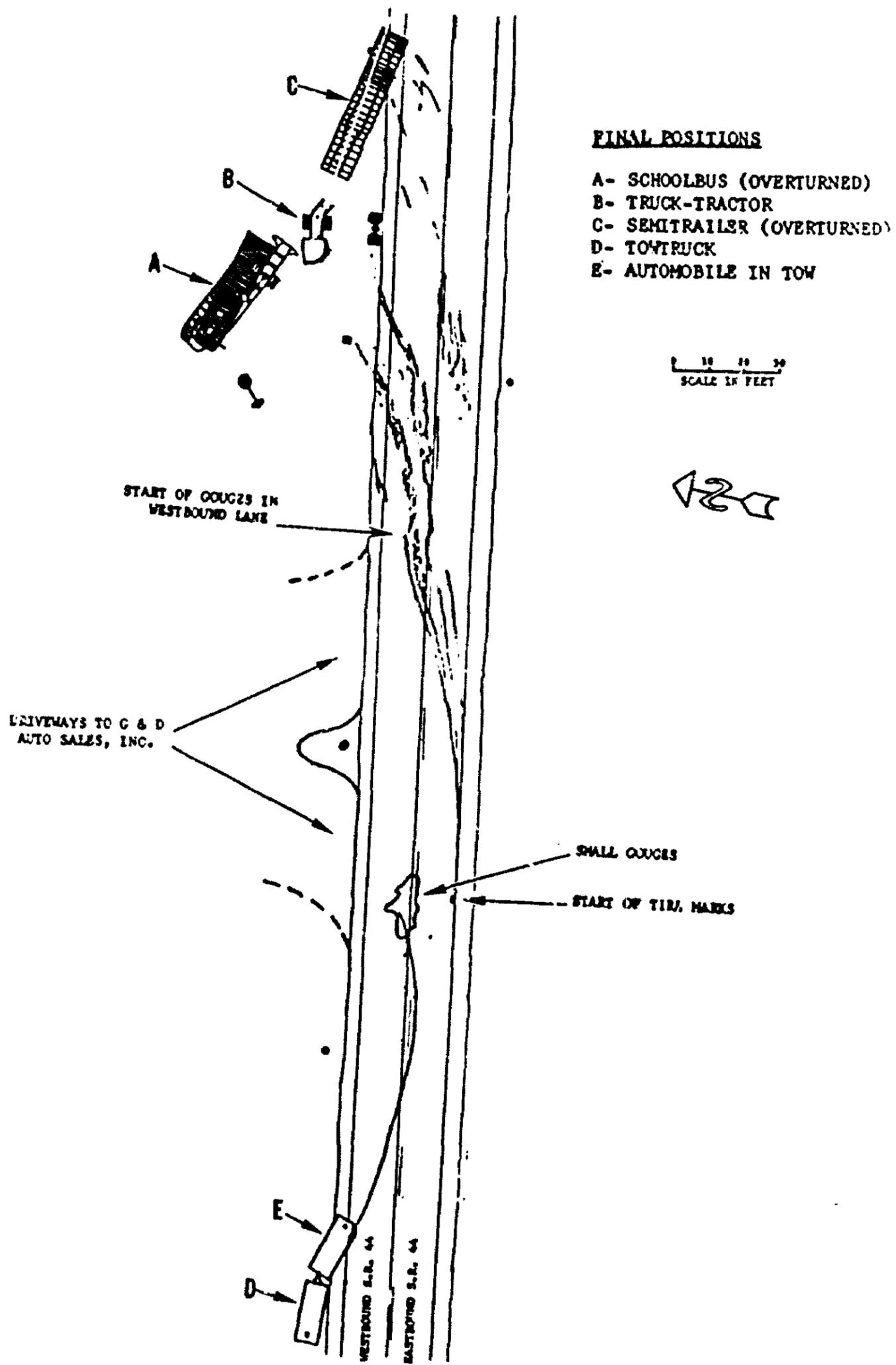


Figure 2.—Accident site.



Figure 3.—View of accident scene looking west on State Route 44. Overturned semitrailer is in foreground. (Photo courtesy of Rehoboth Police Department)

grassy area. Two other male motorists who had stopped at the scene entered the bus and evacuated the remaining 10 or 11 children through the rear emergency door. All of the children and the busdriver were removed from the bus before rescue units arrived on scene.

Another motorist removed the truckdriver from the cab and laid him on the ground. Several witnesses reported seeing the schoolbus driver lying on the grass near the schoolbus. It could not be determined who removed the driver from the bus or if she had been wearing her seatbelt.

Eight children were transported to Rhode Island Hospital and five to Sturdy Memorial Hospital in Attleboro, Massachusetts. Rescue units responded from Rehoboth, Seekonk, Dighton, and Norton, Massachusetts.

Injuries to Persons

<u>Injuries</u>	<u>Drivers</u>	<u>Passengers</u>	<u>Totals</u>
Fatal	2	1	3
Severe	0	1	1
Serious	0	1	1
Moderate	0	1	1
Minor	0	9	9
None	0	2	2
Total	<u>2</u>	<u>15</u>	<u>17</u>

Driver Information

None of the drivers involved in the accident had been convicted of any traffic violations.

Tow Truck Driver.—The 45-year-old tow truck driver was the owner of G & D. He had worked as a tow truck operator and an automobile mechanic for 29 years and had been self-employed in the tow truck/auto body repair business since 1962. He held a valid Massachusetts operator's license with no restrictions.

Tractor-Semitrailer Driver.—The 35-year-old tractor-semi-trailer driver had been employed by Branch Motor Express Company since August 1979, and had driven tractor-semi-trailers for 9 years. He held a valid Connecticut operator's license, and his August 1983 medical examination showed that he was physically qualified to operate commercial vehicles in interstate commerce. At the time of the accident, the driver had been on duty 4 hours since his last 8 or more consecutive hours off duty and was in compliance with the U. S. Department of Transportation requirements regulating the maximum hours of service of interstate commercial vehicle drivers.

Schoolbus Driver.—The 49-year-old schoolbus driver had operated schoolbuses for 13 years. She held a valid Massachusetts operator's license with an endorsement authorizing the operation of schoolbuses. The endorsement, which required renewal annually, had expired on October 4, 1983. The driver had failed to take the required physical examination which was required for renewal of her schoolbus endorsement.

### Vehicle Information and Damage

Tow Truck.—The 1975 Ford towtruck was owned by G & D and was not damaged in the accident.

Passenger Car in Tow.—The brown 1981 Oldsmobile Cutlass was a 2-door sedan with a tan vinyl top. The right front fender suffered extensive damage. The right front tire was deflated, the bead flange of its rim was bent, and the outside sidewall and part of the tread were cut. A rectangular imprint on the right fender panel started 17 inches forward of the rear of the panel. The hood sustained minor collision damage to the right front corner, and the entire hood was displaced to the left at an angle of 26° from the car's longitudinal axis. (See figure 4.)

Investigators for the Rehoboth Police Department reported that there was no key in the ignition switch of the Oldsmobile and that the notch on the ignition switch was aligned with the arrow embossed on the right side of the steering column, which normally would indicate that the steering wheel was in the "locked" position. (See figure 5.) The steering wheel could be turned freely by hand, and there was no evidence that the steering wheel had been secured by any other means, such as a rope lashed from the wheel to some other fixed object on the vehicle.

Tractor-Semitrailer.—The 1978 Kenworth tractor with a 1978 Transcraft flatbed semitrailer was leased to Branch Motor Express Company of New York, New York. The 76,950-pound truck was transporting 49,005 pounds of sheet stainless steel from Philadelphia, Pennsylvania, to Taunton, Massachusetts. The vehicle was 8 feet wide and 53 feet long.

