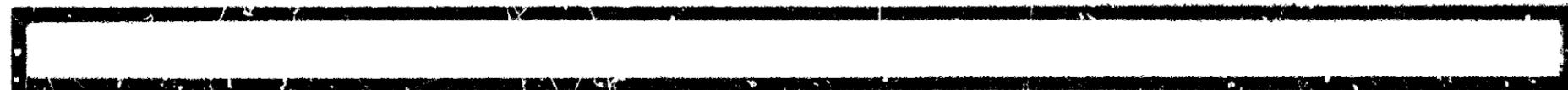
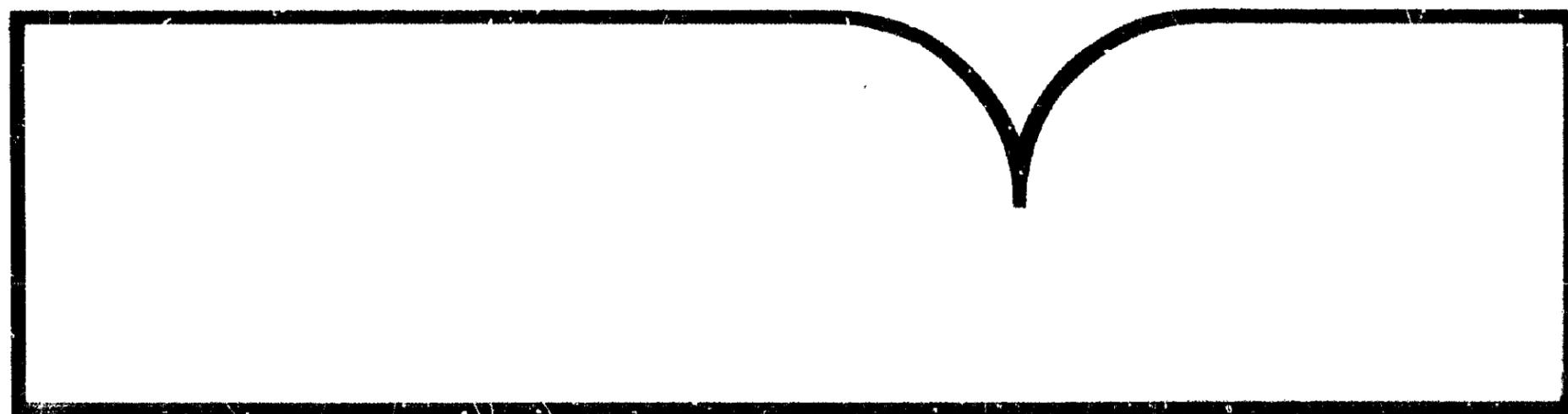


PB87-916203

Highway Accident Report - Schoolbus-Loss of  
Control and Collision with Guard Rail and Sign  
Pillar, U.S. Highway 70 near Lucas and Hunt Road  
St. Louis County, Missouri, November 11, 1985

(U.S.) National Transportation Safety Board  
Washington, DC

14 Apr 87



U.S. Department of Commerce  
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16. Abstract <p>About 2:43 p.m. central standard time on November 11, 1985, a schoolbus owned by R. W. Harmon and Sons, Inc. was eastbound on I-70 transporting 13 high school students to their homes in St. Louis, Missouri, from the Parkway North Senior High School. As the schoolbus was approaching the Lucas and Hunt Road exit it went out of control, swerved to the right, and the right front of the schoolbus struck a guard rail, a concrete pedestal, and a sign support pillar located adjacent to the right eastbound roadway. The schoolbus body and the steering axle separated from the chassis during the collision. The weather was cloudy and the pavement was dry. The schoolbus did not catch fire. Two students were killed; the schoolbus driver and one student sustained serious injuries, and the remaining 10 students sustained minor to moderate injuries.</p> <p>The National Transportation Safety Board determines that the probable cause of this accident was the operation of the schoolbus at an excessive speed and in a reckless manner by a driver under the influence of alcohol. Contributing to the severity of the accident was the use of a guard rail of insufficient height and stiffness to deflect the schoolbus body away from the concrete pedestal and sign support pillar.</p>					
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## EXECUTIVE SUMMARY

About 2:43 p.m. central standard time on November 11, 1985, a schoolbus owned by R. W. Harmon and Sons, Inc. was eastbound on I-70 transporting 13 high school students to their homes in St. Louis, Missouri, from the Parkway North Senior High School. As the schoolbus was approaching the Lucas and Hunt Road exit it went out of control, swerved to the right, and the right front of the schoolbus struck a guard rail, a concrete pedestal, and a sign support pillar located adjacent to the right eastbound roadway. The schoolbus body and the steering axle separated from the chassis during the collision. The weather was cloudy and the pavement was dry. The schoolbus did not catch fire. Two students were killed; the schoolbus driver and one student sustained serious injuries, and the remaining 10 students sustained minor to moderate injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the operation of the schoolbus at an excessive speed and in a reckless manner by a driver under the influence of alcohol. Contributing to the severity of the accident was the use of a guard rail of insufficient height and stiffness to deflect the schoolbus body away from the concrete pedestal and sign support pillar.

This report discusses several safety issues including the adequacy of several States' requirements concerning schoolbus driver applicant pre-employment screening; the availability of driving and criminal record histories of schoolbus driver applicants to prospective employers; the adequacy of the guard rail installed to protect vehicles from colliding with the concrete pedestal and the sign pillar; and the crashworthiness of the schoolbus.

The report concludes that several of the States and the District of Columbia should revise minimum requirements concerning schoolbus driver applicant pre-employment screening and should revise existing policies and procedures which restrict the availability of criminal histories of prospective schoolbus drivers. The report also concludes that there is more to be done by the Federal Highway Administration to encourage the State highway departments to systematically evaluate the performance of crash-damaged highway appurtenances, and to upgrade these appurtenances if necessary to meet current design standards. The report contains safety improvement recommendations addressing these issues.

**NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C. 20594**

**HIGHWAY ACCIDENT REPORT**

**Adopted: April 14, 1987**

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**SCHOOLBUS LOSS OF CONTROL AND COLLISION  
WITH GUARD RAIL AND SIGN PILLAR  
U.S. HIGHWAY 70 NEAR LUCAS AND HUNT ROAD  
ST. LOUIS COUNTY, MISSOURI  
NOVEMBER 11, 1985**

**INVESTIGATION**

**Schoolbus Driver Activities Before the Accident**

Officials for the schoolbus operator, R. W. Harmon and Sons, Inc., informed Safety Board investigators that the schoolbus driver was off duty the 2 days before the day of the accident and that they had no information concerning the schoolbus driver's off-duty activities. The schoolbus driver's attorney refused to permit investigators to question his client, and no other sources of information concerning the schoolbus driver's activities on the days immediately preceding the accident could be located.

According to his timecard at Harmon, on November 11, 1985, the driver reported for work at the Harmon schoolbus garage in St. Louis, Missouri, at 5:26 a.m. The driver was assigned and drove a morning schoolbus route. After the morning route was completed the driver was counseled by a Harmon supervisor concerning a complaint that he had been late for a student pick-up on the morning route. Harmon representatives indicated that a complaint of this nature was common and that the driver was simply made aware of the complaint in order to take any required corrective action. According to his timecard the driver left the Harmon garage at 8:34 a.m. and was off duty the rest of the morning of the accident.

The schoolbus driver and three other Harmon drivers were seen next by a Harmon supervisor getting out of the schoolbus driver's car near the Harmon facility in St. Louis about 12:50 p.m. on the afternoon of the accident. One of the other three drivers who was seen with the schoolbus driver in his car reported after the accident that he observed the schoolbus driver in a nearby bar and restaurant at about 12:30 p.m., and that while in the bar he did not see the schoolbus driver eat or drink anything. This driver also stated that the schoolbus driver had informed him about the morning counseling session and that the schoolbus driver was irritated about the incident.

The schoolbus driver arrived for work at 12:58 p.m. to stand by and be available to drive an afternoon schoolbus route. He was assigned to drive an afternoon route in Harmon schoolbus number A-522, and to transport students from the Parkway North Senior High School to their homes in St. Louis.

The other driver who had been observed getting out of the schoolbus driver's car, and who also saw the schoolbus driver in the bar and restaurant, as well as the schoolbus driver's irritation with the morning counseling session, was also assigned to transport students from the Parkway North Senior High School in Harmon schoolbus number A-309.

Between 1:45 p.m. and 2:00 p.m. a motorist traveling at least 60 mph westbound on I-70 near St. Louis, witnessed a schoolbus with the number A-522 displayed on the rear "pass him like he was standing still." The motorist noticed that the schoolbus was being driven erratically, was weaving in and out of traffic, and was cutting in front of other vehicles. He then saw another schoolbus pass him, but he lost sight of both schoolbuses in about 1/4 of a mile. He indicated that there were no passengers in either schoolbus at the time he saw them.

Another motorist stated that about 2:00 p.m., when he was traveling about 50 to 55 mph westbound on I-70 near the junction with I-170 in St. Louis, he was suddenly passed by two schoolbuses numbered A-522 and A-309. He estimated that both schoolbuses were traveling between 70 and 75 mph. Neither schoolbus had passengers aboard. The motorist reported he was so upset by the way the schoolbuses were being driven that he wrote their numbers down and intended to file a complaint.

A student at the Parkway Senior High School who was not an occupant of either schoolbus spoke with the schoolbus driver about 2:15 p.m. at the school, and detected a strong odor of alcohol on the schoolbus driver's breath. Several of the occupants of schoolbus A-522 stated they smelled alcohol on the schoolbus driver's breath, and that during the trip and before the accident, when one of the students asked if he had been drinking, the schoolbus driver responded, "Yeah, so what."

A motorist who was northbound on Fee Fee Road near the Parkway North Senior High School stated that as she approached the exit from the Parkway school parking lot onto Fee Fee Road, schoolbus A-309, followed closely by schoolbus A-522, pulled out from the parking lot in front of her onto Fee Fee Road, and that ". . . when bus 522 pulled out of the high school . . . he went around the corner rather fast because the children sitting . . . in the back two rows of the bus were almost thrown out of their seats." Some of the schoolbus occupants stated that they were thrown out of their seats.

The motorist who witnessed the schoolbus' exit from the school parking lot and most of the occupants of both schoolbuses stated that the schoolbuses then began to race. An occupant of schoolbus A-522 reported that when the schoolbus exited I-270 onto eastbound I-70 the students on the right side of the schoolbus were thrown to the left side. It was also reported that at one point during the trip before the accident, schoolbus A-522 pulled off onto the highway shoulder and waited for schoolbus A-309 to catch up. After schoolbus A-309 caught up, it pulled off onto the shoulder in front of A-522, and the driver of schoolbus A-309 came back and conversed briefly with the A-522 schoolbus driver. The substance of this conversation was not determined.

After this brief roadside conversation, schoolbus A-309 resumed the trip ahead of A-522 which reportedly had difficulty in getting its engine re-started. The occupants of A-522 reported that after the engine was re-started the schoolbus re-entered the traffic stream and the driver began to race to catch up to A-309. The schoolbus was travelling faster than the traffic around it and at a speed which some occupants estimated to be as high as 75 mph. The occupants also reported that the schoolbus driver was weaving across several of the traffic lanes.

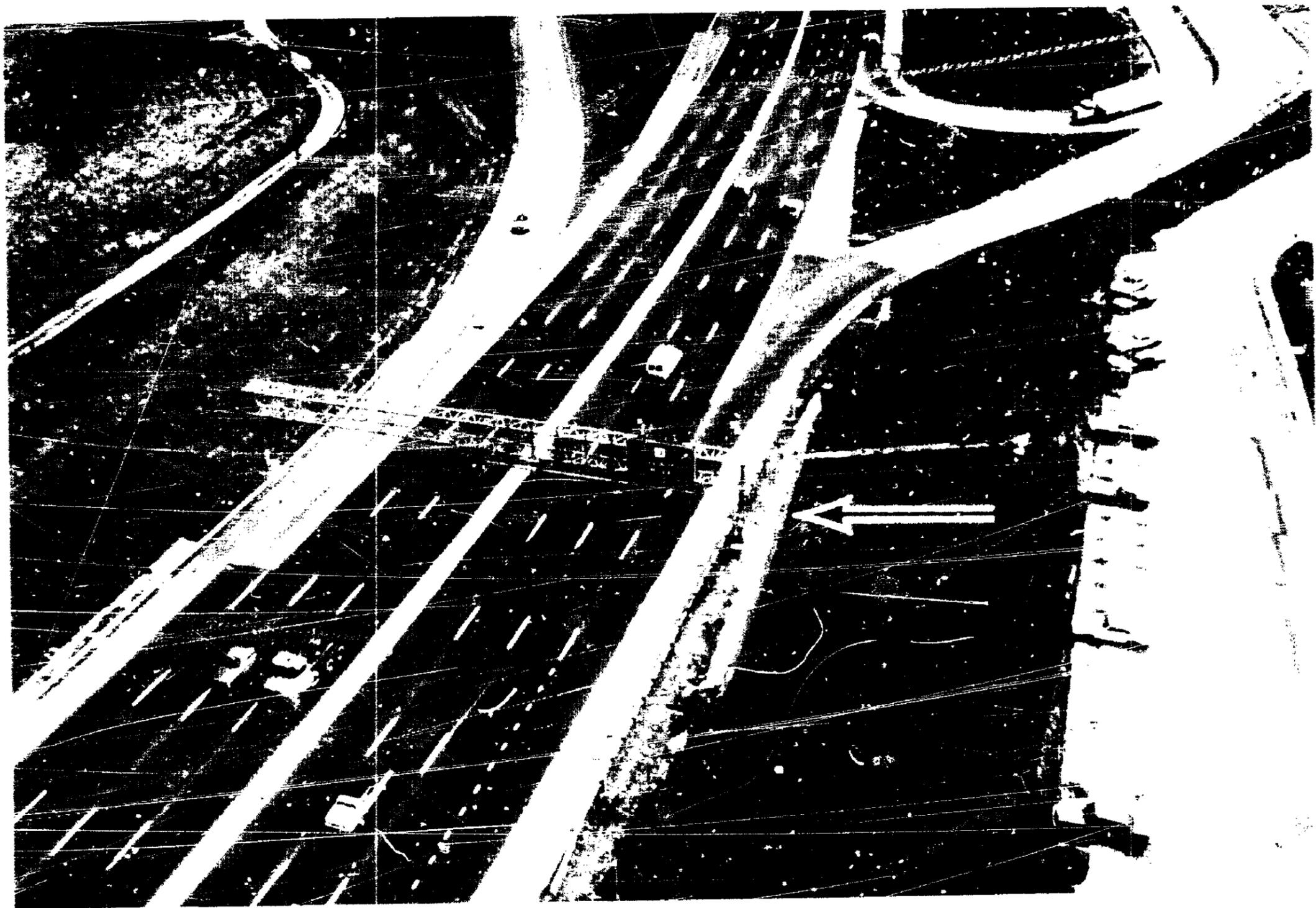


Figure 1.—Aerial view of Lucas and Hunt Road interchange with I-70. (Arrow indicates accident site.)

Schoolbus A-522 caught up with and then passed schoolbus A-309 on the left side and continued eastbound on I-70 at a high rate of speed. Several of the passengers in both buses were frightened and began pleading with the drivers to slow down.

At about 2:43 p.m., as schoolbus A-522 was approaching the Lucas and Hunt Road exit from eastbound I-70 (see figure 1), several of the occupants reported that the schoolbus was running alongside a green Volkswagen which was to the left of the schoolbus. Nine of the surviving occupants stated that at this point the schoolbus driver yelled out ". . . do you want me to hit him [or it]?" or ". . . do you want me to run him off the road?" At least one, and possibly several, of the schoolbus occupants screamed "Yes" and others screamed "No."

### The Accident

The schoolbus occupants reported that the schoolbus first swerved left toward the green Volkswagen, then swerved to the right. The schoolbus then went out of control, crossed over at least two of the three eastbound I-70 traffic lanes, the Lucas and Hunt Road exit lane and the eastbound shoulder, and the right front initially collided with a guard rail. After this initial collision, the schoolbus continued eastbound in contact with the guard rail and collided with a concrete pedestal and a sign pillar supporting the overhead sign marking the Lucas and Hunt Road exit from eastbound I-70.

The schoolbus body and the steering axle separated from the chassis during the collision. The schoolbus body rotated almost 90° clockwise around the sign pillar and came to rest blocking the right eastbound shoulder and the Lucas and Hunt Road exit lane next to the sign pillar. The right front of the chassis overrode the guard rail and came to rest east of the sign support pillar blocking the right eastbound shoulder and part of the exit lane to Lucas and Hunt Road. The steering axle came to rest east of the chassis on the eastbound shoulder. (See figures 2 and 3.) The weather was cloudy and the pavement was dry. The schoolbus did not catch fire.

One of the schoolbus passengers who reported that he was seated in the fourth seat on the left (driver's) side of the schoolbus before the collision, stated that he did not remember anything that happened from the time the schoolbus hit the pole until he "woke up," and that when he did, he was lying outside the schoolbus on a schoolbus "seat" (probably a seat cushion) which was bent over the guardrail. It could not be determined if this, or any of the other passengers were actually ejected from the front of the schoolbus body during the collision, or were carried out by other schoolbus occupants or rescuers.