The three-axle tractor was equipped with brakes on all wheels. After the accident, the slack adjuster for the left steering axle brake was located in the cab under the driver's seat. The left side of the tractor cab near the driver's seat and the left side of the dashboard were displaced about 4 feet rearward and 5 feet to the left with the left portion of the dashboard almost flush against the back of the driver's seat. The seat was firmly anchored to the floor. The steering wheel was compressed down onto the left side of the driver's seat. The front bumper was bent into the left steering axle tire which was deflated. The bead flange of the tire rim was bent outward and almost directly to the rear. The front side of the bumper had brown paint transfers on the left for 14 inches and yellow paint transfers across the entire front of the bumper. A tire mark was imprinted on the side of the right saddle-mounted fuel tank. The bottom of this imprint began about 21 inches from ground level. The rear drive axle separated from the frame during the accident.

The headerboard <sup>2/</sup> of the flatbed semitrailer was displaced forward about 1 foot on the left side. The right side rail was torn out for about 6 feet 7 inches starting 8 feet from the front of the trailer.

The lower half of the fifth wheel assembly from the truck tractor was found still locked to the trailer kingpin. The front underside and landing gear of the semitrailer showed several rubber transfers from the tractor tires.

<sup>2/</sup> A headerboard is a device that is installed at the front of the trailer to protect the driver's compartment from crushing or penetration by forward-shifting cargo.



Figure 4.—Damage sustained by Oldsmobile in collision  
with tractor-semitrailer.  
(Photo courtesy of Massachusetts State Police)

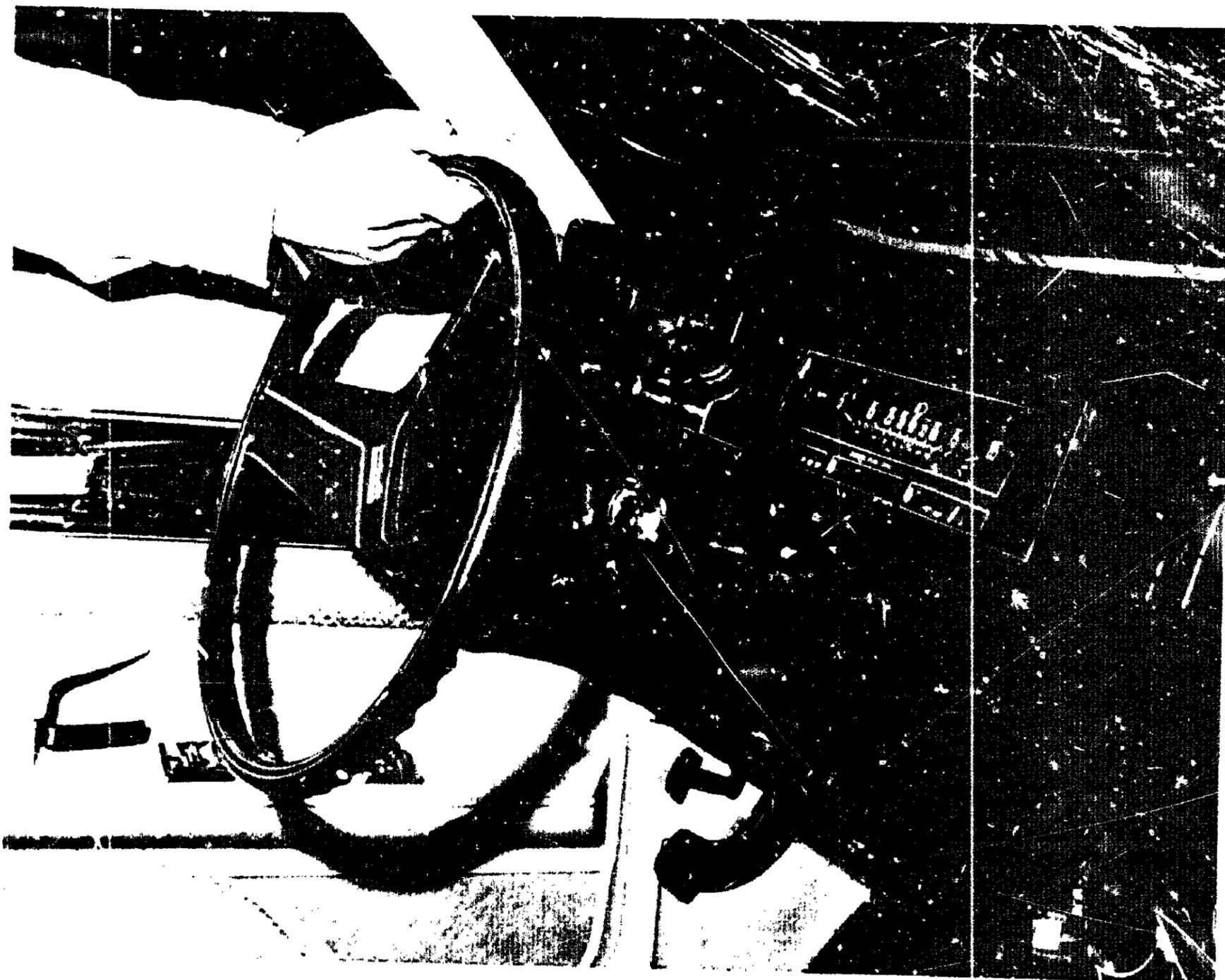


Figure 5.—View of undamaged right side of Oldsmobile's steering column and ignition switch.  
(Photo courtesy of Massachusetts State Police)

Schoolbus—The 65-passenger schoolbus was owned and operated by the Town of Rehoboth. It had a 1979 International Harvester Corporation chassis and a 65-passenger 1979 Wayne Corporation body. It was equipped with an 8-cylinder gasoline engine and a 5-speed manual shift transmission. At the time of the accident, the estimated loaded weight of the bus was 15,000 pounds.

After the accident, the left longitudinal frame rail was bent to the left at two places. The first bend was located 7 feet from the front and displaced the front 7 feet of the left frame rail 7° degrees to the left of the normal position. The second bend was located 18 1/2 feet from the rear of the rail and resulted in a 2° displacement to the left.

The body of the schoolbus was secured to each longitudinal frame rail by two brackets near the front and nine body mounting clips on each side. Each clip was bolted to the transverse body frame members and clipped under the top lip of the longitudinal frame rail. After the accident, the bus body was partially detached from the frame. The brackets on both sides were broken. The body mounting clips on the left side were intact. The two rear and four front body mounting clips on the right were bent down and away from their normal positions. The remaining three body mounting clips located 5.2, 14.2, and 16.5 feet from the rear were torn from the transverse body frame members to which they were bolted.

The entire steering axle assembly was torn from the frame. The left front tire was deflated and the right front tire was inflated.

Two 22-gauge steel interior roof panels and two 20-gauge steel exterior roof panels extended the full length of the bus body. No separations were found in the roof panels, and no penetration was found in the passenger compartment from the roof. All roof fasteners were spaced on 1 1/2-inch centers. The maximum exterior roof panel deformation was 4 1/2 inches. At the rear of the bus, the undamaged floor to ceiling dimension was 72 1/2 inches; however, moving toward the front of the bus, this dimension decreased. Photographs taken at the scene showed that the front of the roof contacted the engine firewall when the bus overturned and came to rest on its roof. (See figure 6.)

The right and left front roof support pillars were displaced to the right and were broken away from the roof at the roof joint. The left front roof support pillar was displaced into the area normally occupied by the driver at an angle of approximately 45° to the longitudinal axis of the vehicle.

There were no body panel penetrations or separations except in the major area of impact. There was some minor penetration of the full-length, 22-gauge steel, exterior body panels on the left side behind the driver's seat. Also, there was some separation of the full length, 20-gauge steel, interior panel at the bottom of the lower horizontal sash frames of the first 3 passenger windows behind the driver. Fasteners for the exterior and interior panels were spaced on 9- and 3-inch centers, respectively.

Extensive collision damage was found on the left side of the body starting immediately to the rear of the left front of the bumper and extending rearward for 16 feet. Maximum penetration into the sidewall of the schoolbus body was 18 inches at the rear of the barrier between the driver's seat and the first passenger seat on the left side. (See figure 7.)



Figure 6.—View of schoolbus showing roof collapsed onto vehicle's firewall.  
(Photo courtesy of Massachusetts State Police)

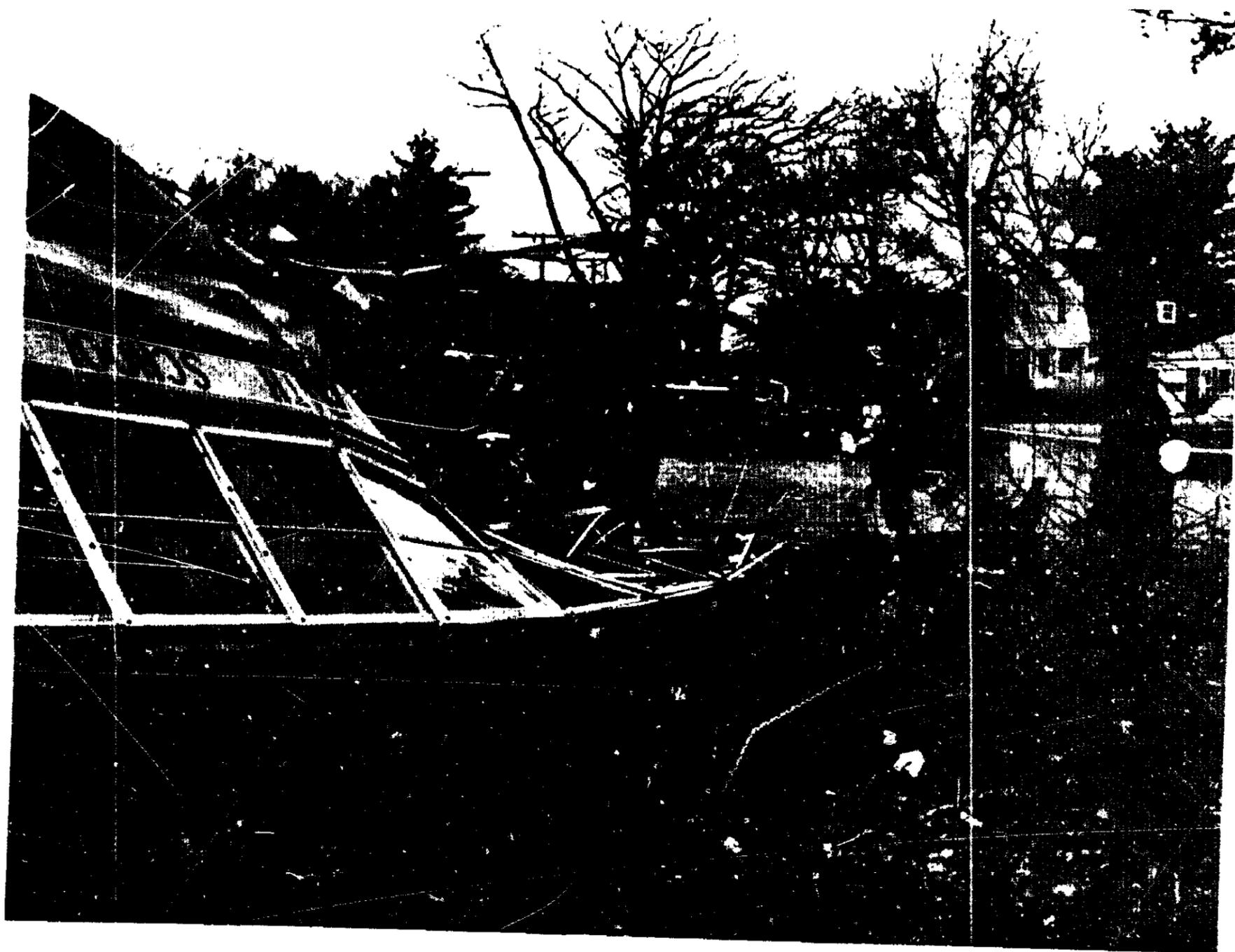


Figure 7.—View of schoolbus in area of impact with tractor-semitrailer.  
(Photo courtesy of Massachusetts State Police)

The 14-gauge steel panels of the floor buckled across the width of the bus at four locations: between the seat legs of rows one, two, and three, and between the rear seat legs of row three and the forward legs of row four. The height of the floor buckles were 8, 6, 3, and 6 inches, respectively.

The driver's seat was in the major impact area and was against the barrier installed behind the seat. The left front corner of the seat cushion was deformed to the right 6 inches laterally and 11 inches longitudinally and was in contact with the damaged left side of the bus. The seat assembly separated from the seat base frame, which remained attached to the schoolbus floor at all four attachment points. The steering wheel and column were deformed to the driver's left. Two of the three steering wheel spokes were broken and forced downward at the steering wheel hub. The outer steering wheel rim was broken at one of the steering wheel spokes. The normal 21-inch distance between the center of the steering wheel hub and the front of the driver's seatback was decreased to 12 inches. The bottom of the broken steering wheel was 8 inches from the back of the driver's seatback. The seat belt was found stowed in the seat belt retractors which operated properly after the accident.

The padded barriers between the driver's seat and the first passenger seat on the left, and in front of the first passenger seat on the right remained attached to the floor and sides of the schoolbus interior. The frames of these barriers were constructed of 1-inch outside diameter (O.D.) steel tubing with 10-gauge steel legs bolted to the floor of the bus on the aisle side and to the side of the bus on the outboard side of the barrier. The barriers were padded with polyurethane foam. The left barrier was in the major impact area. The aisle side of the right barrier was displaced 3/4 inch to the rear.

Each of the 22 passenger seats was 39 inches wide and could accommodate 3 small passengers, with the exception of the two-passenger seat on the last row on the left. The passenger seats did not have, nor were they required by Federal regulation to have, seatbelts. The frame of each seat was constructed of 1-inch O.D. 14-gauge steel tubing with stiffeners at the base angle and a 14-gauge steel support panel at the seat back and cushion junction on each side of the seat. The aisle side of the seat was supported by two legs constructed of 1-inch O.D. 14-gauge steel tubing welded to 12-gauge steel foot pads. Each pad was attached to the floor by two bolts and two hex head screws. The outboard side of the seat was mounted to the schoolbus wall by a metal mounting clip and a hex head bolt and nut at the front and by a 14-gauge steel metal bracket and a hex head bolt and nut at the rear of the seat frame. The seat back was padded with polyurethane foam and was covered with vinyl-coated fabric.

The seat legs of the first seat behind the driver, the rear seat legs of the second and third seats on the left, and the rear seat legs of the first two seats on the right had separated from their respective foot pads. The pads remained bolted to the floor. No other leg/floor separations were noted.

The front end of the seat frame of the first seat behind the driver was separated from the side wall and the metal mounting clip was missing. The bracket which attached the rear of the seat frame to the sidewall remained intact. No other separations of the seats from the sidewall were noted.

Before the accident, the seat-back to seat-back measurement was approximately 27 inches and the aisle width was 15 3/4 inches. The postcrash measurements were essentially the same.

The 13-pound seat cushions were constructed of polyurethane foam on a 1/2-inch plywood base. The seat cushions were attached to the seat frame by two retaining clips on the front and the rear of each cushion. To install, each seat cushion was dropped perpendicularly onto the frame to engage the fixed front clips and then rotated toward the seat back. After emplacement of the seat cushion, the two retaining clips at the rear were rotated 90° to engage the seat frame. Photographs showed that at least seven seat cushions came loose from their mountings and were lying on the inside roof panels of the bus after it overturned.

The rear emergency door was not damaged and was operable after the accident. The right front door was damaged and was not operable. The 2- by 2-foot windows opened from the top down and provided an opening of 9 by 24 inches when fully opened. The last seven windows on the left side were operable. The remaining windows in the bus were damaged and could not be opened.