One student sustained critical injuries and was pronounced dead at 3:12 p.m. on the day of the accident. Another student sustained critical injuries, remained comatose after the accident, and died on November 18, 1985. The schoolbus driver and one student sustained serious injuries, and the remaining students sustained minor to moderate injuries.

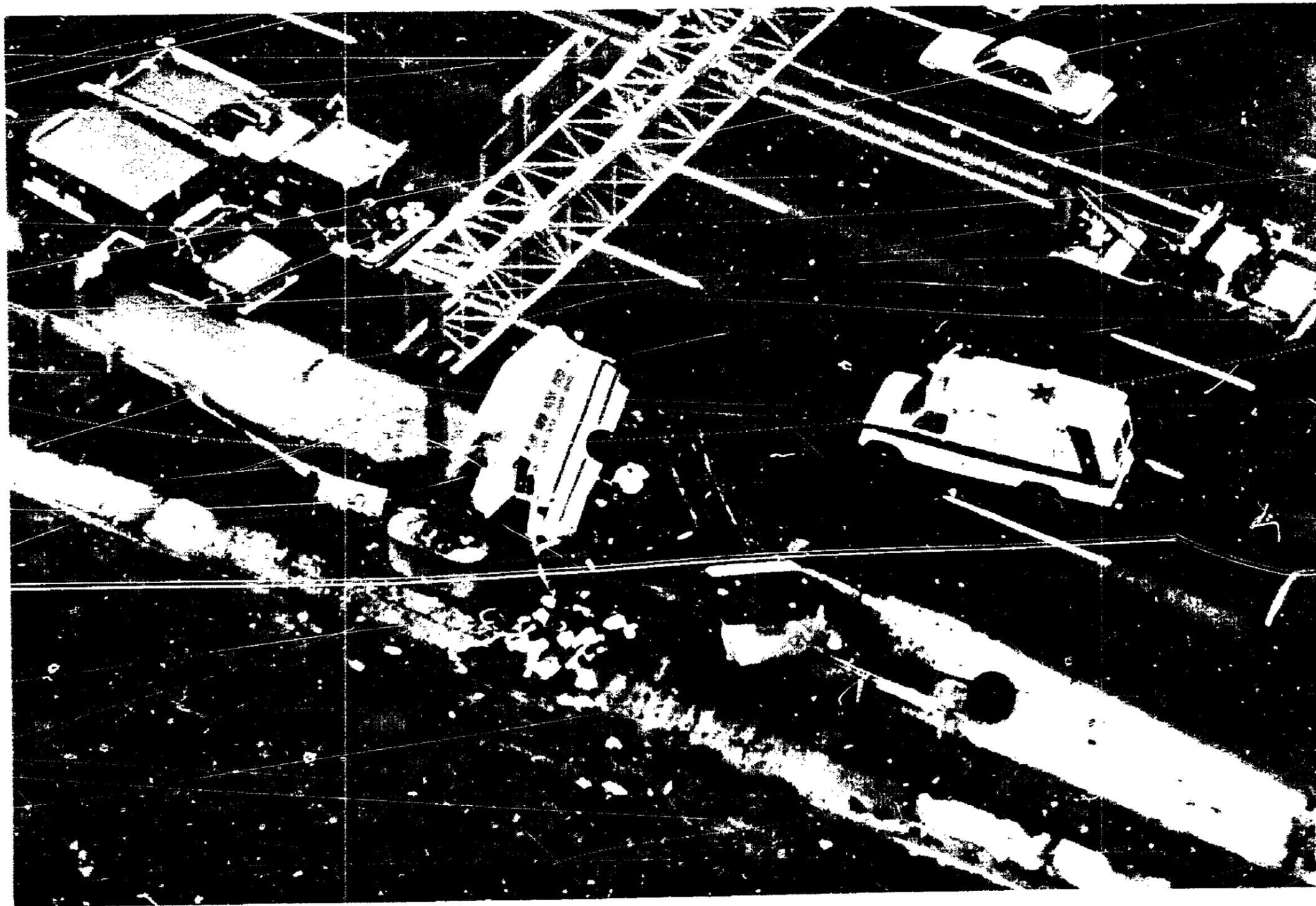


Figure 2.—Aerial view of accident site.



Figure 3.--Opening at front of schoolbus body.

**Injuries**

	<u>Driver</u>	<u>Passengers</u>	<u>Totals</u>
<u>Fatally Injured</u>			
Critical (AIS-5)	0	2	2
Subtotal	0	2	2
<u>Nonfatally Injured</u>			
Serious (AIS-3)	1	1	2
Moderate (AIS-2)	0	2	2
Minor (AIS-1)	0	8	8
Uninjured (AIS-0)	0	0	0
Subtotal	0	11	11
Total	1	13	14

Note: "AIS" refers to the Abbreviated Injury Scale of the American Association for Automotive Medicine. Historically the Safety Board has used the International Civil Aviation Organization (ICAO) criteria to classify severity of personal injury in transportation accidents. Based on the ICAO criteria, two schoolbus passengers sustained fatal injuries, the schoolbus driver and two schoolbus passengers sustained serious injuries, and the remaining nine schoolbus passengers sustained minor injuries.

**Emergency Response**

The North County Emergency Communications Center (NCECC) in St. Louis County received a telephone call from a citizen at 2:43 p.m. advising them of the accident. At 2:44 p.m. the NCECC dispatcher notified emergency response units. The Normandy Fire Protection District, the Community Fire Protection District, St. Louis County, the Berkley Fire Department, and the Normandy Osteopathic Hospital all dispatched emergency response vehicles to the accident site, including two truck pumpers, two emergency medical care units, and two ambulances. All these units arrived between 2:47 and 3:00 p.m.

One of the ambulance crewmembers reported that a person who appeared to be a nurse had set up a triage area on the slope behind the guard rail and was administering first aid to the schoolbus passengers who were out of the schoolbus. The schoolbus driver and several other passengers were extricated from the wreckage by emergency response personnel.

All of the injured were transported from the scene to area hospitals by 3:21 p.m. The schoolbus driver and six passengers were taken to Normandy Osteopathic Hospital, which was 1.8 miles from the accident site. Seven schoolbus passengers were transported to DePaul Health Center, which was 8 miles from the accident site.

**Schoolbus Driver Information**

Employment History.—The 26-year-old schoolbus driver had been employed by Harmon since August 1985 as a "stand-by" driver. He was assigned as a replacement or substitute driver on different routes daily when the regular drivers were not available. The driver completed an application for employment at Harmon's facility in St. Louis on July 26, 1985. The employment application included the question "Have you ever been convicted of a crime other than nonmoving traffic violations?" The driver answered "no" to this question.

According to his employment application filed with Harmon, the schoolbus driver had not been previously employed as a professional driver, but had been employed as a stock clerk, a laborer, a clerk in a fast food restaurant, and a food preparer in a hospital in the St. Louis area. He had been laid off from all of his previous jobs. Two of his previous employers indicated to Safety Board investigators that the schoolbus driver had been a good employee, but was laid off because there was no more work for him.

Medical Information.—The schoolbus driver's medical records indicate that he was healthy with no known chronic or acute illnesses or ailments. On August 8, 1985, in compliance with a Missouri State schoolbus driver applicant requirement, the schoolbus driver was examined by a physician who certified that the driver was in good health, free of contagious disease, and physically capable of driving a schoolbus.

Training.—The schoolbus driver received about 38 hours of training from Harmon between August 1 and August 21, 1985. Training included classroom instruction and "hands on" experience on schoolbus operations, company policies, pre- and posttrip inspections, use of safety equipment, emergency evacuation, first aid, handling maneuvers, and a defensive driving program. The driver successfully completed the initial training curriculum and was hired as a "stand-by" driver by Harmon.

From September 11 to October 22, 1985, Harmon gave the schoolbus driver five routine "Road Observation and Check Ride Reports." The reports indicated that the schoolbus driver performed satisfactorily with only following distance and turn signal use problems noted on the October 22 report.

Licensing Information.—The schoolbus driver possessed a valid Missouri automobile operator's license when he was employed by Harmon, and in August 1985 he was issued a Missouri chauffeur's license, which was the type of license the State required to operate a schoolbus.

Driving Record.—From January 8, 1980, to the date of the accident, the schoolbus driver had five convictions on his Missouri driving record, including three for speeding, one for improper lane use, and one for the operation of a motorcycle without a proper license. The most recent violation occurred on June 7, 1984.

Criminal Record.—Information obtained from the St. Louis County Police Department revealed that on February 12, 1980, the schoolbus driver was arrested by the St. Louis Metropolitan Police and charged with unlawful possession of a concealed firearm. On September 30, 1980, the driver entered a plea of guilty to a charge of unlawful use of a weapon and conspiracy. The court suspended imposition of sentence and the driver was placed on 6 months probation for this offense.

On December 13, 1982, the schoolbus driver was arrested by the Ferguson, Missouri, Police Department. He entered a guilty plea to a charge of felony theft on April 6, 1983. The court suspended imposition of sentence, and the driver was placed on 3 years probation. This probation was still in effect at the time of the accident.

Activities After the Accident.—The driver of schoolbus A-522 reported to accident investigators for the St. Louis County Police Department that he was driving 50 mph when a passenger in the back of the schoolbus threw something which struck the front window. He then turned to see what it was and told the passengers to sit down. When he turned back, a car was in front of him and in an attempt to avoid a collision he lost control of the schoolbus. Two passengers on the schoolbus reported that nothing was thrown either at the schoolbus driver or the front window before the schoolbus went out of control.

The driver of schoolbus A-309 reported that he saw a car cut in front of schoolbus A-522 just before the accident and that he witnessed the collision. However, several of the students on schoolbus A-309 stated that they arrived at the accident scene minutes after the collision had occurred and that they did not witness the collision. Several of the students on schoolbus A-309 reported they smelled alcohol on their driver's breath.

On December 4, 1986, the driver of schoolbus A-522 was found guilty of two counts of involuntary manslaughter and one count of second-degree assault, and was sentenced to serve 20 years in prison for these three offenses.

#### Vehicle Information and Damage

The 35-passenger schoolbus was a 1979 International Harvester Company chassis and a 1980 Ward Industries, Inc., body. The schoolbus chassis and body were assembled in June 1980. The two-axle schoolbus was equipped with an eight-cylinder gasoline engine, a 4-speed manual transmission, power-assisted hydraulic drum brakes on all wheels, and power steering. The rear axle was equipped with dual tires on each wheel. The odometer registered 77,537.5 miles. The vehicle was not equipped with a speed-governing device.

A certificate mounted on the interior forward wall above the windshield near the driver's position indicated that the vehicle complied with all applicable Federal Motor Vehicle Safety Standards in effect in October 1979.

Before the accident, the schoolbus body was attached to the chassis by J-shaped bars bolted to the schoolbus body floor and hooked to the longitudinal frame members at the front and by tie-down clips bolted at 27-inch intervals to the underside of the schoolbus floor and the upper flange of each longitudinal frame member. Based upon measurements taken of a similar schoolbus, the bottom of the body aft of the stepwell on the right side was 2 feet above ground level. The collision completely separated the chassis from the schoolbus body.

There was no contact damage to the left front of the schoolbus chassis. The right side of the front bumper was bent back parallel to the right longitudinal frame rail and the right side of the fiberglass hood was torn away.

The fuel tank, which was mounted outboard of the right longitudinal frame member between the steering and drive axles, was enclosed by a tubular steel structure attached to the right frame member. After the collision the outboard forward corners of both the fuel tank and the tubular steel structure were abraded and the top outboard edge of the fuel tank was crushed inboard about 3 inches. The fuel tank's fill pipe, which was located on the forward outboard corner of the tank, was bent aft.

Although the fuel tank cap was missing, there was no fuel spillage reported as a result of the collision. (See figure 4.) Part of the missing fuel cap was later found in the debris behind the guard rail at the crash site.

The steering axle assembly was torn from its attachments to the front suspension and came to rest east of the rest of the chassis in the eastbound shoulder next to the guard rail. The output shaft connecting the pitman arm to the steering gear box was fractured and the pitman arm remained attached to its connection to the drag link of the steering axle assembly. (See figure 5.)

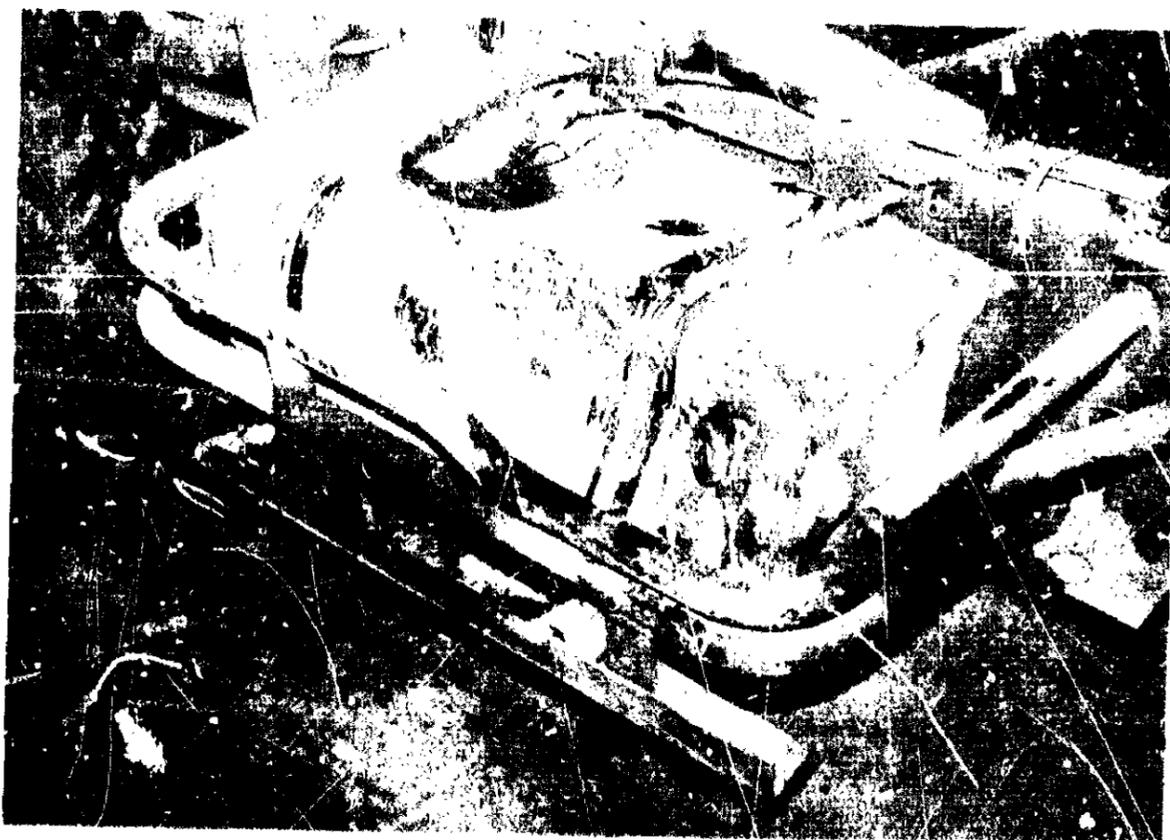


Figure 4.--Schoolbus fuel tank.

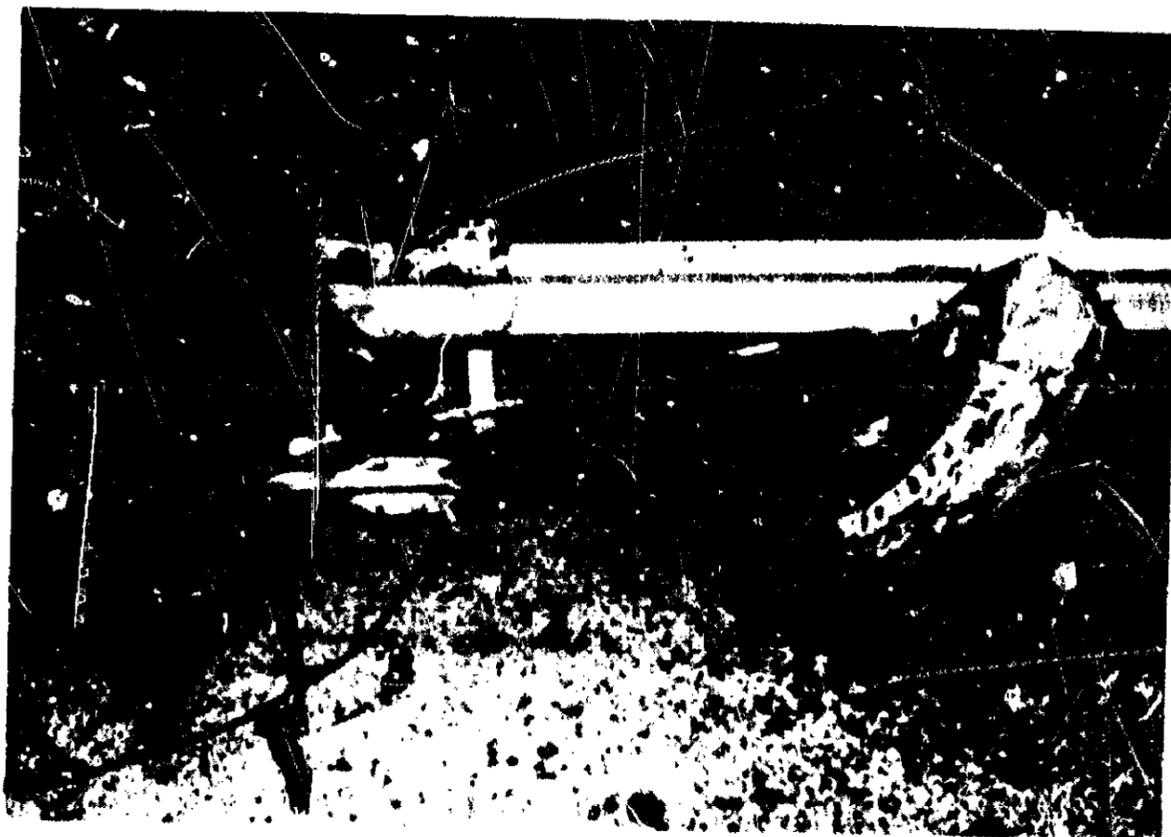


Figure 5.—Schoolbus steering axle.  
Fractured output shaft in pitman arm is in left foreground.