Neither the fire extinguisher, which was mounted in a bracket under the right side of the instrument panel, nor the first aid kit under the first right seat were used after the accident.

The 60-gallon fuel tank was mounted behind the front entrance doors on the outboard side of the right longitudinal frame member. It was dented inward approximately 1/2 inch on its top and the forward end of its supporting bracket was bent upward. There was no fuel leakage after the bus overturned.

#### Highway Information

At the accident site, S.R. 44 is a straight, 50-mph, two-lane, east-west, undivided highway with about a 12-foot-wide traffic lane in each direction, with 5 1/2 foot-wide paved shoulders. The roadway is a 2 1/4 percent upgrade westbound and is marked as a "no-passing" zone for westbound vehicles. The average daily traffic volume is 6,600 vehicles. During the onscene investigation, traffic was observed traveling between 45 and 60 mph. The sight distance is about 1 mile eastbound and about 450 feet westbound from the area of the collision of the Oldsmobile and the tractor-semitrailer.

The following accident statistics were compiled for calendar years 1981, 1982, and 1983 for the 5.53-mile-long portion of S.R. 44 within the Rehoboth Town limits:

<u>Year</u>	<u>Total Accidents</u>	<u>Total Injury Accidents</u>	<u>Total Fatal Accidents</u>
1981	52	19	None
1982	54	16	2
1983	38	16	None

There were no accidents involving a head-on collision between two large vehicles during the three previous calendar years.

The first tiremark attributed to the accident was located 19 inches to the left of the eastbound white edgeline in the traffic lane and slightly west of the company driveway reportedly used by the tow truck driver. There were two small gouges in the eastbound lane adjacent to the initial tiremark and about 2 feet from the highway centerline.

Tire yaw marks were found beginning about 2 feet east of the gouges and within 1 foot of the eastbound white edgeline. These marks continued eastward and crossed the highway centerline at a point approximately 75 feet east of the first tiremark. There were several gouges in the center of the westbound lane approximately 110 feet east of the first tiremark, followed by tiremarks and gouges leading off the westbound lane of the highway to the final rest positions of the vehicles. (See figure 1.)

#### Meteorological Information

At the time of the accident, the weather was overcast and the highway surface was damp with condensation.

#### Medical and Pathological Information

The truckdriver's death was attributed to a massive internal hemorrhage due to a ruptured heart. Other injuries included fractured ribs (left side) and contusions and abrasions to the left side of the chest, face, shoulder, pelvis, knees, and hands. A blood sample was found to be negative for alcohol and narcotic drugs.

The schoolbus driver's death was attributed to a massive internal hemorrhage due to a ruptured heart. Other injuries included a compound fracture of the right lower leg; a fracture of the left leg and right wrist; contusions and abrasions to the hands and left side of the abdomen, face, forehead, nose, lower lip, and upper lip; and lacerations and contusions on both legs and thighs. A blood sample was found to be negative for alcohol and narcotic drugs.

One passenger in the first row behind the driver died 10 days after the accident on January 20, 1984. Cause of death was shown as "craniocerebral trauma." The next most seriously injured passenger, a female child, was sitting in the same seat on either the window or the aisle side. The child suffered head injuries, transient hypoxia, numerous broken teeth and a fractured mandible; she was discharged from the hospital on February 22, 1984. A male passenger sitting in the third seat on the driver's side suffered a fracture of the left femur and abrasions and contusions of the face and forehead; he was discharged from the hospital on January 28, 1984. A male passenger sitting in the first seat on the right side next to the window suffered a bruise to the parietal area of the head and an abrasion to the forehead; he was discharged on January 11, 1984.

Nine passengers were treated for minor abrasions and contusions and were released. Two children were not injured. (See figure 8.)

#### Survival Aspects

Witnesses stated that the schoolbus passengers sat one and two to a seat, except in one instance where three passengers sat together. It was reported that the driver required the passengers to sit in the first six rows of the schoolbus so that she could monitor their activities. The most seriously injured passengers were sitting in the first three rows of the schoolbus. None of the occupants were ejected from the bus.

#### Tests and Research

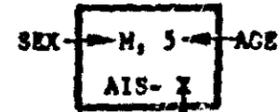
A schoolbus with an identical engine and body was accelerated from River Street, where the accident bus had turned onto westbound S.R. 44, to the point of collision with the tractor-semitrailer with the following results:

LEGEND

AIS\* SEVERITY CODE

- 1 MINOR
- 2 MODERATE
- 3 SERIOUS
- 4 SEVERE
- 5 CRITICAL
- 6 MAXIMUM INJURY,  
VIRTUALLY UNSURVIVABLE

\* American Association for Automotive  
Medicine's Abbreviated Injury Scale



AIS CODE

\* Occupant died ten days after  
accident.

\*\* Estimated Seating Position.

F, 49 FATAL					
M, 5 AIS-6		** F, 6 AIS-4	M, 6 AIS-1		M, 6 AIS-2
		M, 5 AIS-1			
M, 6 AIS-3			M, 5 AIS-1		M, 5 AIS-1
			M, 6 AIS-1	M, 5 NO INJ.	M, 6 AIS-1
					F, 6 AIS-1
		F, 5 NO INJ.	F, 5 AIS-1		F, 5 AIS-1

Figure 8.—Schoolbus seating and injury chart.

<u>Test No.</u>	<u>Time In Seconds</u>	<u>Indicated Speed</u>	<u>Radar Reading</u>
1	15	31	28
2	15	32	30
3	15	32	28

Based on the results of the tests, Safety Board investigators determined that the schoolbus was traveling about 31 mph at the time it collided with the tractor-semitrailer.

The right front tire and wheel of the Oldsmobile was compared to the left front tire and wheel of the truck tractor. The outside bead flanges of the respective rims "fit" together at the points where they were damaged. With the two rims fitted together, the longitudinal axis of the Oldsmobile tire rim was at an angle of not more than 15° to the left of the longitudinal axis of the left steering axle rim of the truck tractor.

On January 16, 1984, the steering column of the Oldsmobile was disassembled by a consultant for the Massachusetts Authorities to determine and assess the effect of the damage done to the steering wheel interlock system by the person(s) who stole the Oldsmobile on January 4. The consultant reported that after the thieves had removed the housing from the left side of the steering column, they pulled out the lock bolt spring so that it no longer activated the lock bolt when the ignition key was removed. With the spring pulled out, the lock bolt could no longer engage the lock plate below the steering wheel, and the steering wheel was free to move with no key in the ignition.

#### Other Information

G & D Auto Sales, Inc. Towing Service.—G & D is one of two towing companies in the Rehoboth area which performs towing services for the Rehoboth Police Department. The company was authorized in August 1977 by the Massachusetts Department of Public Utilities to transport used motor vehicles to and from points within the territorial limits of Rehoboth, Seekonk, Attleboro, Taunton, Dighton, and Swansea, Massachusetts, as an irregular route motor common carrier.

Schoolbus Safety Standards.—Schoolbuses manufactured after April 1, 1977, are required to meet Federal Motor Vehicle Safety Standard (FMVSS) 220, Schoolbus Rollover Protection. Two requirements of the standard are that: (1) when a force equal to 1 1/2 times the unloaded vehicle weight is applied to the roof of the vehicle's body structure through a force application plate, the downward vertical movement at any point on the plate shall not exceed 5 1/8 inches, and (b) that each emergency exit shall be capable of opening after the test conditions are applied.

In addition to FMVSS 220, schoolbuses manufactured after April 1, 1977, must comply with FMVSS 221, 222, and 301.

FMVSS 221, Schoolbus Body Joint Strength, requires that both inside and outside panels of a schoolbus be fastened to other parts and to each other by joints which have at least 60 percent of the strength of the metal of the thinner panel which is joined. The purpose of this standard is to prevent separations of the exterior and interior panels that form part of the schoolbus body.

FMVSS 222, Schoolbus Passenger Seating and Crash Protection, established occupant protection requirements for schoolbus seating and restraining barriers for buses.