There was extensive contact damage to the front of the schoolbus body. Both front support pillars of the body were separated at their point of attachment to the roof and the roof was displaced downward and to the driver's right. The first two support pillars separating the windows on the right side separated from their attachments to the schoolbus body at the bottom of the window wells. A 24-inch wide semi-circular indentation started at the right front of the roof and extended back obliquely 8.6 feet toward the center of the schoolbus body. This indentation was at a 54° angle to horizontal level and penetrated downward to a distance of 24 inches above the floor at the right front of the schoolbus body.

The schoolbus was equipped with a rear emergency door which was operable after the collision. It was reported that ambulatory occupants of the schoolbus did not use this door to exit the schoolbus after the collision, but rather exited through the opening created by the collision in the front of the schoolbus body.

The driver's seat, which was intact after the accident, was equipped with a lap belt. An additional lap belt was found wrapped around the rear seat leg of the first seat on the right side. Harmon officials speculated that at one time the schoolbus may have regularly transported a handicapped student who was secured in the bus by this lap belt. The remainder of the passengers' seats were not equipped with lap belts, nor were they required to be by Federal standards.

The schoolbus was equipped with padded restraining barriers on each side in front of the first row of seats and six rows of padded bench-type seats on each side of the center aisle. The restraining barrier on the right side was torn from its attachments to the floor and was entangled with the first bench seat on the right side. The seatback of the second seat on the right side was crushed downward and folded forward flush against the seat frame, and the cushion for this seat was missing. The seatbacks of the third, fourth, and fifth seats on the right side were displaced forward between 5 and 10 inches. The sixth row seat on the right side was undamaged.

The restraining barrier on the left side was displaced 23 inches forward and downward toward the driver's position. The first seat on the left side was rotated about 30° clockwise and the seatback was crushed under the roof. The seatbacks in the second, third, and fourth seat rows on the left side were all displaced forward between 3 and 9 inches. The seatbacks of the fifth and sixth seat on the left side were not damaged.

There was a deposit of blood and hair on the interior roof panel above the third seat on the right side of the schoolbus. A joint in the schoolbus floor was separated laterally for about 20 inches between the second and third seat rows, and a seat cushion was found partially protruding through this opening in the schoolbus floor. Three other seat cushions were found detached from their seat frames.

Before the accident, a 6-foot 10-inch long interior maintenance access panel housing a wiring harness and installed below the windows at the right side of the schoolbus was attached to the interior sidewall by three sheet metal screws about 1/8 inch in diameter and 27 inches apart. (See figure 6.)

After the accident this maintenance access panel was found separated from the schoolbus body, and the joint joining the bottom of the window wells to the interior sidewall below the windows which had been covered by the maintenance access panel was exposed. There was a quantity of blood splatter, hair, and tissue on this joint between the third and fourth seat rows on the right side of the schoolbus. (See figure 7.)



Figure 6.--Preaccident installation of maintenance access panel below side window.

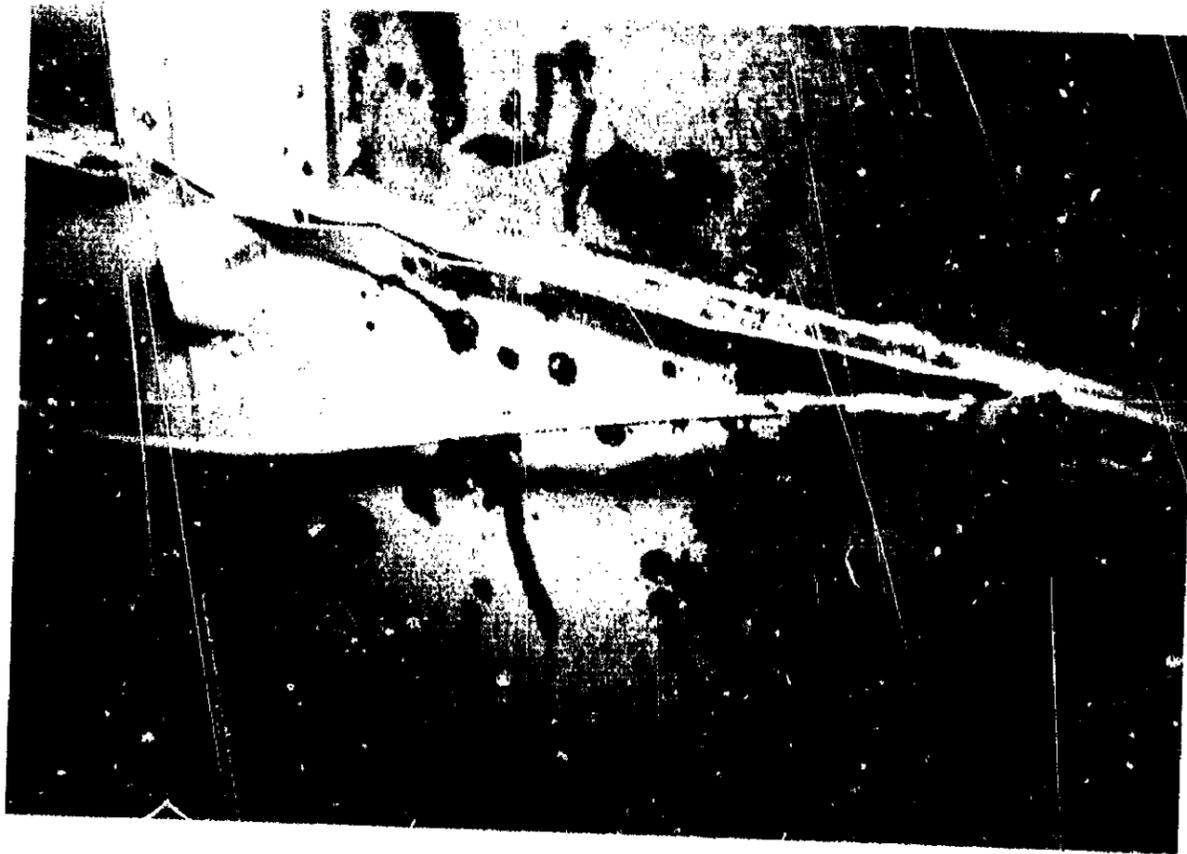


Figure 7.--Blood, hair, and tissue found on body panel joint exposed when maintenance access panel separated.

Another driver who drove schoolbus A-522 the morning of the accident reported that he did a complete inspection of the bus and found no mechanical defects before he drove it, and the vehicle handled properly when he drove the bus.

#### Highway Information

Interstate 70 is a 6-lane, urban freeway which traverses St. Louis, Missouri, and some of its suburbs, in generally an east-west direction. The highway was originally built as U.S. Route 40 and later was included as part of the interstate system designated as I-70. The initial construction was completed in 1958, and the eastbound lanes at the accident site were resurfaced in 1984.

In the eastbound direction at the accident site there are three 12-foot wide through lanes, a 12-foot wide deceleration lane for the Lucas and Hunt Road exit, and a 10-foot wide outside shoulder. The speed limit for vehicles in the through lanes is 55 mph. The deceleration lane for the Lucas and Hunt Road exit is marked with a sign advising an exit speed of 25 mph.

At the accident site the asphalt roadway has a 3.6 percent downgrade with a 3,819-foot radius curve to the left for eastbound vehicles, and the superelevation is a minus 2 percent from the inside to the outside highway lanes.

At the outside edge of the shoulder a 153-foot long section of 27-inch high steel W-beam guard rail was installed to protect an 8-foot long concrete pedestal and a 24-inch diameter steel sign pillar. The guard rail was supported by steel posts about 6.25 feet apart. The center of the pillar was located 110 feet east of the west end of the guard rail. The pillar provided the outside support for an overhead sign marking the Lucas and Hunt Road exit. The inside face of the guard rail was 2 feet from the side of the concrete pedestal closest to the roadway shoulder. (See figures 8 and 9.)

The first highway evidence attributed to the accident was a pair of 186-foot long parallel curved striated tire marks which began about 55 feet west of the west end of the guard rail and about 1 foot left of the pavement marking separating the center and the right through highway lanes. These marks curved to the right, crossed the outside through lane, and ended about 2 feet left of the center of the exit lane to the Lucas and Hunt Road exit. (See figure 10.)

After a gap of about 21 feet from the east end of the striated tire marks there were two sets of parallel straight tire marks. One set of marks, which were about 19 feet long, began in the center of the roadway shoulder about 48 feet west of the sign pillar and ended at the guard rail about 27 feet west of the sign pillar. The other set of marks, which were in line with the east end of the striated parallel tire marks, started at the edgeline separating the Lucas and Hunt Road exit lane from the shoulder and about 33 feet west of the pillar and ended in the center of the shoulder next to the pillar. All of the straight tire marks approached the guard rail at a 12°-angle.

Based upon measurements and photographs taken of the damaged guard rail at the accident site by the St. Louis County Police Department, the first contact damage to the guard rail started about 27 feet west of the pillar. Continuing eastward, the amount of deflection of the guard rail increased until at a point about 12 feet west of the pillar the guard rail was deflected about 4 feet, 2 feet past the north face of the concrete pedestal.

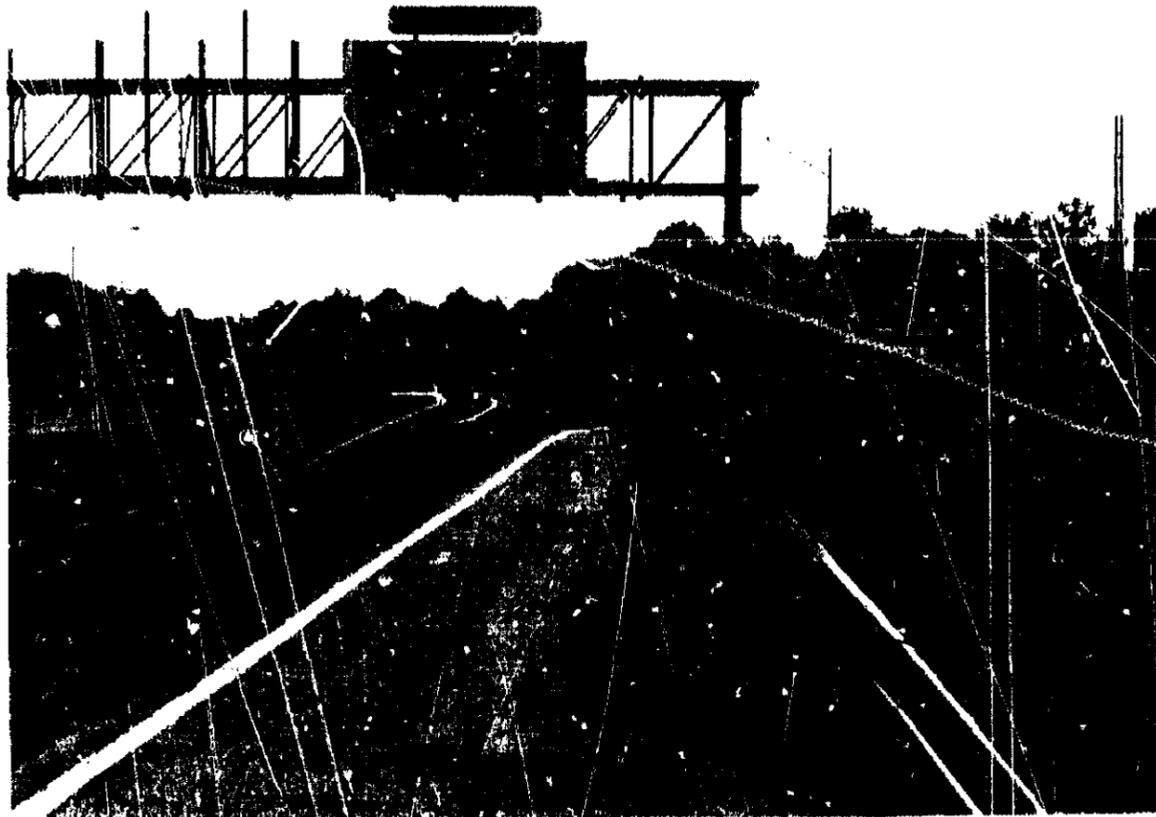


Figure 8.—Guard rail and sign support pillar looking east.

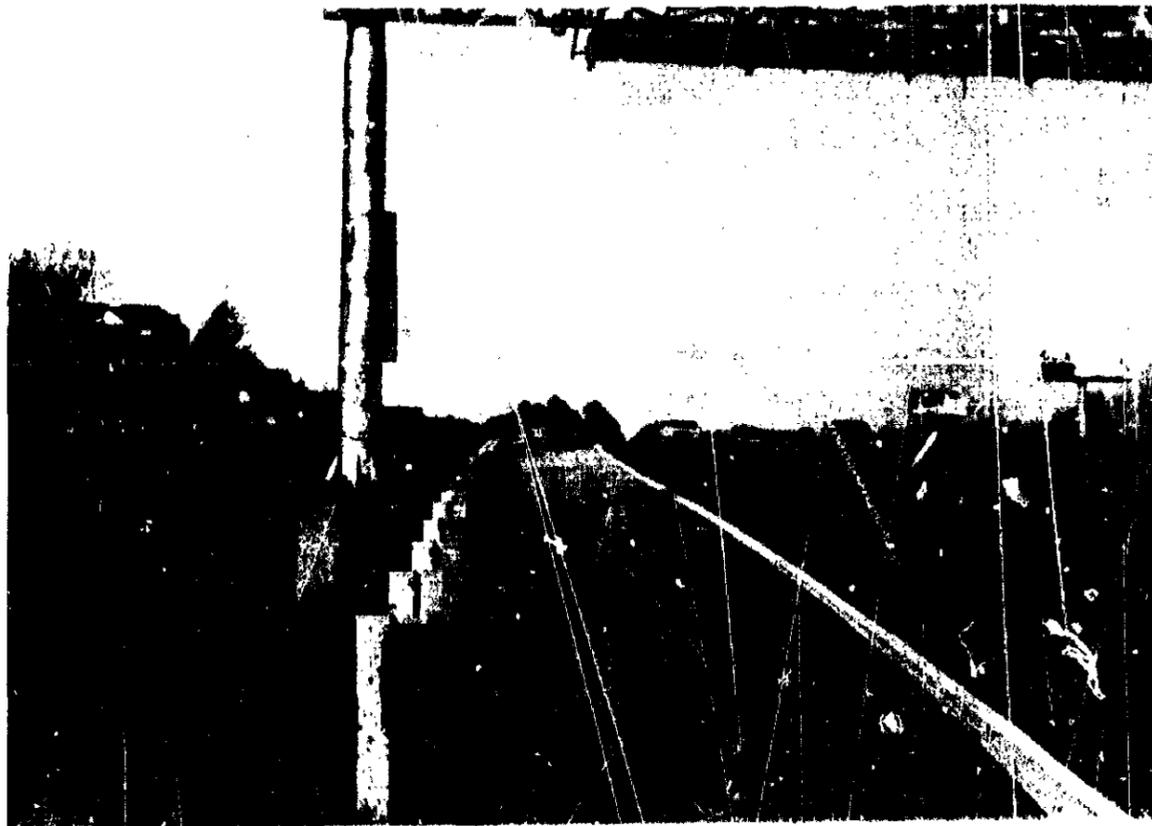


Figure 9.— Guard rail and sign support pillar looking west.

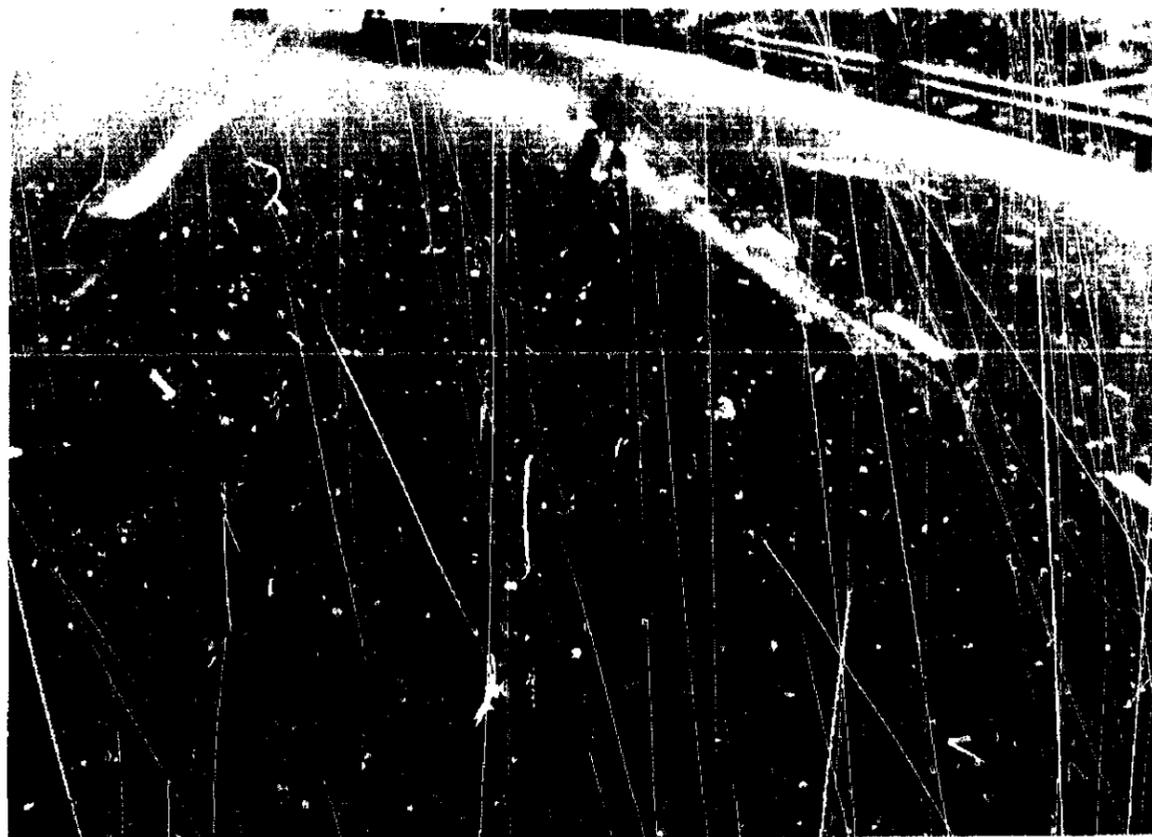


Figure 10.--Curved, striated tire marks leading to guard rail.

The amount of guard rail deflection then decreased as it approached the pedestal, and the guard rail adjacent to the pedestal was deflected flush against it. (See figure 11.) Scratches and yellow paint transfers were noted on the sign support pillar at a height of 10 1/4 feet above the surface of the pavement shoulder.

At the time the highway was designed, there were no interstate standards, and the State of Missouri did not have a "clear" or "safety zone" construction policy, as it now does, requiring a clear space off the highway shoulder free of obstacles or obstructions allowing for the safe recovery of an errant vehicle. The concrete pedestal was 2 feet from the shoulder of the highway.

A representative of the Missouri Highway and Transportation Department (MHTD) testified during a deposition taken by Safety Board investigators that at the time the guard rail was installed the existing design standard provided for this 2-foot distance between a guard rail and the object it was installed to protect. Although this standard was revised in January 1982 and presently provides for a distance of 4 feet, after the accident the damaged sections of the guard rail were replaced and the guard rail was reinstalled in its preaccident configuration.

The MHTD representative also testified that he was aware the results of two tests of a similar guard rail, one using a 4,960-pound passenger auto which struck the guard rail at a 25° angle while traveling at 66 mph, and another using a 3,813-pound passenger auto which struck the guard rail at a 28° angle at 56.8 mph. The tests resulted in dynamic deflections of the test guard rails of 2.6 and 4.05 feet, respectively. 1/

1/ For more detailed information, read "Guide for Selecting, Locating, and Designing Traffic Barriers," The American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street N.W., Washington, D.C. 20001, 1977.

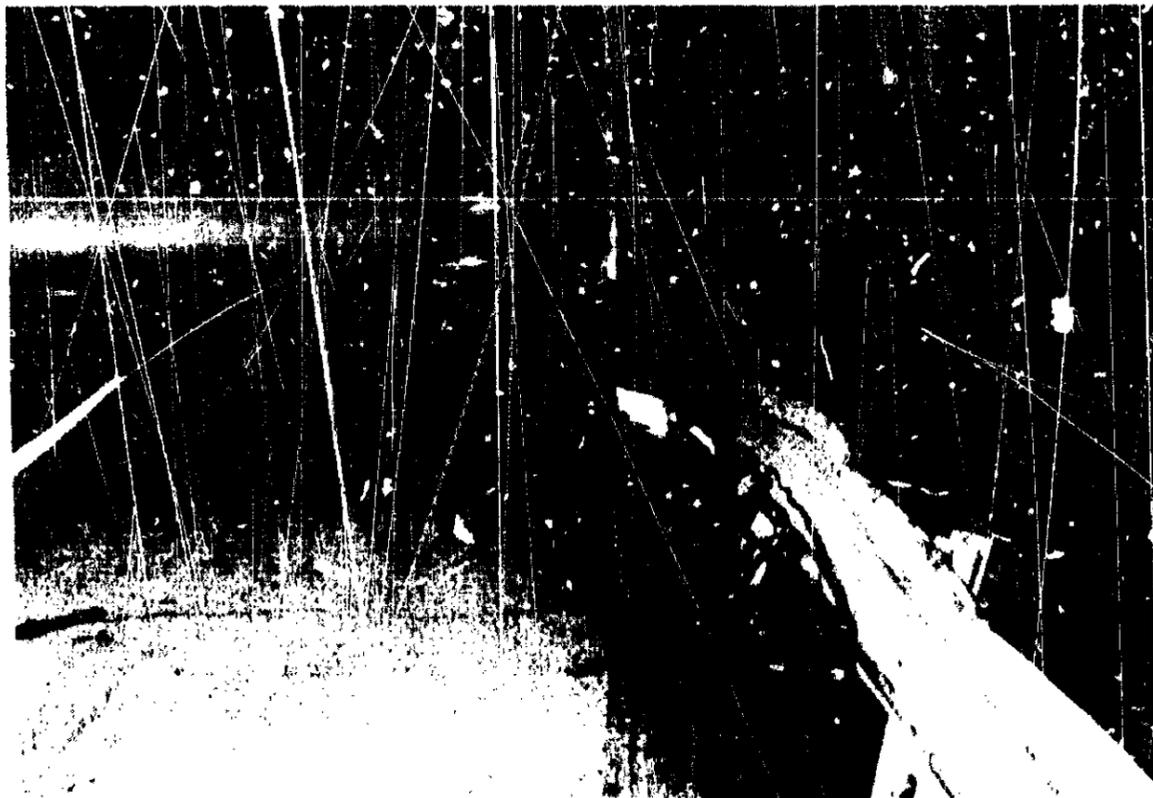


Figure 11.--Outboard deflection of guard rail.

#### Medical and Pathological Information

After the accident, the schoolbus driver stated to an investigator for the St. Louis County Police Department that he had consumed one beer at 10:00 a.m. and one over-the-counter cold capsule at 10:30 a.m. the day of the accident. When he was admitted to the hospital for treatment of his injuries, the schoolbus driver admitted to the interviewing physician that he had consumed "two beers" on the day of the accident. The physician stated in his report that while he was examining the schoolbus driver "ethanolic odor was detected to the examiner."

A blood sample obtained by the hospital from the schoolbus driver at about 3:35 p.m. about 3/4 of an hour after the accident disclosed that the schoolbus driver's blood contained 189 milligrams (mg.) of ethanol (alcohol) per deciliter. A urine sample obtained by the hospital from the schoolbus driver at about 6:15 p.m. the day of the accident tested positive for nicotine, ethanol, and cannabinoids (marijuana).

Safety Board investigators obtained a sample of blood drawn from the schoolbus driver by the hospital at about 3:35 p.m. the day of the accident, and obtained the remainder of the urine sample obtained by the hospital at 6:15 p.m. These samples were forwarded to an independent laboratory for testing. The alcohol concentration of the blood sample was 0.14 percent weight to volume (w/v). The blood also contained 4 nanograms per milliliter (ng/ml) of carboxylic acid metabolite of delta 9-tetrahydrocannabinol (THC) (marijuana). The urine alcohol concentration was 0.17 percent w/v, the THC concentration in the urine was 14 ng/ml, and the urine also contained 130 ng/ml of phencyclidine (PCP).

The schoolbus driver refused to supply toxicological samples to the St. Louis County Police Department for chemical testing even though Missouri has an "implied consent" statute. A search warrant was issued, and blood was drawn at 6:43 p.m., 4 hours after the accident. The blood alcohol concentration of this sample was found to be 0.09 percent w/v. Urine was obtained at 7:11 p.m. The urine was found to contain 106 ng/ml of PCP. A test for the presence of cannabinoids in the urine was negative.

A blood alcohol level of 0.10 percent or above is accepted by the State of Missouri as prima facie evidence that the person was intoxicated at the time the specimen was taken. The toxicological samples obtained by the Safety Board and the St. Louis County Police Department were tested using gas chromatographic methods. The toxicological samples obtained and tested by the admitting hospital were tested using enzymatic methods.

One of the schoolbus occupants who died was reported to have been sitting in the second seat on the right side on the aisle. A postmortem examination disclosed that the cause of death was a diffuse brain injury. The other occupant who died, who was sitting in the fifth row on the left side next to the window before the collision, was found in the front of the schoolbus after the collision. A postmortem examination of this student disclosed that the cause of death was head injuries, including basilar skull fractures and cerebral edema.

The schoolbus driver, who reported that he was secured in the driver's seat by his lap belt, sustained serious injuries including a concussion, a fracture of the left ulna, and facial lacerations. The surviving schoolbus passengers sustained minor to serious injuries including fractures, concussions, lacerations, contusions, abrasions, and cervical and lumbar strains. (See figure 12.)

#### Missouri Schoolbus Driver Requirements

At the time of the accident the State of Missouri required that any person driving a schoolbus:

Shall be duly licensed in accordance with Missouri Statutes;

Shall be in good physical and mental health, free from communicable disease, and have normal use of both arms, hands, legs, and feet;

Shall have visual acuity of at least 20/20 in one eye with 20/40 vision in the other eye, or 20/30 vision in both eyes, with correction if necessary;

Shall be able to distinguish the colors of red, green, and yellow;

Shall have hearing adequate to hear ordinary conversation;

Shall undergo a physical examination annually by a licensed physician designated by the local board of education and present a signed physical examination certificate to the employer; and

Shall be neat and clean; abstain from the use of tobacco in the bus; refrain from driving under the influence of intoxicants, narcotics, or drugs; and conduct himself or herself in a manner that will influence the students positively.

LEGEND

AIS\* SEVERITY CODE

- AIS-0 NO INJURY
- AIS-1 MINOR
- AIS-2 MODERATE
- AIS-3 SERIOUS
- AIS-4 SEVERE
- AIS-5 CRITICAL
- AIS-6 MAXIMUM INJURY;  
VIRTUALLY UNSURVIVABLE

M-10; AIS-X  
 ↑     ↑     ↑  
 SEX   AGE   SEVERITY

\*AMERICAN ASSOCIATION FOR  
 AUTOMOTIVE MEDICINE:  
 ABBREVIATED INJURY SCALE

AIS CODE DETERMINED BY MAXIMUM INJURY

- - FATALLY INJURED
- - SURVIVED

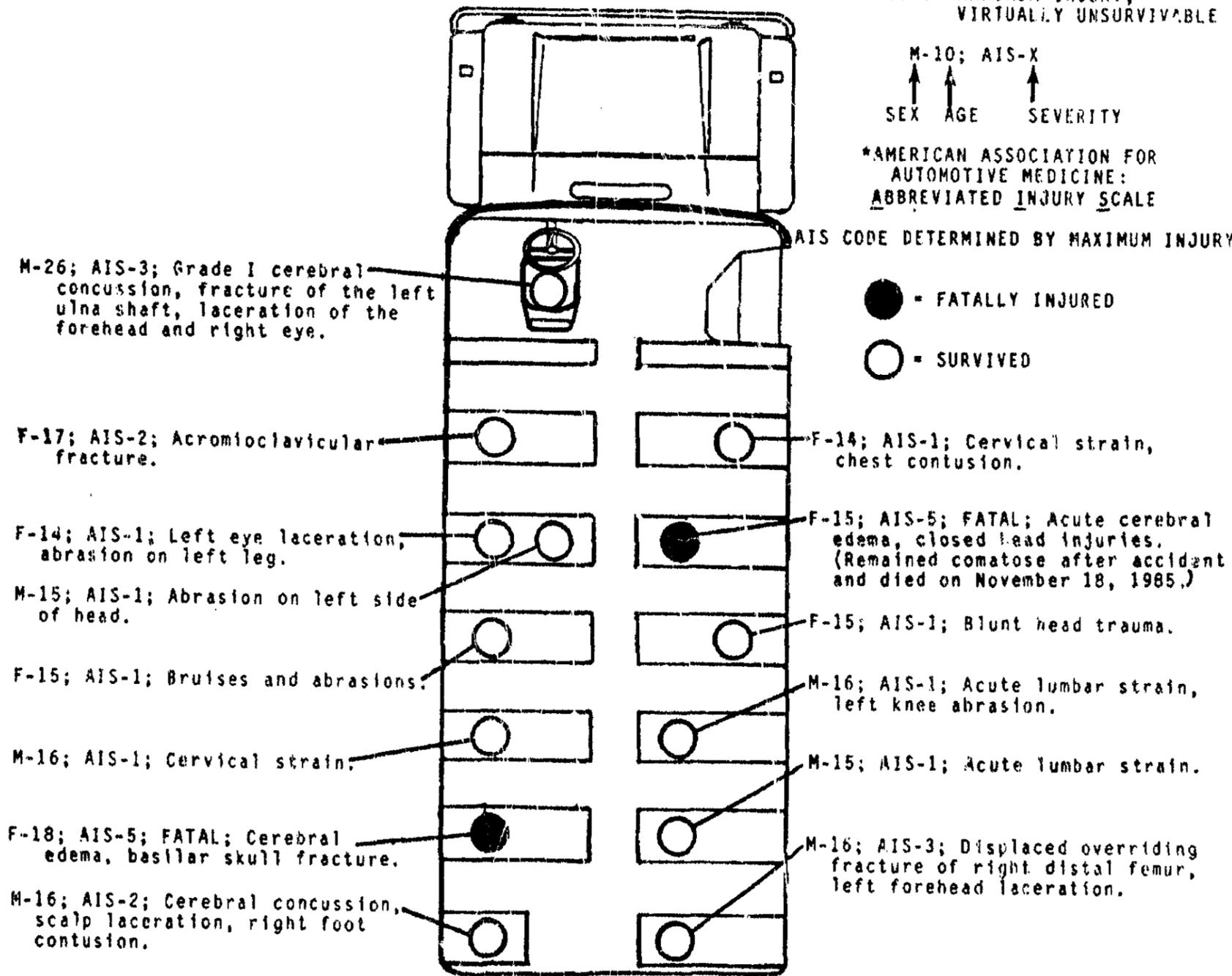


Figure 12.--Schoolbus occupant seating and injury chart.

Local school boards within the State are responsible for determining if schoolbus driver applicants meet these minimum State-wide qualification requirements, and may, at their discretion, require additional minimum qualifications for schoolbus driver applicants, and may prescribe additional preemployment screening requirements, such as driving and criminal violations checks, and prohibitions against using drivers with "poor" driving records or felony criminal convictions.

After the accident, on April 30, 1986, a joint House/Senate Conference Committee of the Missouri legislature passed, and on June 27, 1986, the Governor of Missouri signed Senate Bill No. 707 (SB 707) which amended certain provisions of section 302.270 of the Missouri statutes relating to schoolbus driver qualifications. This bill provided that, effective on January 1, 1988, all persons driving a schoolbus must have been issued a schoolbus driver's permit, and this permit shall be issued only to an applicant who meets the following qualifications:

The applicant has a valid operator's or chauffeur's license;

The applicant shall be at least 21 years of age and not over 70 years of age;

The applicant shall have passed a medical examination, including vision and hearing tests, as prescribed by the director of revenue; and

The applicant shall have passed an examination for the operation of a schoolbus as prescribed by the director of revenue. The examination shall include a written test and a driving test in the type of vehicle to be operated.

A representative of the Missouri Department of Elementary and Secondary Education (MDOE) testified in a deposition taken by Safety Board investigators that although SB 707 did not specifically provide for preemployment drug screening of schoolbus driver applicants, the bill empowered the director of the Missouri Department of Revenue (MDOR) to specify the type of physical examination that was to be performed. The representative believed that a urine test for drug usage would be included in any physical examination procedure specified by the MDOR, but "I have no guarantee of that."