The purpose of this standard is to reduce the number of deaths and injuries resulting from the impact of schoolbus occupants against structures within the vehicle during crashes and sudden driving maneuvers.

FMVSS 301, Fuel System Integrity, established fuel system requirements for large schoolbuses. The purpose of this standard is to reduce deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes.

### ANALYSIS

#### The Accident

The weather, the condition of the highway, the condition of the drivers, and the pre-accident condition of the tractor-semitrailer and the schoolbus were not factors in this accident.

The location and direction of the tire mark made by the truck near the eastbound edgeline indicated that the 8-foot-wide tractor-semitrailer was traveling on the right side of the 12-foot-wide eastbound lane with its front wheels in the straight ahead position when it collided with the Oldsmobile. Damage to the right front tire and wheel of the Oldsmobile and the left front tire and wheel of the truck tractor showed that the bead flanges of the rims of the two vehicles hooked together at impact. The partial cut across the tread face of the Oldsmobile tire indicated that the bead flange of the truck tractor steering axle tire impacted the tread portion of the right front tire of the Oldsmobile before the respective rims hooked together.

The rectangular imprint on the right front fender of the Oldsmobile matched the left front corner of the front bumper of the truck tractor and, given the location of the truck's tire mark, positively placed the right front corner of the Oldsmobile at least 4 1/2 feet across the centerline into the eastbound lane at the point of impact. The angle of collision between the right front wheel of the Oldsmobile and the left steering axle wheel of the truck tractor was not more than 15°. The angle of collision between the Oldsmobile hood and the left front of the truck tractor was not less than 26°. The difference in collision angles indicates that the front wheels of the Oldsmobile were not aligned with the longitudinal axis of the Oldsmobile and that the front wheels were turned left. The Safety Board concludes that the front steering axle wheels of the Oldsmobile were not secured to prevent tracking outside the turning radius of the tow truck and that as the tow truck executed the right turn onto westbound State Route 44, the front end of the Oldsmobile crossed over the highway centerline and was struck by the tractor-semitrailer.

Although the driver of the tow truck stated that he traveled about 30 yards on westbound S. R. 44 when he felt the impact with the tractor-semitrailer, the Safety Board believes that the distance the driver traveled was probably not more than 50 feet because a vehicle being towed with unsecured front wheels would swing outside the tracking radius immediately after a right turn is made.

There was no evidence of any brake application by the driver of the tractor-semitrailer. The straight tire mark which is a collision scuff and which was essentially parallel to the eastbound edgeline at the point of impact indicated that the truckdriver did not make a last-second steering maneuver to avoid the collision with the Oldsmobile. Therefore, the truckdriver probably did not become aware of the danger until

it was too late to take evasive action or to apply the brakes to avoid the collision. When the left steering axle tire of the truck tractor struck the Oldsmobile, the truckdriver lost control of his vehicle, which crossed over into the westbound lane and struck the schoolbus.

Based upon observation of eastbound traffic speeds in the area, it is estimated that the truck was traveling between 45 and 55 mph at the time it collided with the Oldsmobile. Based upon tire marks and gouges, the distance between the point of collision of the tractor-semitrailer with the automobile and the collision with the schoolbus was about 90 feet. Given the difference in momentum between the truck and the Oldsmobile, the truck lost very little velocity in the collision with the automobile and traveled the distance to the point of impact with the schoolbus at a speed of 45 to 55 mph in slightly more than 1 second. The driver of the schoolbus, therefore, did not have sufficient time to perceive the danger and take evasive action to avoid the collision.

#### Drivers' Qualifications

The qualifications and experience of the tractor-semitrailer and the schoolbus drivers did not contribute to the accident. The fact that the schoolbus driver was operating her vehicle with an expired schoolbus operator's endorsement on her Massachusetts vehicle operator's license also was not a factor in this accident. However, the Town of Rehoboth, Massachusetts, School District should institute procedures to ensure that all schoolbus drivers have valid operator licenses and schoolbus endorsements in accordance with the laws of the Commonwealth of Massachusetts, and to ensure that all licenses and endorsements are renewed when they are due to expire.

The driver of the tow truck had 29 years' experience and had been self-employed in the tow truck/body repair business for 22 years. The driver's qualifications and experience do not appear to be factors in this accident. However, after the accident, the tow truck operator reported that he thought that the steering axle wheels of the Oldsmobile were "locked." The fact that the key was not in the ignition and the position of the ignition switch, which indicated that the wheel was locked, may have misled the driver into believing the steering axle wheels were secured. Towing companies, especially those which tow recovered stolen vehicles for law enforcement agencies should be advised of the circumstances of this accident.

#### Driver Fatalities

As the left front of the tractor-semitrailer struck and penetrated the left front and side of the schoolbus, both drivers sustained fatal blunt trauma injuries to their hearts as their respective drivers' areas became crushed. Other left side injuries to both drivers indicates that they were propelled forward and to the left into the direction of major impact.

Postcrash examination of the schoolbus showed that the driver's area had been reduced significantly. The front instrument panel was displaced rearward. The left side wall and side instrument panel were displaced inward toward the driver and were in contact with the left side of the driver's seat. The steering wheel was displaced rearward 9 inches from its normal position and the rim was broken in several places. This damage most likely occurred at the point of major impact when the crash forces were the greatest. Also, the Safety Board believes the schoolbus driver's fatal heart injury occurred as the truck collided with the bus and the driver struck the steering wheel and/or crushed the front and side instrument panels. This driver's use of a lapbelt would not have prevented her fatal injuries.

Postcrash examinations of the tractor cab revealed total destruction of the left side of the tractor cab and driver's area. The truckdriver's fatal heart injury most probably was caused by contact with the steering wheel and/or rearward displacement of the left front of the cab and instrument panel. Use of a seatbelt would not have prevented the truckdriver's fatal injuries.

### Survival Aspects

It could not be determined whether the two passengers who were in the first seat behind the driver were sitting as shown in figure 8 or vice versa. However, based on the severity of injury, it is believed that the fatally injured passenger was sitting near the window and that the injury most likely was caused by severe impact forces as the passenger was propelled forward into the barrier to the front and the crushed left sidewall of the bus as the tractor forced the schoolbus body off its chassis. These crash forces were concentrated in the major impact area adjacent to where the child was sitting.

The passenger who is believed to have been sitting on the aisle side in the same seat as the fatally injured passenger experienced the same kinematics and suffered severe head injuries. However, the passenger's injuries were not fatal because the passenger was seated farther away from the major impact area and probably did not come in contact with the left sidewall of the bus. The same is true of the passenger in the second seat behind the driver who was sitting on the aisle to the right of the major impact area and who suffered minor head contusions on the left side and a bruised knee.

The passenger who was in the third seat on the driver's side by the window was located in the major impact area and suffered a fracture of the left femur. The passenger in the sixth seat behind the driver sustained no injuries. This passenger was seated away from the major impact area.

In sum, for the passengers seated on the left side of the bus, the severity of their injuries is directly related to their proximity to the major impact area where the crash forces would have been the greatest. While most of the passengers' minor injuries probably occurred after the bus rolled onto its top, the fatal and most severe injuries are believed to have occurred during initial impact with the tractor-semitrailer.

The passenger who was seated in the first seat in the right side next to the window recalled being propelled into the barrier to the front. He suffered a fractured left clavicle which is consistent with the occupant kinematics of being propelled forward and to the left. The eight passengers who sustained minor injuries and the passengers who were not injured did not experience the severe crash forces experienced by those who were sitting in the first three rows on the left side of the bus. The injuries to passengers seated on the right side of the bus probably occurred while the bus was rolling over when they contacted the right side windows, the sidewall, and the roof of the bus.