SB 707 also provided that the MDOR shall not issue or renew a schoolbus operator's permit to any applicant:

Whose driving record shows that such applicant's privilege to operate a motor vehicle has been suspended or revoked or whose driving record shows a history of moving vehicle violations;

Who has been convicted of any felony for an offense against the person, any misdemeanor or felony for a sexual offense, any misdemeanor or felony for an offense against the family, and any misdemeanor or felony for pornography or a related offense; or

Who, in the last 10 years, has been convicted of any felony involving robbery, arson, burglary, or a related offense, any felony or misdemeanor for a violation of drug regulations, or any similar crime.

SB 707 also provides that the Missouri Department of Social Services or the Missouri Highway Patrol (MHP) shall provide a record of clearance or denial for any applicant for a schoolbus operator's permit within 30 days of the date requested.

The MDOE representative testified that although the provisions of SB 707 are intended to become effective on January 1, 1988, there were several "glitches" in SB 707 relating to inadequate lead time for the MDOR, the MDOF, and the MHP to implement procedures to comply with the provisions of SB 707 as well as other technical errors in the legislation, and that because of these "glitches" the Governor of Missouri had instructed the involved Departments not to enforce SB 707 on the effective date. He testified that "If the legislature doesn't come back and correct the technical errors, we're in the same place we were before . . ." with respect to State oversight of schoolbus driver preemployment screening and qualifications.

The MDOE witness also testified that after the accident he collaborated with all schoolbus contractors involved in the voluntary desegregation program (see the next section) and made arrangements with the MHP for criminal records checks for all schoolbus driver applicants transporting students enrolled in the program.

#### Harmon Schoolbus Driver Preemployment Screening Procedures

R. W. Harmon and Sons, Inc., employs about 3,000 schoolbus drivers and operates about 2,500 schoolbuses in its pupil transportation operations in Alabama, Arizona, Colorado, Georgia, Illinois, Iowa, Kansas, Missouri, Nebraska, Tennessee, and Utah.

The Harmon schoolbus involved in the accident was transporting pupils who were participating in a voluntary desegregation program which was initiated in the 1982-1983 school year and continued the following years in St. Louis County. Rather than being administered by the local school board, the program is administered by the MDOE, which contracted with Harmon to provide the transportation services in St. Louis County.

During the 1984-1985 school year, there were about 75 Harmon routes; the number of routes increased to about 225 for the 1985-1986 school year. As a result Harmon hired and trained about 150 new drivers during the summer of 1985 including the driver involved in the accident.

The contract between the DOE and Harmon for the 1985-1986 school year provided that all drivers employed by Harmon shall meet the following qualifications:

Must have and maintain a valid Missouri chauffeur's license;

Must have a good driving record;

Must not have been convicted of any felony;

Must submit to a physical exam including a tuberculosis test by a physician licensed to practice medicine in the State of Missouri and must provide a report of the exam prepared by the physician to the contractor which indicates that the driver's physical condition does not preclude, hinder, or jeopardize his/her ability to drive a vehicle. The contractor must maintain the physical exam reports on file and make them available for inspection by the State agency upon request; and

Must be adequately trained to safely transport handicapped students.

The MDOE did not specify or provide guidelines as to what constituted a "good" driving record or how Harmon was to verify a driver applicant's driving and criminal felony conviction record.

Before the accident all Harmon schoolbus driver applicants were required to submit an employment application; preemployment interviews were conducted; references, prior employment history, and the status of the applicants' schoolbus operator's license or permit were verified; applicants were physically examined; alcohol and drug testing was done on a "reasonable cause" basis only (the person appeared to be under the influence of a drug); and driving and criminal history inquiries were made, usually of a "local" law enforcement agency.

A Harmon official testified in a deposition taken by Safety Board investigators that the cooperation received from "local" law enforcement agencies varied depending on the locale and the policies of the local police agency and that in some cases only a verbal report of convictions was received.

In the case of the schoolbus drivers used in St. Louis County, Harmon routinely queried the Metropolitan Police Department Record Center (MPDRC) in St. Louis for driving and criminal conviction records of schoolbus driver applicants in the St. Louis area in the summer of 1985. Before the accident, Harmon officials thought that any driving or criminal convictions in the State of Missouri would be found by making inquiry of the MPDRC. A report dated July 29, 1985, and received from the MPDRC by Harmon for the schoolbus driver involved in the accident stated that he had "No Record of Conviction."

A Harmon driver hiring-training manual stated, "A check of driving record may be made at the State capitol. (We have an account set up this year in Missouri.)" The Harmon official testified that this statement meant that the State capitol was one of several possible sources of accurate driver record information which could be used.

After being accepted as potential employees, applicants were enrolled in a training and orientation program and received training in company procedures, passenger discipline, loading and unloading procedures, driving fundamentals, road signs, first aid, accident and emergency procedures, emergency and defensive driving techniques, preventive maintenance, pretrip inspections, and transporting the handicapped. After being hired, drivers' on-the-job performance was routinely monitored by Harmon driver trainers and reports of the drivers' performance were made a part of the drivers' personnel files.

After the accident Harmon modified its schoolbus driver preemployment screening procedures. In Missouri and Kansas the applicant's driving record inquiry was redirected to the central State licensing agency rather than to a "local" law enforcement agency. In States where a criminal record is available to a noncriminal justice agency (see the following section), criminal record inquiries are directed to a central State agency. In addition to the "for cause" drug testing procedure in effect before the accident, all schoolbus driver applicants are now screened for drug use before they are employed, and all schoolbus driver employees are screened annually for drug use.

#### Availability of Driving and Criminal Histories in Missouri

The MDOR is the agency responsible for the issuance of drivers' licenses and the maintenance of driving violation records in the State.

After receipt of conviction information from the various State courts by the MHP, the information is forwarded to the MDOR. Any vehicle-related felony convictions or

violations related to alcohol or drugs are retained permanently on the driving record and would be available to a nonpublic agency upon request. Minor traffic violation information such as stop sign violations and speeding are purged after 5 years.

In a deposition taken by Safety Board investigators, a representative of the MDOR testified that driving violation records of Missouri-licensed drivers are designated as being public records by statute, and any person can obtain the driving violation record of a driver by paying a \$1.00 fee to the MDOR headquarters in the State capital. A response from the MDOR is usually forwarded to the requestor within 5 to 7 days.

The director of the Criminal Records Division of the MHP testified in a deposition taken by Safety Board investigators that criminal justice agencies in the State have access to both arrest and conviction or other arrest "disposition" data maintained by the MHP concerning felonies or aggravated misdemeanors that are submitted, but that at the present time not all agencies are submitting the data.

Section 43.503 of the Missouri statutes provides that, effective on January 1, 1988, all felony or aggravated misdemeanor arrests, convictions, or other dispositions will be required to be reported to the MHP by any Missouri criminal justice agency. Under the provisions of Section 435.24 of the Missouri statutes, agencies may request an extension of the effective date to January 1, 1989.

Criminal justice agencies in Missouri use the Missouri Uniform Law Enforcement System (MULES) to obtain arrest data, conviction data, or other disposition data in some cases via remote computer terminals. Public and private agencies not involved in the administration of criminal justice or law enforcement are not allowed access to the MULES system.

Section 610.105, "Effect of nolle pros - dismissal - sentence suspended on record," of the Missouri statutes provides:

If a person arrested is charged but the case is subsequently nolle prossed, dismissed, or the accused is found not guilty or imposition of sentence is suspended in the court in which the action is prosecuted, official records pertaining to the case shall thereafter be closed records when such case is finally terminated except as provided in section 610.120.

Section 610.120 provides that records closed under the provisions of section 610.105 shall be available only to the defendant, courts, administrative agencies, law enforcement agencies, and Federal agencies for "purposes of prosecution, litigation, sentencing, parole consideration and to Federal agencies for such investigative purposes as authorized by law or presidential executive order." 2/

A representative of the MHP testified in a deposition taken by Safety Board investigators that at the time of the accident noncriminal justice agencies could obtain criminal conviction data only by writing or appearing in person at the MHP headquarters and requesting the data. However, if an arrest resulted in a "disposition" other than a final conviction, no information would be released. Before 1987 there was no fee for this service. Effective on January 1, 1987, any noncriminal justice agency or person requesting criminal conviction data will be charged \$5.00 for a name search and \$14.00 for a fingerprint card search.

2/ "Vernon's Missouri Statutes," (Ann.) Sections 610.105 and 610.120, (Cum. Supp. 1986).

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Because imposition of sentence was suspended after the schoolbus driver pled guilty to a charge of felony theft in 1983, in accordance with section 610.105 of the Missouri statutes an inquiry of the MPDRC by a noncriminal justice agency such as Harmon would not reveal that the schoolbus driver had pled guilty to a felony.

**Availability of Driving and Criminal Information in Other States**

At the start of the 1986-1987 school year, Harmon transported school children in 10 other States in addition to Missouri, and reported the following information concerning the availability of driving and criminal history information in these States.

Alabama.--Driving records are available through the Department of Education, Transportation Division. Criminal history information is not available to any noncriminal justice agency through any State agency. Criminal record inquiries are made to the local law enforcement agency.

Arizona.--Driving records are available through the State Department of Motor Vehicles. Criminal history information is available to noncriminal justice agencies for employment purposes through the State Department of Public Safety.

Colorado.--Driving records are available through the State Department of Motor Vehicles. Criminal record information is obtained indirectly through the local county sheriff who makes inquiry of the Colorado Bureau of Investigation.

Georgia.--Driving records are available through the State Department of Public Safety. Before November 1, 1986, criminal record information was obtained indirectly through the Georgia Board of Education. After November 1, 1986, Harmon obtains criminal record information directly from the Georgia Bureau of Investigation.

Illinois.--Driver record inquiry is made by the State Department of Education of the Secretary of State. Criminal record information is obtained by the State as part of the schoolbus driver licensing procedure. Criminal records are not available to a noncriminal justice agency.

Iowa.--Driving records are available through the Department of Public Instruction. Criminal records are not available to a noncriminal justice agency from a State agency. Criminal record information is obtained through a local law enforcement agency.

Kansas.--Driving records are available through the State Department of Motor Vehicles. Criminal records are not available to a noncriminal justice agency from a State agency. Criminal record information is obtained through a local law enforcement agency.

Nebraska.--Driving records are available through either the State Department of Motor Vehicles or the State Department of Education. Criminal records are available from the State Highway Patrol.

Tennessee.--Driving records are available through the State Board of Education. Criminal record information is obtained through the State Board of Education from the State Department of Safety.

Utah.--The State checks all schoolbus driver driving records semiannually. Criminal record information is obtained through a local law enforcement agency.

### Federal Motor Vehicle Safety Standards

The schoolbus involved in this accident was manufactured after April 1, 1977, therefore, it was required to meet several Federal Motor Vehicle Safety Standards (FMVSS) promulgated by the National Highway Traffic Safety Administration (NHTSA).

FMVSS 221, Schoolbus Body Joint Strength, requires that an inside or outside body panel of a schoolbus be fastened so that the body panel is capable of holding the body panel to the member to which it is joined when subjected to a force of 60 percent of the tensile strength of the weakest joined member. (See appendix B.) The purpose of this standard is to reduce deaths and injuries resulting from the structural collapse of schoolbus bodies during crashes.

The standard defines the term "body panel" as a body component used on the exterior or interior surface to enclose the schoolbus' occupant space, and defines "body panel joint" as the area of contact or close proximity between the edges of the body panel and another body component, excluding spaces designed for ventilation or another functional purpose, and excluding doors, windows, and maintenance access panels.

FMVSS 222, Schoolbus Passenger Seating and Crash Protection, establishes occupant protection requirements for seats and restraining barriers for schoolbuses. The purpose of this standard is to reduce the number of deaths and injuries resulting from the impact of schoolbus occupants with structures within the vehicle during crashes and sudden driving maneuvers. FMVSS 222 provides for occupant crash protection through the use of strengthened, closely spaced, and padded seatbacks, and padded restraining barriers installed in front of the first row of seats in large schoolbuses.

FMVSS 301, Fuel System Integrity, establishes 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.

### Tests and Research

Safety Board investigators removed the steering pitman arm containing part of the fractured output shaft from the rest of the separated steering axle assembly of the schoolbus for metallurgical examination. A Safety Board technician determined that the fracture surface of the output shaft displayed characteristics typical of a ductile torsional overstress, and that there was no evidence of a preexistent failure of this component.

Due to inclement weather and hazardous traffic conditions Safety Board investigators were unable to measure directly the radius of the curved, striated tire marks on the roadway before they were obliterated by traffic. Investigators used a photograph of the parallel curved striated tire marks taken by the St. Louis County Police Department to make an orthogonal map of these marks using photogrammetry and computer programs developed by the Safety Board's Engineering Services Division. This technique uses four points in a photograph whose distance relative to each other is known. Using these points, a matrix is developed to place other points on the same map. 3/

3/ Baker, J. Stannard, "Perspective Grid for Photographic Mapping of Evidence," second ed., Northwestern University, 1977; the Safety Board has developed a computer program which automates the process for recovering orthogonal planform coordinate information from photographic evidence.

It was determined that an arc of the curved tire marks in the photograph with a chord of 120 feet had a middle ordinate of 4 feet. Using these data it was determined that the average radius of this arc was 452 feet.

Skid tests conducted in accordance with the American Society for Testing and Materials Standard E-274 by the Missouri Highway and Transportation Department in 1984 after the eastbound roadway at the accident site had been resurfaced indicated that the average wet surface friction number of the roadway surface in the vicinity of the accident site was 39.95 or 0.39 stated as a frictional coefficient.

Other data indicate that on an asphalt roadway surface frictional coefficients increase by a minimum of 0.20 and a maximum of 0.25 from wet to dry surface conditions at speeds greater than 30 mph. 4/ Tests performed for the NHTSA indicate that the peak lateral force coefficient for truck tires was about 0.65. 5/ Based upon these data, it is estimated that the dry friction coefficient of the roadway surface at the accident site was between 0.59 and 0.64 at the time the accident occurred.

## ANALYSIS

### The Accident

The weather and the condition of the highway did not cause or contribute to the loss of control of the schoolbus. A Safety Board metallurgical examination determined that the fracture surface of the output shaft connecting the steering gearbox with the pitman arm displayed characteristics typical of a ductile torsional overstress and that there was no evidence of a preexistent failure of this component. The Safety Board concludes that the failure of this component was not due to metal fatigue or any preexistent defect of this component but rather was caused by overstress due to collision forces.

No other preexistent mechanical defects were found during the postcrash examination, and the Safety Board therefore concludes that there was no mechanical defect which may have caused or contributed to the accident.

The curved striated tire marks which began in the center through lane and ended in the Lucas and Hunt Road exit lane were centrifugal scuff marks made by the left rear dual tires of the schoolbus when the schoolbus swerved to the right. This maneuver loaded the tires on the left side of the vehicle which caused these tires to sideslip as they were rotating and to leave the striated marks on the pavement surface.

By determining the average radius of these curved striated marks (452 feet), the coefficient of friction of the roadway surface with the vehicle's tires (0.59 to 0.64), and the superelevation of the roadway where the marks were made (.02), it is possible to estimate the average speed of the vehicle when these marks were being made. Using these data, the Safety Board estimates that the average speed of the schoolbus at the time it made these tire marks was between 59 and 67 mph.

4/ Baker, J. Stannard, "Traffic Accident Investigation Manual," first ed., Northwestern University, 1975, p. 210.

5/ Enco, Inc., "Truck Tire Braking and Cornering Traction Study," 1979, 5408 A Port Royal Road, Springfield, Virginia, 22151, p. 46.

The two sets of straight tire marks starting at the edgeline separating the Lucas and Hunt Road exit lane from the shoulder were skid marks made by the tires on the left and right sides of the schoolbus when these wheels were locked and sliding over the highway surface. The Safety Board concludes that the schoolbus driver applied the vehicle's brakes and locked the vehicle's wheels immediately before the collision with the guard rail.

The straight tire marks also show that the right front of the schoolbus initially collided with the guard rail at a  $12^\circ$  approach angle. This collision caused the guard rail to deflect outboard while at the same time the guard rail began to redirect the chassis and possibly the lowest parts of the right front of the schoolbus body (including the stepwell) back toward a path parallel with the guard rail. Further deflection of the guard rail was prevented when the outboard face of the guard rail came into contact with the concrete pedestal supporting the sign pillar.

At the same time the chassis was being redirected back toward a path parallel to the guard rail, the momentum of the upper part of the schoolbus body carried it further outboard over the guard rail as the collision sequence progressed and until the right front of the schoolbus body collided with the top of the concrete pedestal and the sign pillar. The angle of the 24-inch wide semicircular indentation extending obliquely across the schoolbus roof shows that at the point of maximum engagement the schoolbus body rode up on the sign pillar to an angle of about  $54^\circ$  to horizontal level. (See figure 13.)

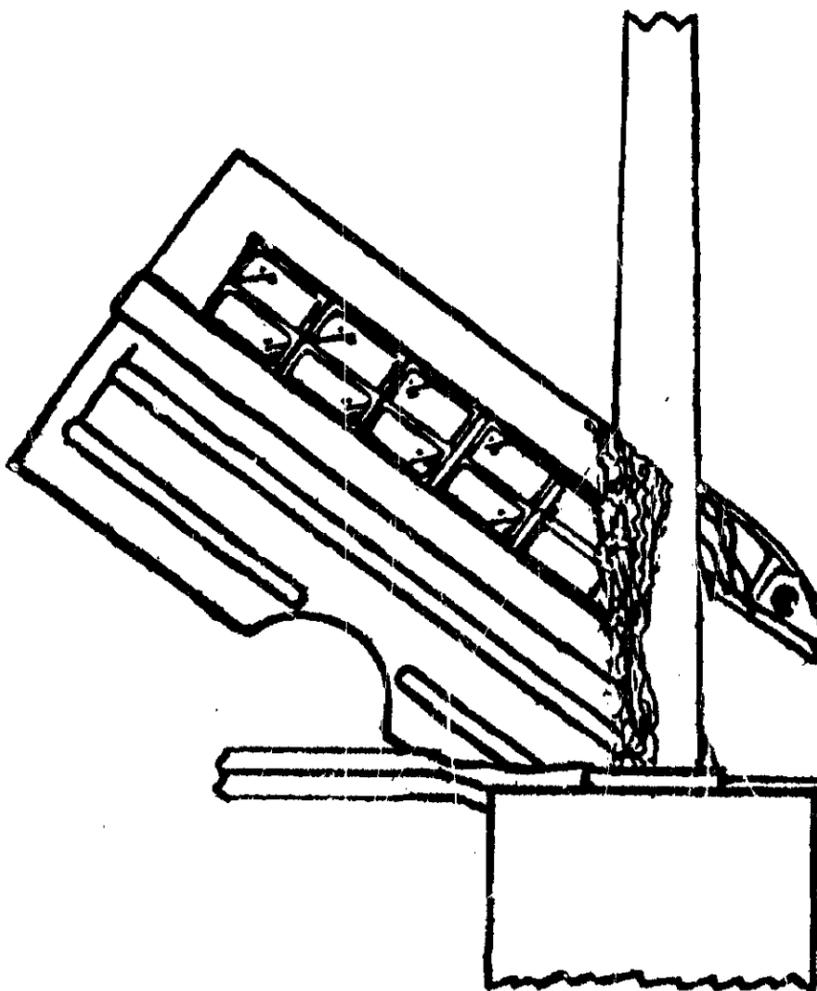


Figure 13.--Side view of collision of schoolbus body with sign pillar.

The chassis probably separated from the schoolbus body at the maximum engagement point of the schoolbus body with the sign pillar when the sign pillar prevented further eastward travel of the schoolbus body and the guard rail had redirected the path of the chassis away from that of the schoolbus body.

After the body-chassis separation, the right front of the chassis remained in contact with the guard rail. This contact at the right front caused the rear of the chassis to begin a clockwise rotation out into the Lucas and Hunt Road exit lane where the rear of the chassis came to rest. The forward momentum of the rear of the schoolbus body caused it to rotate almost 90° clockwise around the pillar out into the Lucas and Hunt Road exit lane, where it came to rest.

### Highway Factors

When the sign support pillar and its concrete pedestal were installed, there were no Missouri or Federal highway design standards in effect to provide for a "clear zone" adjacent to the highway which was free of obstacles and which provided space for the safe recovery of an errant vehicle, and Missouri standards in effect at the time required a 2-foot distance from the guard rail to the object it protected.

According to tests of the type of W-beam guard rail installed at the accident site, the guard rail deflected between about 2 to 4 feet when struck by passenger autos approaching the guard rail at speeds over 55 mph and angles of 25° or more. The collision of the schoolbus with the guard rail at a 12°-approach angle deflected the guard rail outboard at a maximum of about 4 feet, about 2 feet past the preaccident distance of the inboard face of the concrete pedestal from the guard rail. Further outboard deflection of the guard rail was prevented when the outboard face of the guard rail was deflected flush against the concrete pedestal.

Although new highway design standards in Missouri provide for a 4-foot deflection distance from a guard rail to a fixed object, the Safety Board believes that, even if the distance from the guard rail to the pedestal was 4 feet instead of 2 feet, the upper portion of the schoolbus body would probably still have struck the sign pillar due to the amount the guard rail actually deflected and the height of the schoolbus body over the top of the guard rail. (See figure 14.)

The Safety Board believes that although the highway design had no role in contributing to the cause of the accident, the location of the concrete pedestal and the sign support pillar in combination with the type and location of the guard rail installed to protect the pedestal and the pillar contributed to the severity of the accident.

Full-scale crash testing of barrier systems, including guard rails, using large vehicles has been limited. A test of a W-section guard rail similar to that installed at the accident site, as specified in the 1977 AASHTO Guide 6/ was conducted in June 1980 by the Texas Transportation Institute. The vehicle used was a ballasted schoolbus weighing 20,050 pounds. The W-section guard rail failed to contain the schoolbus satisfactorily. 7/

6/ AASHTO Guide, op. cit.

7/ Texas Transportation Institute, "Test and Evaluation of W-Beam and Three-Beam Guardrails," draft final report, March 1981.

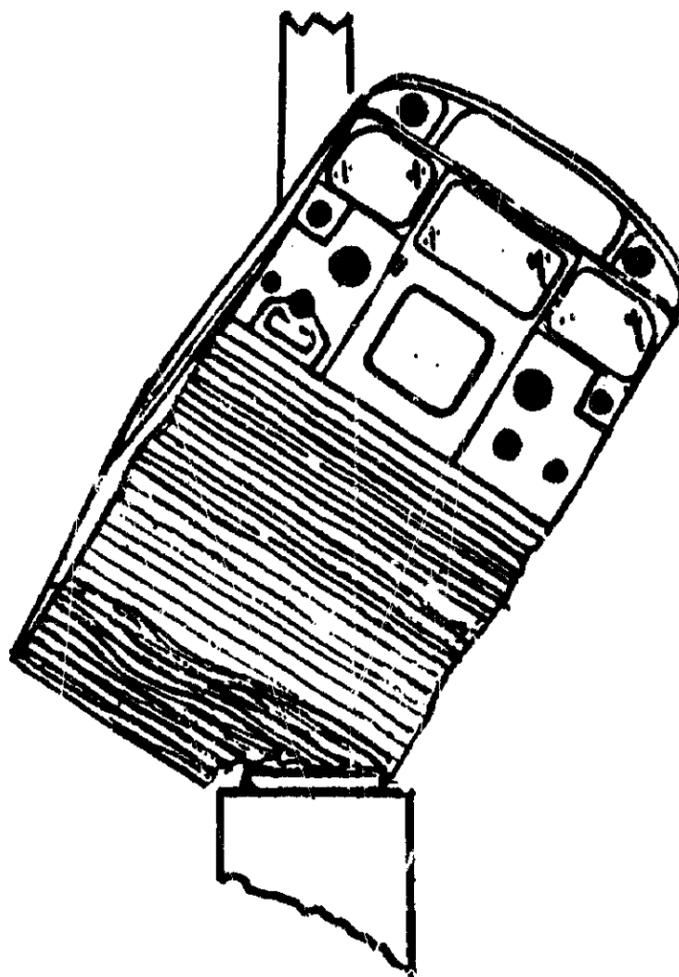


Figure 14.—Rear view of collision of schoolbus body with sign pillar.

Additional tests with schoolbuses were performed in June 1980 using a Thrie-Beam guard rail and in January 1981 using a modified Thrie-Beam guard rail. In addition to redirecting the schoolbuses successfully, the modified Thrie-Beam guard rail successfully redirected a 32,000 pound intercity bus at an impact speed of 60 mph and an impact angle of 15°. According to a 1982 cost analysis, the Thrie-Beam guard rail costs about 25 percent more than the conventional guard rail. <sup>8/</sup>

There are also other high-performance barriers available, such as the New Jersey-shaped concrete barrier and the Self-Restoring Traffic Barrier (SERB). Tests on the SERB by Southwest Research have found it to smoothly redirect small autos, schoolbuses, and intercity buses. <sup>9/</sup>

<sup>8/</sup> Ivery, Donald L., and McDevitt, Charles F., "Thrie-Beam Guardrails for School and Intercity Buses," Transportation Research Board Paper, January 1982.

<sup>9/</sup> Southwest Research Institute, "SERB - A New High-Performance Self-Restoring Traffic Barrier," January 1981.

The in-place guard rail at the accident site failed to prevent the schoolbus body from overriding the guard rail and colliding with the concrete pedestal and the sign pillar. The collision with the sign pillar caused the greatest amount of damage and deformation of the schoolbus body and subjected the schoolbus occupants to the most severe crash forces experienced during the collision sequence.

The Safety Board concludes that the results of the collision would have been considerably less severe if any in-place barrier system had successfully redirected the schoolbus away from the pedestal and sign pillar, provided that this redirection did not result in an equally severe secondary collision with another vehicle and/or a fixed object.

Even though the minimum standard for guard rail distance to protected object had changed from 2 feet to 4 feet, after the accident the guard rail was replaced in its preaccident configuration with no apparent evaluation of its performance or consideration given to upgrading the guard rail. The Safety Board has a long-standing concern about this issue, which resulted in a safety improvement recommendation involving the repair of crash-damaged highway fixtures.

At 1:35 p.m. on August 6, 1976, near Neola, Iowa, a Tri-Center Community Schools schoolbus left the roadway, struck and overrode a guard rail and concrete bridge parapet, fell about 15 feet onto a sloped embankment below the bridge, and landed on its roof. Three children were killed, and the driver and 29 children were injured. <sup>10/</sup> On the day after the accident, the State of Iowa replaced the damaged guard rail with one that had the same design deficiencies as the old one.

Highway Safety Program Standard (HSPS) Number 12, administered by the Federal Highway Administration of the U.S. Department of Transportation, requires that "... State and local jurisdictions establish programs to correct safety deficiencies on all urban and rural roads with new construction, reconstruction, and improved maintenance" and that "Procedures should be established, if they are not presently used, for a plan of operation to repair and correct crash-damaged highway features that may create a hazard to the traveling public."

As a result of its investigation of the Neola, Iowa, accident, the Safety Board was concerned that the maintenance procedures that the Iowa Department of Transportation used at this accident location may reflect some ineffectiveness in the national effort to establish roadway maintenance programs that are in compliance with HSPS 12. The Safety Board issued Safety Recommendation H-77-1 to the Federal Highway Administration:

Examine and report to the Board on the effectiveness of Federal Highway Administration efforts to establish roadway maintenance programs that comply with Highway Safety Program Standard Number 12. This report should, as a minimum, review: (1) the adequacy of information about post-crash corrective maintenance procedures and devices in the FHWA maintenance policy; (2) the availability and implementation of training programs in, and up-to-date standards for, postcrash corrective maintenance; and (3) a sample of accidents to assess post-crash maintenance practices within each FHWA region.

In response to this recommendation the FHWA: (1) issued FHWA Notice N 7560.4, Federal-Aid Participation in Highway Appurtenances (crash-damaged), which was superseded by FHWA notice N 7560.6 in 1979; (2) submitted a summary report to the Safety Board on State Maintenance Practices in Replacement of Damaged Highway Hardware; and (3) distributed the 1977 edition of the FHWA Maintenance and Highway Safety Handbook to FHWA Regional and Division (State Headquarters) offices.

FHWA Notice N 7560.6 provides information on the use of Federal aid funds for safety projects to upgrade highway appurtenances that must be replaced due to vehicle accidents, and advised the FHWA Regional and Division offices to encourage the States to adopt a policy of upgrading accident-damaged appurtenances. The notice did not provide for redistribution of the notice to the appropriate State highway offices.

The summary report furnished to the Safety Board by the FHWA in response to recommendation H-77-1 stated that the major reasons States generally replace crash-damaged highway appurtenances in kind are: (1) the cost of materials which meet present rather than previously-existing design standards is usually higher; (2) existing inventories of materials meeting previously-existing standards cannot be used; (3) some State liability laws may hold various highway departments accountable for damage as a result of subsequent accidents if an appurtenance is not replaced to the standard existing at the time of the original construction; and (4) maintenance personnel are not always aware of the latest standards and installation methods. The summary report concluded, "Hopefully, continued emphasis by FHWA will result in more statewide upgrading projects and changes in some State policies." Based upon these actions by the FHWA, Safety Recommendation H-77-1 was classified as "Closed--Acceptable Action" on October 29, 1979.

As a result of its investigation of the St. Louis accident, the Safety Board believes that there is more to be done to meet the intent of HSPS 12. The FHWA should reissue FHWA Notice N 7560.6, "Federal Aid Participation in Highway Appurtenances," and instruct FHWA Regional and Division offices to: (1) provide copies of the notice to the States; (2) actively encourage the States to develop procedures to systematically evaluate the performance of crash-damaged highway safety appurtenances; and (3) encourage the States to upgrade crash-damaged appurtenances if necessary to meet current design standards.

#### Medical and Pathological Factors

The available evidence indicates that on the day of the accident the schoolbus driver was in good general health with no chronic or acute illnesses. The Safety Board concludes that the schoolbus driver's general medical condition and health were not factors in the accident.

Analysis of toxicological samples of the schoolbus driver's blood disclosed the presence of alcohol and cannabinoids, and analysis of the urine established the presence of alcohol, cannabinoids, and phencyclidine (PCP). Safety Board investigators forwarded the results of the toxicological examinations of the schoolbus driver's blood and urine to the Armed Forces Institute of Pathology (AFIP) for analysis. The AFIP concluded:

Toxicology tests indicated that the schoolbus driver was under the influence of ethyl alcohol at the hospital, approximately 1 hour and 22 minutes after the accident. The driver also had cannabinoid metabolites in his blood and urine and phencyclidine in his urine. These findings were consistent with recent illicit drug use but there was no evidence that he was under the influence of cannabinoids or phencyclidine at the time of the accident.

Several reports in the literature correlate behavioral evidence of phencyclidine intoxication with blood levels between 7 and 240 ng/ml (average 75 ng/ml). The reported plasma half-life of phencyclidine is approximately 11 hours. There is no literature suggesting behavioral effects when phencyclidine is not detectable in the blood. Currently available literature support no direct correlation between urine phencyclidine levels and behavioral effects.

#### Harmon's Preemployment Screening and Training Procedures

There is no evidence to indicate that R. W. Harmon and Sons, Inc., relaxed its schoolbus driver preemployment screening procedures due to the increased number of drivers needed for the 1985-1986 school year, or that any responsible person at Harmon was aware before the accident that making inquiry of the MPDRC may not have revealed an applicant's entire Missouri driving and criminal conviction record.

There also is no evidence to indicate that the schoolbus driver was inadequately trained to operate a schoolbus by Harmon, nor is there any evidence to indicate that the schoolbus driver did not possess the physical qualifications and skills necessary to operate a schoolbus safely.

Driving Record Inquiries.—The schoolbus driver answered "no" on his Harmon employment application in response to a question asking him if he had ever been convicted of a crime other than a nonmoving traffic violation. Had Harmon queried the MDOR about the driver's record, the company would have learned that the driver had given a false answer to this question. It is possible that discovery of the falsified employment application may have been sufficient justification for Harmon to discontinue the driver's employment.

Although Harmon failed to ask the MDOR about the accident driver's driving record, the record itself was not serious or extensive enough to prevent the driver from being issued a license to drive a schoolbus, and no specific guidelines concerning disqualifying driving violations were supplied to Harmon by the MDOE.

Criminal Record Inquiries.—Section 610.105 of the Missouri statutes prevents a noncriminal justice agency from determining a person's complete criminal record in cases where imposition of sentence is suspended. Therefore, there was no lawful method available to Harmon to determine the driver's complete criminal history.

#### State Schoolbus Driver Preemployment Screening Requirements

Driving Records.—Safety Board investigators conducted a telephone survey of the 50 States and the District of Columbia to determine the extent the jurisdictions use private contractors to transport public school children. In addition, the survey queried the jurisdictions concerning their schoolbus driver preemployment screening requirements or recommended procedures relating to driving and criminal violation records.

Forty-seven (92 percent) of the jurisdictions use private contractors to some extent to transport public school children. Thirty of the States (59 percent) require, either by statute or regulation, that a prospective employer obtain a schoolbus driver applicant's driving record from the central State driver licensing authority. Fourteen of the States (27 percent) and the District of Columbia have recommendations or guidelines that suggest schoolbus operators obtain the driving record from the State central driver licensing authority.

At the time of the survey, seven States (Alabama, Idaho, Maine, Mississippi, Missouri, North Dakota, and Vermont) did not have statutes, regulations, recommendations, or guidelines to schoolbus operators requiring or suggesting that a schoolbus driver applicant's driving record be obtained from the central State driver licensing agency as part of any preemployment screening procedures. (See appendix C.)

Driving records can be obtained, with certain limitations, by prospective employers from all 50 States and the District of Columbia. Since January 1, 1971, interstate commercial vehicle operators have been required by Federal regulation (Title 49, Code of Federal Regulations, Part 391.23) to obtain a driver applicant's driving record for the preceding 3 years by making inquiry to the appropriate agency in every State in which the applicant held a motor vehicle operator's license or permit during those 3 years.