### Schoolbus Body Rollover Protection

Based on the evidence, the Safety Board believes that the crushing and displacement of the left and right front corner roof support posts of the schoolbus occurred during the initial collision with the truck and substantially weakened the front roof support structure before vertical loads were applied during the subsequent rollover. The crash performance of the schoolbus, therefore, cannot be evaluated strictly in terms of its compliance with the vertical load testing requirements specified in FMVSS 220.

With both front corner support posts displaced, the front of the bus roof collapsed and made contact with the firewall when the vehicle rolled over. However, after the bus rolled over onto its top, the roof was subjected to vertical loading, and it did perform in a crashworthy manner with respect to the requirements of FMVSS 220. Except where the roof collapsed in front, the maximum vertical penetration of 4 1/2 inches occurred on the exterior panels of the roof with only minor buckling of the interior panels. The roof reacted to these forces as a unit, which allowed the vertical forces on the roof to be uniformly distributed. Also, the schoolbus body retained its basic shape, except in the area of maximum engagement with the truck, which provided survivable occupant space given the size of the passengers who were occupying the bus at the time of the accident. If larger, high-school aged passengers had been seated in the front of the bus, they might have suffered serious or fatal head injuries when the front of the roof collapsed during the rollover.

The schoolbus body damage and distortion to the left front, to the right rear corner of the roof, and to the right sidewall did not prevent the rear emergency exit from being fully operable. This exit was used by rescuers to evacuate most of the children from the bus.

#### Schoolbus Body Joint Strength

In its 1970 Special Study on inadequate structural assembly of schoolbus bodies, <sup>3/</sup> the Safety Board pointed out injuries attributed to panel separations in several schoolbus accidents to schoolbus manufacturers and the National Highway Safety Bureau (predecessor to the National Highway Traffic Safety Administration (NHTSA)). Based on the crash performance of the schoolbus body in this accident, it appears that post-standard construction (April 1977) methods represent significant improvements over construction methods in use before the promulgation of FMVSS 221. Most prestandard schoolbus bodies were constructed with roof and side panels joined by fasteners spaced much farther apart. Consequently, panel separations resulted in exposed sharp edges which caused disfiguring occupant injuries and a general collapse of the schoolbus body. In this accident, exterior and interior panels separated only in the major impact area where they would be expected to separate because the crash forces exceeded performance requirements. The Safety Board concludes that the schoolbus body met the requirements of FMVSS 221 and that the schoolbus body crashworthiness has been improved because of this standard.

#### Schoolbus Passenger Seating and Crash Protection

The impact with the tractor-semitrailer transmitted longitudinal forces to the floor of the schoolbus body which buckled at four locations. The buckling occurred between seat legs of the same seat and between the seat legs of adjacent seats. In addition, left side seat frame buckling noted on the first two seats behind the driver indicates that the left sidewall of the bus contacted these seats and forced them laterally inward and upward. The combination of forces and floor buckling most likely caused both seat legs to separate from the foot pads on the first seat on the driver's side and one seat leg/foot pad separation on seats in the second and third rows behind the driver and the first two seats on the right side. The forward left mounting clip on the first seat behind the driver was missing, but the rear bracket was attached to the sidewall of the bus. This seat was the only one that was free to move fore and aft, but still remained attached to the sidewall of

<sup>3/</sup> For more detailed information read Special Study—"Inadequate Structural Assembly of Schoolbus Bodies, The Accidents at Decatur and Huntsville, Alabama" (NTSB-HSS-70-2).

the bus. The fatally injured passenger and the most severely injured passenger were sitting in this seat. However, the Safety Board believes that this seat did not contribute to their injuries because both passengers were propelled from the seat at initial impact and before the mechanical damage to the seat occurred. These seat leg/foot pad separations occurred as a result of mechanical damage in the major impact area and not because kinematics propelled the occupants into the rear of the seat backs. The seat back to seat back spacing remained as originally assembled except where the seats at the front of the bus were damaged as a result of the collision. Those seats that had one seat leg/foot pad separation retained their basic structural integrity and remained secured to the floor in their original positions and did not contribute to occupant injuries. Despite the distortions to the floor and the inward displacement of the left sidewall of the bus, none of the foot pads came loose from the schoolbus floor.

FMVSS 222 provides for occupant crash protection through the use of strengthened, properly spaced, and padded seatbacks and padded restraining barriers for front row seats. During the collision with the truck, the passengers were contained in their respective seating areas and the padding on the seats and barriers provided for a less hostile environment than pre-1977 buses which generally had exposed metal seat frames. Nine out of 13 injured passengers suffered minor injuries, and 2 passengers sustained major injuries. There were no serious injuries outside the major impact area attributed to passengers' contacting seats or barriers.

One undesirable crashworthiness factor noted in this accident was that a number of seat cushions came loose from the seats during the bus rollover. FMVSS Standard 222 requires that "...the seat cushion shall not separate from the seat at any attachment point when subjected to an upward force of five times the seat cushion weight..." In this accident, the seat cushions came free because the clips at the rear of the cushion were free to rotate and, therefore, did not secure the cushion to the rear of the seat frame. It is possible that some of the movable seat cushion clips were not secured onto the seat frames before the accident, or that the clips rotated to the unsecured position during the rollover.

Loose seat cushions are a hazard during a crash. As the bus rolled over, the loose 13-pound cushions became missiles and may have contacted and injured some of the passengers. In addition, the loose cushions could have concealed small unconscious passengers and prevented them from being readily observed by rescuers. The Safety Board believes that an improved method of fastening the seat cushion to the frame is required to prevent seat cushion separation during impacts or rollovers.

#### Front Seat Barriers

The two front seat barriers performed as intended by FMVSS 222, i.e., the barriers are required to have no component or attachment separation when the standard's test loads are applied. No such separations were found on either barrier.

The left barrier was located in the major impact area and was subjected to severe crash forces. It is believed that the crash performance of the barrier prevented the passenger's sitting in the front seat on the aisle from being propelled into the crushed driver's area.

The crash performance of the right seat barrier prevented the two occupants sitting in the first seat of the right from being propelled into the windshield and firewall where

they would have struck hard, unyielding surfaces and possibly would have been crushed when the roof contacted the firewall during the rollover. The fact that they were restrained at initial impact by the padded barrier resulted in their less severe injuries.

#### Other Crashworthiness Features of the Schoolbus

The Schoolbus Body and Metal Floor.—At impact, the schoolbus body was crushed rearward starting at the left side firewall. The crushing of the schoolbus body and the buckling of the schoolbus metal floor dissipated some of the crash energy because exterior and interior panelings and the metal floor retained their respective structural integrities, allowing the schoolbus body to remain together as a unit and providing survivable occupant space. The energy expended in forcing the schoolbus body free of the chassis mounting brackets and clips and off the chassis also served to dissipate additional crash energy. Had the mounting brackets and clips held, the crash energy would have had to be dissipated by additional crushing of the schoolbus body and, thus, would have reduced the occupants' survivable space. In this accident, the separation of the schoolbus body from its chassis had positive results. This may not prove to be true in other accidents. Additional analysis of the crash performance of post-1977 schoolbuses involved in collisions with large heavy vehicles is necessary to evaluate the effect of body/chassis separation on occupant survivability.

The metal floor in the schoolbus effectively absorbed crash energy because of improved construction practices. The crash performance of the post-standard schoolbus body in this accident is a significant improvement over the crash performance of schoolbuses in accidents investigated by the Safety Board before the promulgation of FMVSS's 220, 221, and 222. In one pre-standard schoolbus accident, the floor panels separated and two passengers fell through the opening and sustained fatal injuries. <sup>4/</sup>

The Schoolbus Fuel Tank.—The fuel tank on the schoolbus was not significantly damaged during the collision and rollover. The structure encasing the fuel tank performed as intended and prevented loss of fuel and possibly a catastrophic fire. The fuel tank met the performance requirements of FMVSS 301.

#### Emergency Response

Motorists removed both the schoolbus and tractor-semitrailer drivers and the school children from their respective vehicles before emergency response personnel arrived at the scene. A local resident and the tow truck driver used fire extinguishers to extinguish the fire in the engine compartment of the bus. Fire and ambulance units were at the scene within minutes, and the rescue operations were performed in an efficient manner.