According to the American Trucking Associations, <sup>11/</sup> driver license records are available to prospective employers at a cost ranging from \$10.00 in Louisiana to \$0.75 in Nebraska for each inquiry submitted. Several jurisdictions impose limitations on the age of convictions that will be reported. Some jurisdictions require a signed release from the driver applicant or a certification from the requestor that the inquiry is for employment purposes before any record of driving convictions will be released. Massachusetts will furnish driving records only to the license holder.

Some jurisdictions include both driving violation convictions and accidents in the information supplied in response to a request. In other jurisdictions accident information must be requested separately and an additional fee may be charged.

The purpose of issuing drivers' licenses by the States is to establish minimum driver qualifications and to ensure that the driving privilege is granted only to those individuals who meet the minimum qualifications. Driving violation records are maintained so that the licensing agency can identify an individual with driving violations so that steps can be taken either to improve that individual's driving behavior or to withdraw the driving privilege.

Although there is no evidence indicating that the schoolbus driver had more than one operator's license, the Safety Board is aware that a driver may be able to conceal some or all of his driving violations from a licensing agency or a prospective employer by not reporting that he holds licenses from more than one State. <sup>12/</sup>

A State licensing agency or a prospective employer must also address the problem of determining what type and/or number of driving violations accumulated over an arbitrary period of time will disqualify a prospective employee from driving a schoolbus. Simply requiring that a schoolbus driver have a "good" driving record provides almost no guidance to a prospective employer.

Nevertheless, in spite of the informational limitations and inconsistencies which presently exist in the driver licensing and qualification system in the United States, the Safety Board believes that before an applicant is employed a schoolbus operator should

<sup>11/</sup> "How and Where to Check Driving Records and Report Accidents," American Trucking Associations, Department of Safety, 2200 Mill Road, Alexandria, Virginia 22314, rev. January 1986.

<sup>12/</sup> For more detailed information, read--"Training, Licensing, and Qualification Standards for Drivers of Heavy Trucks," April 17, 1986," (NTSB/SS-86/02).

obtain a report of a schoolbus driver applicant's license status and driving violation record from the central State licensing agency in each State where the applicant is or has been licensed.

This preemployment screening process would verify that the applicant is properly licensed, and would help a prospective employer make a more informed judgement on the applicant's qualifications to operate a schoolbus safely. States which do not presently mandate such an inquiry should do so without delay.

Criminal Conviction Records.—Nineteen (38 percent) of the States require, either by statute or regulation, that a schoolbus driver applicant's criminal history be obtained from a State central records authority; 14 States (28 percent) and the District of Columbia have guidelines or recommendations that this be done. Eighteen States (36 percent) have neither a requirement nor a recommended practice that a schoolbus driver applicant's criminal conviction record be obtained as a part of preemployment screening procedures. (See appendix C.)

In 1986, after a schoolbus driver employed by the Dallas, Texas, County Schools (DCS) allegedly molested a 13-year-old special education student, all 1,000 of the schoolbus drivers employed by the DCS were checked for criminal records in Dallas County, Texas. As a result of these criminal record checks, 42 schoolbus drivers were dismissed after it was determined that these drivers had one or more felony convictions on their records, including possession of drugs, felonious assaults, sex crimes, and driving while under the influence of alcohol.

Before the alleged molestation, the DCS policy was to check each schoolbus driver's driving record annually; no criminal record checks were performed. After the incident, the DCS changed its policy and now all new schoolbus driver applicants' driving and criminal records are checked State-wide. In addition, all presently-employed schoolbus driver's driving records are checked three times each school year, and twice each school year all drivers are checked for criminal convictions in Dallas County. The superintendent of the Dallas County Schools reported that state-wide criminal conviction checks could not be made on currently-employed schoolbus drivers.

As is the case concerning driving records, the Safety Board believes that knowledge of a schoolbus driver applicant's criminal history provides a useful means of predicting future performance, and that a person with a recent history of crimes committed against persons, serious crimes committed against property, sex-related crimes, alcohol abuse, or illicit drug use or involvement should be prohibited from operating a schoolbus.

The Safety Board believes that the criminal record of a schoolbus driver applicant should be made available to or determined by either the licensing jurisdiction at the time a license to operate a schoolbus is issued or renewed, or the criminal record should be made available to and should be used by a prospective employer as a part of a required preemployment screening process.

#### Availability of Criminal Records in Missouri

After the accident Missouri enacted SB 707 which specifies certain crimes which will disqualify a person from being issued a schoolbus operator's permit or having an existing schoolbus operator's permit renewed. SB 707 clearly states that disqualification is contingent on that person's conviction of the crime(s) listed in the law.

It is, therefore, conceivable that if a person pleads or is found guilty of one or more of the crimes listed in SB 707 after the provisions of SB 707 become effective, but imposition of sentence is suspended, a noncriminal justice agency would be unable to determine a person's complete criminal history.

It is neither intended nor should it be inferred that the Safety Board is attempting to substitute its judgement for that of a court charged with the serious responsibility of assessing penalties for a particular crime or for determining the potential and possibly unnecessary negative effect that a "conviction" for a serious crime will have upon a particular defendant's future employment opportunities.

The interests of justice may, in many circumstances, clearly dictate that imposition of sentence for a particular crime should be suspended, particularly in cases involving young or first-time offenders. (The accident driver was 21 years old when he pled guilty to the weapons and conspiracy charges in 1980.)

The Safety Board is concerned that in Missouri a final "conviction" of certain crimes will disqualify a person from operating a schoolbus after the provisions of SB 707 become effective, but a plea or finding of guilt of the same crime, in cases where imposition of sentence is suspended, will not disqualify an applicant from operating a schoolbus, and public availability of that information will be restricted to the same extent as if a defendant were found not guilty or the State declined to prosecute the case.

The Safety Board believes that the legislature of the State of Missouri should revise the Missouri statutes to ensure that a plea or finding of guilt of one or more of the crimes listed in SB 707 will disqualify a person from operating a schoolbus in the State of Missouri even if imposition of sentence is suspended.

#### Federal Motor Vehicle Safety Standards

In its 1970 Special Study on inadequate structural assembly of schoolbus bodies, <sup>13/</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 NHTSA). Before the promulgation of FMVSS 221, most prestandard schoolbus bodies were constructed with roof and side panels joined by fasteners spaced much further apart which resulted in body joints with low joint strengths. Consequently, panel separations resulted in exposed sharp edges which caused disfiguring occupant injuries and a general collapse of the schoolbus body.

When FMVSS 221 was promulgated in 1977, exterior and interior maintenance access panels were exempted from the joint strength requirement of the standard. On November 27, 1981, the NHTSA issued a notice of proposed rulemaking (NPRM) in the Federal Register which requested public comment on a proposal to amend FMVSS 221 to require that most maintenance access panels in large schoolbuses comply with the joint strength requirement of that standard.

The NPRM stated that the NHTSA had become concerned that schoolbus manufacturers were circumventing FMVSS 221 to a limited extent by the excessive use of maintenance access panels. Most schoolbus manufacturers had created maintenance access panels that were located above the window area and which extended the entire length of the schoolbus.

<sup>13/</sup> For more detailed information, read--"Inadequate Structural Assembly of Schoolbus Bodies, The Accidents at Decatur and Huntsville, Alabama," 1970, (NTSB-HSS-70-2).

The NPRM further stated that these panels were usually loosely attached and could not withstand much force before they would detach from the schoolbus body. The NHTSA had tentatively concluded that many of these panels were located in an area of the schoolbus likely to impact the heads of the passengers.

Over 200 individuals or organizations involved in the manufacture or sale of schoolbuses, school districts, schoolbus contractors, and private individuals submitted comments on the NPRM. Most of those who commented opposed the amendment, stating that there was no documentation which attributed injuries to schoolbus occupants due to contact with separated maintenance access panels, that the cost was excessive for the benefits accrued, that the proposed rule did not provide enough time for retooling to meet the proposed standard, and/or that the matter needed further study.

On July 2, 1984, the NHTSA terminated the rulemaking action with no changes to the existing rule, but urged the schoolbus manufacturing industry to minimize the number of maintenance access panels.

On April 29, 1985, a tractor-semitrailer combination transporting livestock struck the rear of an 84-passenger 1977 (post-FMVSS 221) schoolbus transporting 32 students which was stopped to discharge passengers on U.S. 160 near Tuba City, Arizona. 14/ Two of the students were killed and the truckdriver, the schoolbus driver, and 26 of the students sustained minor to serious injuries.

Postcrash examination of the schoolbus involved in the Tuba City accident disclosed that, although the rear of the schoolbus was subjected to severe crash forces, none of the interior or exterior body panel joints that were subject to the joint strength requirement of FMVSS 221 failed. However, it was noted that an interior maintenance access panel located above the side windows at the left rear of the schoolbus separated from its adjacent body components, and the Safety Board concluded that:

As occurred in this accident, contact of schoolbus occupants with exposed metal edges of body or maintenance access panels during collisions and overturns can result in severe disfiguring and sometimes life-threatening injuries.

As a result of its investigation of the Tuba City, Arizona, accident, and two other accidents which occurred on December 11, 1984, near Durango, Colorado 15/ and September 11, 1985, in Woodside, Delaware, 16/ and which resulted in maintenance access panel separations in post-FMVSS 221 large schoolbuses, the Safety Board on February 6, 1986, issued Safety Recommendation H-85-51 to the NHTSA:

Revise Federal Motor Vehicle Safety Standard 221, School Bus Body Joint Strength, to require that the joints of interior body maintenance access channels within a defined occupant contactable zone meet the joint strength performance requirement of other body panel joints.

14/ For more detailed information, read Highway Accident Report—"Collision of Tuba City District Schoolbus and Bell Creek, Inc. Tractor-Semitrailer, U. S. 160 near Tuba City, Arizona, April 29, 1985." (NTSB/HAR-85/06).

15/ NTSB Docket No. DEN 85-H-SB08.

16/ NTSB Docket No. HY-476-85.

In its March 31, 1986, response to this recommendation, the NHTSA advised the Safety Board that it did not believe rulemaking to amend FMVSS 221 was justified at the time because the NHTSA was concerned that "requiring additional fasteners on maintenance access panels might increase poor or inadequate maintenance of schoolbuses and result in a negative effect on safety," because "the added time and effort needed to unfasten those panels might result in necessary school bus maintenance being deferred or entirely ignored by maintenance personnel under scheduling pressures," and that "the integrity of the panels would be dependent on replacement of the fasteners."

The NHTSA also advised that it was sending the reports of maintenance panel failures to all schoolbus manufacturers and would remind the manufacturers of the importance of minimizing and relocating these panels to the floor or lower bus walls.

Because of the NHTSA's failure to take more positive action on the Safety Board's recommendation, on July 1, 1986, Safety Recommendation H-85-51 was placed in a "Closed—Unacceptable Action" status.

The 6-foot-10-inch long maintenance access panel which separated in the St. Louis accident was attached to the interior sidewall below the schoolbus' windows on the right side by three 1/8-inch diameter sheet metal screws about 27 inches apart. Such an installation would probably have separated even if the crash forces experienced in this accident had been considerably less severe. The presence of blood, hair, and tissue on the body panel joint which was exposed when the panel separated clearly indicates that one of the schoolbus occupants sustained a head injury due to contact with the exposed edges of this joint. (See figure 6.)

Based on its investigations of crashes involving post-FMVSS 221 large schoolbuses, including the accident which occurred in St. Louis, Missouri, the Safety Board believes that FMVSS 221 has contributed to improved structural integrity of schoolbus bodies during crashes. However, the Safety Board also believes that the standard is flawed in that it permits a schoolbus manufacturer to locate a weakly-fastened maintenance access panel at points in the schoolbus interior (usually above or below the side windows) where passengers could easily contact the sharp metal edges created or exposed if these panels separate from their adjacent body components during collisions and overturns.

The Safety Board also believes that it is also technologically and probably economically feasible to locate interior maintenance access panels where occupants will be less likely to contact sharp edges created or exposed after the panels separate (such as a location low on the schoolbus' interior sidewall or on the floor).

It is also possible to eliminate maintenance access panels on schoolbus interior sidewalls altogether and route wiring harnesses (which are the principal vehicle components located behind maintenance access panels on schoolbus sidewalls) along the frame rails under the schoolbus and/or behind exterior trim panels on the schoolbus body.

The Safety Board believes that continuing to exempt interior maintenance access panels from the joint strength requirement of FMVSS 221 poses an unnecessary hazard to schoolbus passengers. As a result of a safety study of 43 crashes involving 44 post-1977 large schoolbuses, 17/ including the schoolbus involved in the St. Louis accident, the Safety Board adopted Safety Recommendation H-87-11 to the NHTSA on March 18, 1987.

17/ For more detailed information, read-- "Safety Study: Crashworthiness of Large Poststandard Schoolbuses," (NTSB/HSS-87/01.)

Amend Federal Motor Vehicle Safety Standard 221, Schoolbus Body Joint Strength, to include interior maintenance access panels in the standard's performance requirements.

Due to its recency, the NHTSA has not yet responded to this recommendation.

On the other hand, the tubular steel structure surrounding the fuel tank on the right side of the schoolbus protected the fuel tank from being punctured or torn open when the schoolbus contacted the guard rail. Though the fuel cap was torn off the fill pipe, no fuel leakage was reported at the accident site or observed during the postcrash inspection of the vehicle. The Safety Board concludes that the fuel tank demonstrated the crashworthiness required by FMVSS 301.

#### Separation of Chassis from Schoolbus Body

In an accident which occurred in Rehoboth, Massachusetts, on January 10, 1984, a post-1977 65-passenger schoolbus collided head on with a tractor-semitrailer. <sup>18/</sup> The body of the schoolbus partially separated from the schoolbus chassis and the schoolbus body overturned. In its investigation of the accident, the Safety Board determined that the energy expended in forcing the schoolbus body off the chassis served to dissipate crash energy which otherwise would have been absorbed by the schoolbus body, and which may have resulted in a reduction of the occupant's survivable space in the front of the schoolbus.

In an accident which occurred near Carrsville, Virginia, on April 12, 1984, a post-1977 64-passenger schoolbus was struck by a train. <sup>19/</sup> During the initial collision the schoolbus chassis was struck and was forced completely away from the schoolbus body. In its investigation of this accident, the Safety Board concluded that the chassis absorbed much of the initial crash forces without transmitting these forces to the schoolbus body and its occupants.

The body of the schoolbus involved in the St. Louis accident was attached to its chassis in a manner similar to that used in the schoolbuses involved in the Rehoboth and Carrsville accidents. When the schoolbus body collided with the sign pillar, the forward momentum of the chassis carried the chassis away from under the schoolbus body and reduced the amount of energy which otherwise would have had to have been absorbed by the schoolbus body and its occupants.

As was the case in the Rehoboth and Carrsville accidents, the Safety Board concludes that the separation of the schoolbus body from its chassis in the St. Louis accident had positive safety results in that crash forces transmitted to the schoolbus body were reduced as a result of the body being forced off the chassis.

#### Lap Belt Use and Federal Motor Vehicle Safety Standards

Whether large schoolbuses should have lap belts for passengers has been debated since the beginning of Federal rulemaking on schoolbus occupant protection. Since 1977, when new schoolbus safety standards relating to occupant protection were promulgated,

<sup>18/</sup> For more detailed information, read 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).

<sup>19/</sup> For more detailed information, read Highway Accident Report--"Collision of Isle of Wight County, Virginia, Schoolbus with Chesapeake and Ohio Railway Company Freight Train, State Route 615 near Carrsville, Virginia, April 12, 1984," (NTSB/HAR-85-02).

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<sup>19/</sup> For more detailed information, read Highway Accident Report--"Collision of Isle of Wight County, Virginia, Schoolbus with Chesapeake and Ohio Railway Company Freight Train, State Route 615 near Carrsville, Virginia, April 12, 1984," (NTSB/HAR-85-02).

the NHTSA has required schoolbus manufacturers to use compartmentalization for occupant protection rather than requiring the installation of lap belts for passengers in large schoolbuses. Compartmentalization is passive in that an occupant is protected against injury by padding of the seatbacks and restraining barriers and by controlled bending of the seat back or restraining barrier in front of or behind the occupant.

Compartmentalization probably offered the schoolbus occupants some protection when the schoolbus first struck the guard rail and then the sign pillar. Almost immediately, however, the schoolbus body separated from the chassis, and the body rotated up and around the pillar. The resulting high vertical collision angle at least partially negated the compartmentalization provided by the padded seatbacks and restraining barriers in front of the occupants when crash forces propelled them forward out of their seats and over the seatbacks. Because of the 54°-collision angle and because of their size, the heads and upper torsos of these 16- and 18-year-old occupants were not protected from contacting the unpadded interior roof panels of the schoolbus.

The blood and hair found on the interior roof panel above the third seat on the right side of the schoolbus during the postcrash examination was probably from the occupant who sustained fatal head injuries when she was propelled forward from her seat in the fifth row and who was found in the front of the schoolbus body after the collision. The installation and use of a lap belt would probably have prevented the basilar skull fracture sustained by this occupant.

Use of a lap belt would have prevented the occupant in the rear seat on the right side from sustaining the fractured femur. However, the severity of the injuries that would have been sustained by these two occupants if they had been lap belted cannot be determined.

The installation and use of a lap belt by the student seated in the second row on the right side would not have prevented her fatal head injuries. She was seated in the area which was crushed in the collision with the sign pillar, and the seatback of the second seat on the right side was crushed downward and folded forward against the seat frame. This crushing did not provide for survivable space.

Post-crash examination of the lap belt installed in the first seat on the right side of the schoolbus disclosed that the lap belt was not in use at the time of the crash. The occupant of this seat was also in the major impact area, and collision forces probably propelled her forward against the padded restraining barrier resulting in her chest contusion, and out of the area crushed by the collision with the pillar. Use of the lap belt by the occupant of this seat, who sustained minor injuries, probably would have resulted in more severe or even fatal injuries if she had been restrained by the lap belt.

The installation and use of lap belts by the rest of the unrestrained students, who all sustained either minor or moderate injuries, would not have prevented these high school-aged students from striking their heads or possibly even their upper torsos on the padded seatback or restraining barrier in front of them, or in the case of those seated on the right side of the schoolbus, from striking the windows or the sidewall on the right side. These occupants sustained abrasions, lacerations, one fracture, and lumbar and cervical strains, and although lap belt use may have resulted in different injuries, they probably would not have been any less severe.

The speed of the schoolbus was between 59 and 67 mph when it swerved out of control. Although roadway evidence indicates that the schoolbus driver applied the vehicle's brakes about 19 feet before the right front of the schoolbus collided with the guard rail, the brake application and the subsequent collision with the guard rail probably decelerated the schoolbus only about 5 mph before the schoolbus body collided with the sign pillar at a speed calculated to be between 54 and 62 mph.

Due to this relatively high collision speed, the Safety Board considers the crash forces experienced in this accident to be atypical and unusually severe compared to crash forces experienced in most other injury-producing schoolbus crashes. It is even more atypical of schoolbus accidents as a whole, which usually result in only property damage.

In its recently-released special study <sup>20/</sup> of the crashworthiness of 44 large post-1977 schoolbuses, including the schoolbus involved in the St. Louis accident, the Safety Board analyzed the injuries sustained by unrestrained passengers in order to estimate what difference lap belt use might have made. Injury outcome and contact points for 1,119 schoolbus passengers were considered. As a result of this study, the Safety Board concluded:

Lap belt use probably would have made no change in the total number of schoolbus passengers who died in the crashes investigated for this study (possibly one more death would have resulted);

Lap belt use probably would have made no change in the number of surviving schoolbus passengers with severe or worse injuries;

At best, lap belt use probably would have reduced somewhat the injuries of less than a third (8) of the 24 surviving schoolbus passengers with serious injuries in the study and made no change for the majority (12). At worst, it might have increased the injury to almost as many passengers with serious injuries as it improved;

Lap belt use probably would have worsened the outcome for nearly one-fifth of the 58 schoolbus passengers with moderate injuries. The Safety Board cannot determine the effect belt use would have made on the remainder of the passengers with moderate injuries; and

The Safety Board cannot estimate the probable net effect of lap belt use on the unrestrained schoolbus passengers in the study who were uninjured or received only minor injuries; it is unlikely that it would have reduced the minor injuries.

Based upon its findings of its schoolbus study, the Safety Board does not recommend that States or school districts allocate funds to retrofit or order large poststandard schoolbuses with lap belts for passengers, and does not recommend that Federal schoolbus safety standards be amended to require that all new large schoolbuses be equipped with lap belts for passengers.

<sup>20/</sup> "Safety Study: Crashworthiness of Large Poststandard Schoolbuses," op. cit.

## CONCLUSIONS

### Findings

1. The weather and the condition of the highway did not cause or contribute to the loss of control of the schoolbus.
2. There was no mechanical defect which may have caused or contributed to the accident.
3. At the time it went out of control, the schoolbus was traveling between 59 and 67 mph. The schoolbus driver applied the brakes and locked the vehicle's wheels before the collision with the guard rail.
4. The schoolbus struck the guard rail at a 12°-angle at a speed of between 54 and 62 mph.
5. The guard rail at the accident site was of insufficient stiffness and height to prevent the schoolbus body from contacting the sign pedestal and pillar, and the location of the concrete pedestal and sign pillar in combination with the location of the guard rail contributed to the severity of the accident.
6. The schoolbus driver's general medical condition and health were not factors in the accident.
7. The schoolbus driver was operating the schoolbus under the influence of alcohol. Toxicology tests indicated that the schoolbus driver was under the influence of ethyl alcohol at the hospital, approximately 1 hour 22 minutes after the accident. The driver also had cannabinoid metabolites in his blood and urine and phencyclidine in his urine. These findings were consistent with recent illicit drug use, but there was no evidence that he was under the influence of cannabinoids or phencyclidine at the time of the accident.
8. The schoolbus driver's driving record was not sufficiently serious or extensive to automatically disqualify the driver from driving a schoolbus.
9. At the time of the accident, there was no lawful method available to R. W. Harmon and Sons, Inc., to determine the accident driver's complete criminal history in Missouri.
10. In Missouri, in a case where imposition of sentence is suspended after a defendant pleads or is found guilty of a crime, public availability of information about the case is restricted as if the defendant was found not guilty or the case was not prosecuted.
11. Determining a schoolbus driver applicant's driving and criminal record is an essential step in any preemployment screening process.
12. One of the schoolbus passengers sustained a head injury due to contact with an interior body panel joint which was exposed when the maintenance access panel covering the joint's edges separated.

13. Federal Motor Vehicle Safety Standard 221 is flawed because it permits weakly-fastened interior maintenance access panels to be located where passengers could easily contact sharp metal edges created or exposed when these panels separate from adjacent body components during crashes.
14. The schoolbus fuel tank demonstrated the crashworthiness required by Federal Motor Vehicle Safety Standard 301.
15. The separation of the schoolbus body from its chassis had positive safety results in that crash forces which otherwise would have been transmitted to the schoolbus body were expended when the body was forced off the chassis.
16. The installation and use of a lap belt would probably have prevented the fatal basilar skull fracture sustained by the occupant seated in the fifth row on the left side of the schoolbus, and would have prevented the fractured femur sustained by the occupant occupant of the right rear seat.
17. The installation and use of a lap belt would not have prevented the fatal head injury sustained by the occupant of the second seat on the right side of the schoolbus.
18. Use of the installed lap belt by the occupant of the first seat on the right side of the schoolbus probably would have resulted in more severe or even fatal injuries.
19. The installation and use of lap belts by the schoolbus occupants who sustained minor to moderate injuries probably would not have reduced the severity of their injuries.

#### Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the operation of the schoolbus at an excessive speed and in a reckless manner by a driver under the influence of alcohol. Contributing to the severity of the accident was the use of a guard rail of insufficient height and stiffness to deflect the schoolbus body away from the concrete pedestal and sign support pillar.

#### **RECOMMENDATIONS**

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

—to the Federal Highway Administration:

Reissue Federal Highway Administration Notice N 7560.6, "Federal Aid Participation in Highway Appurtenances," and instruct Federal Highway Administration Division Offices to provide copies of the notice to the States. Actively encourage the States to systematically evaluate the performance of crash-damaged highway safety appurtenances and upgrade crash-damaged appurtenances if necessary to meet current design standards. (Class II, Priority Action) (H-87-18)

--to the legislature of the State of Missouri:

Revise the Missouri statutes to ensure that a finding or plea of guilty to one or more of the crimes listed in Senate Bill 707 will disqualify the defendant from operating a schoolbus in the State of Missouri even if imposition of sentence is suspended. (Class II, Priority Action) (H-87-19)

--to 20 selected States and the District of Columbia:

Require, as a part of preemployment screening procedures, that all schoolbus operators in your jurisdiction obtain the driving record for each schoolbus driver applicant for the preceeding 3 years by making inquiry to the appropriate agency in every State in which the applicant held a motor vehicle operator's license or permit for those 3 years. (Class II, Priority Action) (H-87-20)

--to 31 selected States and the District of Columbia:

Require that the criminal records of schoolbus driver applicants be examined, either by the licensing agency in your jurisdiction when a schoolbus driver's license or permit is issued or renewed, or by a prospective employer as part of a preemployment screening procedure. (Class II, Priority Action) (H-87-21)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JIM BURNETT  
Chairman

/s/ PATRICIA A. GOLDMAN  
Vice Chairman

/s/ JOHN K. LAUBER  
Member

/s/ JOSEPH T. NALL  
Member

## APPENDIXES

### APPENDIX A INVESTIGATION

#### Investigation

The National Transportation Safety Board was notified of this accident at 7:00 p.m. on November 11, 1985, by the news media.

A highway accident investigator was dispatched from the Safety Board's Kansas City, Missouri, Field Office and arrived on scene at noon on November 12, 1985. Highway accident investigators were dispatched from the National Transportation Safety Board headquarters in Washington, D.C. and arrived on scene at 11:30 p.m. on November 12, 1985. Participating in the investigation were representatives of the St. Louis County Police Department, R. W. Harmon and Sons, Inc., the Missouri Department of Elementary and Secondary Education, American Transportation Corporation, Navistar Corporation, the Missouri Highway and Transportation Department, and the Federal Highway Administration of the U. S. Department of Transportation.

#### Depositions and Hearing

On October 28, 1986, Safety Board investigators took depositions from representatives of the Missouri Highway Patrol, the Missouri Department of Revenue, American Transportation Corporation, the Missouri Department of Elementary and Secondary Education, R. W. Harmon and Sons, Inc., the Missouri Highway and Transportation Department, and the Federal Highway Administration.

APPENDIX B

FEDERAL MOTOR VEHICLE SAFETY STANDARD 221  
SCHOOL BUS BODY JOINT STRENGTH  
(49 CFR PART 571.221)

§ 571.221 Standard No. 221; School bus body joint strength.

**S1. Scope.** This standard establishes requirements for the strength of the body panel joints in school bus bodies.

**S2. Purpose.** The purpose of this standard is to reduce deaths and injuries resulting from the structural collapse of school bus bodies during crashes.

**S3. Application.** This standard applies to school buses with gross vehicle weight ratings of more than 10,000 pounds.

**S4. Definitions.** "Body component" means a part of a bus body made from a single piece of homogeneous material or from a single piece of composite material such as plywood.

"Body panel" means a body component used on the exterior or interior surface to enclose the bus' occupant space.

"Body panel joint" means the area of contact or close proximity between the edges of a body panel and another body component, excluding spaces designed for ventilation or another functional purpose, and excluding doors, windows, and maintenance access panels.

"Bus body" means the portion of a bus that encloses the bus' occupant space, exclusive of the bumpers, the chassis frame, and any structure forward of the forwardmost point of the windshield mounting.

**S5. Requirement.** When tested in accordance with the procedure of S6.,

each body panel joint shall be capable of holding the body panel to the member to which it is joined when subjected to a force of 60% of the tensile strength of the weakest joined body panel determined pursuant to S6.2.

**S6. Procedure.**

**S6.1 Preparation of the test specimen.**

**S6.1.1** If a body panel joint is 8 inches long or longer, cut a test specimen that consists of any randomly selected 8-inch segment of the joint, together with a portion of the bus body whose dimensions, to the extent permitted by the size of the joined parts, are those specified in Figure 1, so that the specimen's centerline is perpendicular to the joint at the midpoint of the joint segment. Where the body panel joint is not fastened continuously, select the segment so that it does not bisect a spot weld or a discrete fastener.

**S6.1.2** If a joint is less than 8 inches long, cut a test specimen with enough of the adjacent material to permit it to be held in the tension testing machine specified in S6.3.

**S6.1.3** Prepare the test specimen in accordance with the preparation procedures specified in the 1973 edition of the Annual Book of ASTM Standards, published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

**S6.2 Determination of minimum allowable strength.** For purposes of determining the minimum allowable joint strength, determine the tensile

strengths of the joined body components as follows:

(a) If the mechanical properties of a material are specified by the American Society for Testing and Materials, the relative tensile strength for such a material is the minimum tensile strength specified for that material in the 1973 edition of the Annual Book of ASTM Standards.

(b) If the mechanical properties of a material are not specified by the American Society for Testing and Materials, determine its tensile strength by cutting a specimen from the bus body outside the area of the joint and by testing it in accordance with S6.3.

**S6.3 Strength test.**

**S6.3.1** Grip the joint specimen on opposite sides of the joint in a tension testing machine calibrated in accordance with Method E4, Verification of Testing Machines, of the American Society for Testing and Materials (1973 Annual Book of ASTM Standards).

**S6.3.2** Adjust the testing machine grips so that the joint, under load, will be in stress approximately perpendicular to the joint.

**S6.3.3** Apply a tensile force to the specimen by separating the heads of the testing machine at any uniform rate not less than 1/4 inch and not more than 1/4-inch per minute until the specimen separates.

[41 FR 3872, Jan. 27, 1976, as amended at 41 FR 36027, Aug. 26, 1976]

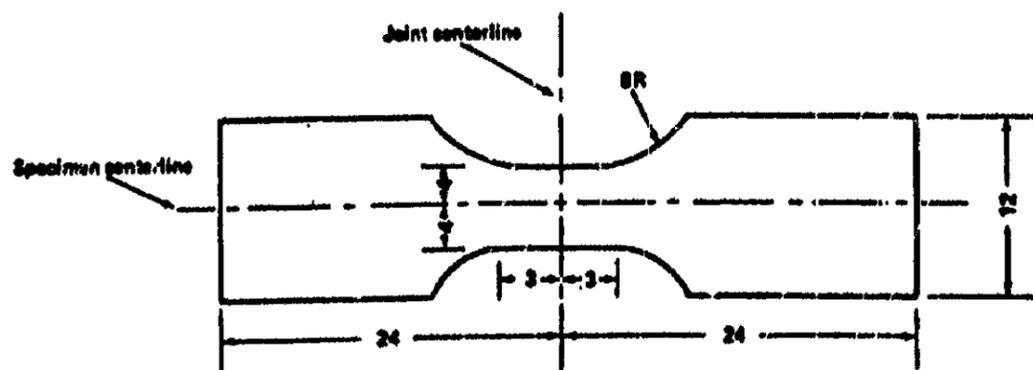


FIGURE 1

APPENDIX C

STATE SCHOOLBUS DRIVER PREEMPLOYMENT SCREENING REQUIREMENTS

STATE	USES PRIVATE CONTRACTORS	REQUIRES DRIVER HISTORY <sup>1</sup>	REQUIRES CRIMINAL HISTORY <sup>1</sup>	RECOMMENDS DRIVER HISTORY <sup>2</sup>	RECOMMENDS CRIMINAL HISTORY <sup>2</sup>
AL	YES	NO	NO	NO	NO
AK	YES	YES	NO	-	NO
AZ	YES	YES	YES	-	-
AR	YES	YES	NO	NO	NO
CA	YES	YES	YES	-	-
CO	YES	YES	NO	-	NO
CT	YES	NO	NO	YES	YES
DE	YES	YES	NO	NO	NO
DC	NO	NO	NO	YES	YES
FL	YES	YES	NO	-	NO
GA	YES	NO	NO	YES	YES
HI	YES	YES	YES	-	-
ID	YES	NO	NO	NO	NO
IL	YES	YES	YES	-	-
IN	YES	NO	NO	YES	YES
IA	YES	NO	NO	YES	NO
KS	YES	YES	NO	-	NO
KY	YES	NO	NO	YES	NO
LA	YES	NO	NO	YES	YES
ME	YES	NO	NO	NO	NO
MD	YES	YES	YES	-	-
MA	YES	NO	NO	YES	YES
MI	YES	NO	NO	YES	NO
MN	YES	YES	YES	-	-
MS	YES	NO	NO	NO	NO
MO	YES	NO	NO	NO	NO
MT	YES	NO	NO	YES	NO
NE	YES	NO	NO	YES	YES
NV	NO	NO	NO	YES	YES
NH	YES	YES	YES	-	-
NJ	YES	YES	YES	-	-
NM	YES	YES	YES	-	-
NY	YES	YES	YES	-	-
NC	YES	YES	YES	-	-
ND	YES	NO	NO	NO	NO
OH	YES	YES	NO	-	YES
OK	YES	YES	YES	-	-
OR	YES	YES	YES	-	-
PA	YES	YES	YES	-	-
RI	YES	YES	YES	-	-
SC	NO	NO	NO	YES	NO
SD	YES	YES	NO	-	NO
TN	YES	YES	YES	-	-
TX	YES	YES	NO	-	YES
UT	YES	YES	YES	-	-
VT	YES	NO	NO	NO	NO
VA	YES	YES	NO	-	NO
WA	YES	YES	NO	-	NO
WV	NO	YES	YES	-	-
WI	YES	YES	YES	-	-
WY	YES	NO	NO	YES	YES

<sup>1</sup>State central records history required by statute or regulation.

<sup>2</sup>State provides guidelines, standards or policy to operators recommending this history. " - " indicates not applicable as state requirement for this history exists (reported in previous columns).