#### Emergency Equipment

The fire extinguisher on the schoolbus was located under the right side of the front instrument panel near the right front entrance door. This door was damaged and could not be opened. Also, the front of the roof had collapsed down into the area. The only access to the fire extinguisher would have been through the rear of the bus. A rescuer would have had to enter through the rear emergency exit door and would have had to proceed to the front of the damaged bus where he would have had to crawl on hands and knees to retrieve the fire extinguisher, if he was aware of the location of the fire extinguisher. Consequently, the fire extinguisher was not readily accessible.

<sup>4/</sup> Railroad/Highway Accident Report—"Penn-Central Freight Train/Schoolbus Collision near Congers, New York, March 24, 1972" (NTSB-RHR-73-1).

In some accidents involving schoolbuses, it may not be possible to retrieve a fire extinguisher from a nearby business or another vehicle. A fire extinguisher located at the rear emergency exit door of the schoolbus would have been easily noticed by anyone using the door. Since the rear of the schoolbus in this accident was not damaged, a fire extinguisher mounted by the rear emergency door would have been readily available for use.

As a result of its investigation of a schoolbus accident on March 25, 1983, near Newport, Arkansas, the Safety Board recommended to all the States, the District of Columbia, and the NHTSA that fire extinguishers be placed at both the front and rear of schoolbuses, that signs be posted in schoolbuses on the location and use of emergency equipment, and that passengers be briefed on the location and use of emergency equipment, both periodically and before beginning activity trips. <sup>5/</sup> (See appendix B.) To date, the NHTSA has not included a requirement for installation of fire extinguishers at both the front and rear exits of schoolbuses as part of the "Program Manual" of Highway Safety Program Standard 17-"Pupil Transportation Safety." The Safety Board reiterates Safety Recommendation H-83-45 to the NHTSA.

Twelve States have responded to Safety Recommendation H-83-48 with varying degrees of acceptance. Five States have placed the matter under study but have expressed a level of skepticism as to the need for the second extinguisher. Three States have expressed concern for the economic impact of such a step citing the high probability for misuse of the fire extinguishers as well as intentional vandalism creating large maintenance costs in addition to the high capital outlay for initial installation. One State, in disagreeing with the recommendation, has strongly endorsed the drilling of students in escape and evacuation procedures after an accident as being safer than providing students with the equipment to fight a fire. One State has agreed to present the idea to an advisory committee for schoolbus safety for consideration. Two States have taken action to implement the two fire extinguisher policy through instructions to local school superintendents from the Governor's office; one of these States has even committed to introducing and supporting this concept at the National Schoolbus Minimum Standards Conference in Warrensburg, Missouri, on May 19 - 24, 1985.

#### Benefits of Seatbelts and Federal Motor Vehicle Safety Standards 220, 221, and 222.

The installation of seatbelts in passengers schoolbuses is a controversial issue. Proponents for installation of seatbelts argue that seatbelts help to attenuate some of the crash forces experienced, keep occupants in their seats, and that occupants are less likely to be ejected when wearing a seatbelt.

Since 1977, when new schoolbus safety standards relating to occupant protection were promulgated, the NHTSA has required schoolbus manufacturers to use a compartmentalization approach to occupant protection rather than the installation and use of passenger seatbelts in schoolbuses. The compartmentalization concept is essentially passive in that the occupant contactable impact zones are defined and an occupant is protected against injury by interior padding and by controlled bending of the seat back or barriers in front of the occupant.

Opponents of Federal regulations requiring seat belt installation on large schoolbuses argue that safety benefits of seatbelts on large schoolbuses built to post-1977

<sup>5/</sup> Highway Accident Report—"Jonesboro School District Schoolbus Run-off Road Overturn, State Route 214 at State Highway 18, Near Newport, Arkansas, March 25, 1983" (NTSB/HAR-83/03).

standards have not been demonstrated; the automatic crash protection provided by the seat design (compartmentalization) is superior to reliance on seatbelts since seatbelts may be unused; and schoolbus design might have to be changed to accommodate seatbelts since the seats designed for compartmentalization may not be compatible with seat belt use, i.e., belted passengers are likely to jackknife at impact, hitting their heads on the seats in front, causing head and facial injuries.

Other arguments against seatbelts in schoolbuses include the allegation that monitors are needed to ensure that students properly wear and use their seatbelts; that the pelvises of very young children are not fully developed and cannot withstand lap belt crash loads; that belts and buckles could be used as "weapons" by unruly students; and that scarce school funds could be used more effectively to improve busdriver visibility, since schoolbus riders are more likely to be killed or injured while boarding or leaving a schoolbus rather than while riding in them. 6/

The use of seatbelts by both drivers and passengers in window seats of rows one and three on the left of the schoolbus would not have benefited them because of the degree of crush at their occupant spaces in the major impact area. The use of seatbelts by all other occupants would have prevented them from being thrown out of their seats and onto the ceiling as the bus collided with the truck and rolled over. However, if the children seated away from the major impact area had been wearing lap belts, their injuries may have been different, but not necessarily less severe because passengers sitting in the outboard seats still would have contacted the seatbacks, the sidewalls, windows, and the roof either during the initial collision with the truck, during the rollover, or both.

At initial impact, passengers seated outside the major impact area probably were thrown forward out of their seats into the padded seat backs or barriers in front of them, with large areas of their bodies contacting the seat backs or barriers, resulting in a better distribution of the crash forces over a wider area. If the children had been wearing lap belts, their heads and upper torsos may have been jackknifed forward into the seat backs and barriers, concentrating the impact on a smaller portion of their heads and facial areas. Concentration of crash forces on these areas may have produced more severe injuries than the children actually experienced. To prevent head or facial injuries to lap-belted occupants, the seats would have to be spaced farther apart, which increases the chance of injury for unbelted occupants because they are no longer "compartmentalized."

As a result of its investigation of the 1977 schoolbus accident at Rustburg, Virginia, the Safety Board saw a need to gather crash performance data on schoolbuses manufactured under the new standards. The Safety Board recommended that NHTSA:

Review available accident statistics involving 1975 and later model schoolbuses equipped with seating arrangements that comply with Federal Motor Vehicle Safety Standard No. 222 to determine if the specific seating, restraining barrier, and impact zone requirements for schoolbuses have reduced the injuries sustained by occupants on these schoolbuses when involved in collisions and rollovers. A report of the findings should be submitted to the National Transportation Safety Board at the earliest opportunity. (H-78-11)

In its June 1978 response to Safety Recommendation H-78-11, the NHTSA stated that, "Vehicles built according to the latest rule. . .are just reaching the operators, and

6/ "Accident Facts," National Safety Council, 1983 Edition, page 92.

considering the safety performance of the national school fleet, it may be several years before a sufficient quantity of data is accumulated." NHTSA said it would "continue to evaluate the effect of the compartmentalization concept as data are received."

In 1980, the NHTSA published a statistical evaluation of the effectiveness of the occupant restraint requirements (for small schoolbuses) and the seat back height and padded seat requirements (for all schoolbuses) of FMVSS 222.<sup>7/</sup> However, the analysis was based on inferences drawn from an examination of the injuries sustained in accidents involving schoolbuses built before the effective date of FMVSS 222. No analysis has been performed yet of the actual accident performance of buses designed to meet the post-1977 schoolbus protection standards (primarily FMVSS 220, 221, and 222).

The school districts of Ardsley and Greensburgh in New York State have required seatbelts in conventional schoolbuses for the 1983-84 school year. In statements made to the New York Legislative Commission on Critical Transportation Issues in December 1983, both school districts reported that the schoolbus "BuckleUp" rate for students in the elementary grades was about 90 percent, with a lower, but improving, percentage for senior high school students. There have been no crashes involving schoolbuses which are equipped with seatbelts for the passengers.

The facts of the January 10, 1984, accident indicate, and the Safety Board concludes, that the schoolbus involved in this accident performed as intended by, and in substantial compliance with, FMVSS 220, 221, and 222. The Safety Board will continue to investigate schoolbus accidents with special emphasis on accidents involving post-1977 schoolbuses to analyze and evaluate the effectiveness of these safety standards.

### CONCLUSIONS

#### Findings

1. The weather, the condition of the highway, and the preaccident condition of the tractor-semitrailer and the schoolbus were not factors in the accident.
2. Because thieves who stole the Oldsmobile damaged the steering wheel lock assembly, its front wheels were free to turn with no key in the ignition switch.
3. The front wheels of the Oldsmobile were not secured in the straight ahead position before the vehicle was towed immediately before the accident.
4. The right front corner of the Oldsmobile was at least 4 1/2 feet into the eastbound lane of S. R. 44 when it was struck by the tractor-semitrailer.
5. The tractor-semitrailer driver lost control of his vehicle after the collision with the Oldsmobile. The tractor-semitrailer then crossed over into the westbound lane and struck the schoolbus.
6. The qualifications and experience of the drivers of the tow truck, the tractor-semitrailer, and the schoolbus were not factors in this accident.
7. The health and physical condition of the schoolbus driver was not a factor in this accident.

<sup>7/</sup> "Statistical Evaluation of the Effectiveness of FMVSS 222: Schoolbus Seating and Crash Protection" (DOT HS-8-02014, October 1980).

8. The key to the Oldsmobile was removed from the ignition, and the position of the ignition switch indicated that the steering wheel was in a locked position.
9. The schoolbus met the requirements relating to rollover protection and joint strength of FMVSS 220 and 221.
10. Although the schoolbus generally met the requirements of FMVSS 222 relating to seating and crash protection requirements, the method used by the bus manufacturer to attach the seat cushions to the seat frame failed to ensure a positive attachment and permitted the seat cushions to come loose during the rollover.
11. In this accident, and for the size of the 5- and 6-year-old occupants, the combined crash performance requirements of FMVSS 220, 221, and 222 resulted in an improved crashworthy schoolbus body in that sufficient occupant space provided for occupant survival and a less hostile passenger environment reduced injury severity.
12. The protective structure surrounding the schoolbus fuel tank performed as intended and prevented a potentially catastrophic accident.
13. The partial separation of the schoolbus body from the chassis allowed some of the the crash energy to be absorbed by the chassis and not transferred to the schoolbus body.
14. The use of available seatbelts would not have prevented the fatal injuries sustained by the drivers of the tractor-semitrailer and the schoolbus because their survivable space was crushed
15. Installation and use of seatbelts by the schoolbus passengers would not have prevented the fatal head injuries sustained by the child sitting in the first seat behind the driver, or mitigated the serious injuries sustained by the child who was sitting in the same seat.
16. Installation and use of seatbelts by the schoolbus passengers might have changed the pattern of those minor injuries sustained by children occupying the bus away from the major impact area when the bus collided with the truck and rolled over. It is uncertain whether seatbelt use would have increased, reduced, or eliminated these minor injuries.
17. The only fire extinguisher, which was installed at the front of the bus, could not have been easily reached because of the deformation of the schoolbus body in the crash.

#### Probable Cause

The National Transportation Safety Board determines that the probable causes of the accident were (a) unsecured steering axle wheels of the vehicle being towed by the rear, (b) excursion of the towed vehicle over the highway centerline into the path of the oncoming tractor-semitrailer, (c) loss of directional control by the driver of the tractor-semitrailer, and (d) entry of the uncontrolled tractor-semitrailer into the opposing traffic lane where it struck the schoolbus.

RECOMMENDATIONS

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

—to the International Association of Chiefs of Police, Inc.:

Issue a notice to all association members advising them of the circumstances of the accident on January 10, 1984, in Rehoboth, Massachusetts, and the fact that the steering wheel lock which secured the steering axle wheels was disabled even though the ignition key was removed and the ignition switch indicated it was in a "locked" position. Suggest to your membership that towing companies performing towing services for each police department be contacted and advised of the circumstances of this accident. (Class II, Priority Action) (H-84-73)

—to the Town of Rehoboth, Massachusetts, School District:

Implement procedures to notify schoolbus drivers of operator's license and endorsement expiration dates, and followup on these notifications to ensure drivers' compliance with the licensing requirements of the Commonwealth of Massachusetts. (Class II, Priority Action) (H-84-74)

—to the National Highway Traffic Safety Administration:

For newly manufactured vehicles, revise Federal Motor Vehicle Safety Standard 222 to include a requirement that schoolbus seat cushions be installed with latching devices which ensure they remain in their latched position during impacts and rollovers. (Class II, Priority Action) (H-84-75)

—to the Wayne Corporation:

On newly manufactured vehicles, improve the method of fastening seat cushions to seat frames by installing latching devices which remain in the latched position during impacts and rollovers. (Class II, Priority Action) (H-84-76)

The National Transportation Safety Board reiterates part 5 of its 1983 recommendation to the National Highway Traffic Safety Administration:

Include in the "Program Manual" of Highway Safety Program Standard 17—Pupil Transportation Safety: 5. Requirements to place fire extinguishers at the front and rear of schoolbuses, post signs in schoolbuses on the location and use of emergency equipment, and brief passengers on the location and use of emergency equipment, both periodically and before beginning activity trips. (Class II, Priority Action) (H-83-45)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JIM BURNETT  
Chairman

/s/ PATRICIA A. GOLDMAN  
Vice Chairman

/s/ VERNON L. GROSE  
Member

G. H. Patrick Bursley, Member, did not participate.

September 5, 1984

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of this accident at 4 p.m., on January 10, 1984, by the news media.

Highway accident investigators were dispatched from the National Transportation Safety Board's Headquarters Office in Washington, D. C., and arrived onscene at 1 p.m., on January 11, 1984. Participating in the investigation were representatives of the Rehoboth, Massachusetts Police Department; the Town of Rehoboth Schools; the Massachusetts State Police; the Massachusetts Registry of Motor Vehicles; the Town and Country Transportation and Leasing Corporation of Warren, Rhode Island; the Wayne Corporation of Richmond, Indiana, the Massachusetts Motor Carrier Safety Office of the Federal Highway Administration; and the Office of the District Attorney, Bristol District, Massachusetts.

Deposition

No depositions were taken and no public hearing was held in conjunction with this investigation.

**APPENDIX B**

**RECOMMENDATIONS H-83-45 AND H-83-48**

**—the National Highway Traffic Safety Administration:**

Include in Highway Safety Program Standard (HSPS) 17--Pupil Transportation Safety and in the "Program Manual" for HSPS 17--Pupil the requirement that the States institute quality control procedures for schoolbus repairs to determine if needed repairs have been performed adequately or if major repairs are required. (Class II, Priority Action) (H-83-44)

Include in the "Program Manual" of Highway Safety Programs Standard 17--Pupil Transportation Safety:

1. Specific, well-defined qualifications for hiring schoolbus mechanics;
2. Specific skill areas for schoolbus mechanics for which certification of proficiency is required;
3. A bibliography of available courses which can be attended or course curricula which can be used as an example to obtain certification of proficiency in the required skill areas;
4. A requirement to institute and enforce procedures to prevent school activity groups from organizing, beginning, or continuing trips in mechanically unsafe vehicles; and
5. Requirements to place fire extinguishers at the front and rear of schoolbuses, post signs in schoolbuses on the location and use of emergency equipment, and brief passengers on the location and use of emergency equipment, both periodically and before beginning activity trips.

(Class II, Priority Action) (H-83-45)

**—all States and the District of Columbia:**

Place fire extinguishers at the front and rear of schoolbuses, post signs in schoolbuses on the location and use of emergency equipment, and brief passengers on the location and use of emergency equipment, both periodically and before beginning activity trips. (Class II, Priority Action) (H-83-48)