PB89-916201

# Highway Accident Report: Pickup Truck/Church Activity Bus Head-on Collision and Fire near Carrollton, Kentucky, May 14, 1988

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

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## TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract: About 10:55 p.m. eastern daylight time on May 14, 1988, a pickup truck traveling northbound in the southbound lanes of Interstate 71 struck head-on a church activity bus traveling southbound in the left lane of the highway near Carrollton, Kentucky. As the pickup truck rotated during impact, it struck a passenger car traveling southbound in the right lane near the church bus. The church bus fuel tank was punctured during the collision sequence, and a fire ensued, engulfing the entire bus. The busdriver and 26 bus passengers were fatally injured. Thirty-four bus passengers sustained minor to critical injuries, and six bus passengers were not injured. The pickup truck driver sustained serious injuries, but neither occupant of the passenger car was injured.

The safety issues discussed in the report include: effect of alcohol on driver performance, effectiveness of driving-under-the-influence program in Kentucky, current Federal standards used in school bus manufacture, flammability and toxicity of school bus seating materials, emergency egress on school bus, and fuel system integrity of school buses

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## EXECUTIVE SUMMARY

About 10:55 p.m. eastern daylight time on May 14, 1988, a pickup truck traveling northbound in the southbound lanes of Interstate 71 struck head-on a church activity bus traveling southbound in the left lane of the highway near Carrollton, Kentucky. As the pickup truck rotated during impact, it struck a passenger car traveling southbound in the right lane near the church bus. The church bus fuel tank was punctured during the collision sequence, and a fire ensued, engulfing the entire bus. The busdriver and 26 bus passengers were fatally injured. Thirty-four bus passengers sustained minor to critical injuries, and six bus passengers were not injured. The pickup truck driver sustained serious injuries, but neither occupant of the passenger car was injured.

The National Transportation Safety Board determines that the probable cause of the collision between the pickup truck and the church activity bus was the alcohol-impaired condition of the pickup truck driver who operated his vehicle opposite to the direction of traffic flow on an interstate highway. Contributing to the severity of the accident was the puncture of the bus fuel tank and ensuing fire in the bus, the partial blockage by the rear bench seats of the area leading to the rear emergency door which impeded rapid passenger egress, and the flammability of the materials in the bus seat cushions.

The safety issues discussed in the report include:

- effects of alcohol on driver performance,
- effectiveness of driving-under-the-influence program in Kentucky,
- current Federal standards used in school bus manufacture,
- flammability and toxicity of school bus seating materials,
- emergency egress on school buses, and
- fuel system integrity of school buses

Safety recommendations addressing these issues were made to the governors of all 50 State, the State of Kentucky, various private church associations and special activity groups, the National Highway Traffic Safety Administration, and the Federal Highway Administration.

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

# PICKUP TRUCK/CHURCH ACTIVITY BUS HEAD-ON COLLISION AND FIRE NEAR CARROLLTON, KENTUCKY MAY 14, 1988

## INVESTIGATION

### The Accident

About 9 p.m on May 14, 1988, a church activity bus departed Kings Island Amusement Park, Cincinnati, Ohio, on a return trip to the First Assembly of God Church (the Church) in Radcliff, Kentucky. The bus was occupied by the busdriver, 3 adults, and 63 children ranging from 10 to 18 years of age.

The bus traveled southbound on Interstate 71 (I-71) from Kings Island, through Cincinnati, toward Louisville, Kentucky. About 22 miles before reaching Carrollton, Kentucky, the busdriver stopped at a gas station to refuel and allow passengers to use the restroom. Shortly afterward, they departed the gas station and continued on I-71. Passengers on the bus said that most of the passengers fell asleep after the stop and that the bus was quiet.

Meanwhile, about 10:30 p.m., the driver of a vehicle traveling southbound on I-71 about 9 miles north of the Carrollton exit saw a vehicle northbound in the northbound lanes of I-71 cross the grass median strip and change its direction of travel to southbound (in the southbound lanes). The witness stated:

> The vehicle's lights were on bright and he followed me for a while at a distance. The next thing I knew, he came up right on the back of my car with his bright lights still on. Then he came around in front of me. There was a tractor trailer in front of me and he was riding real close to the rear of the truck. The tractor trailer put his brakes on and the vehicle would do the same. He was weaving to some degree and he remained close to the rear of the truck.

The witness further stated that ". . . When it did pass me one time, I saw 'Toyota' on the tailgate" of the pickup truck. The witness indicated that he passed both the pickup truck and the tractor-trailer to get away from what he considered a hazardous situation. The witness exited the highway at the Carrollton ramp (43-mile marker), where he stopped to get cigarettes and

a soft drink, and then resumed traveling southbound on I-71. Near the 39-mile marker, the pickup truck, which at this time was traveling northbound in the left lane of the southbound lanes, passed the witness who was proceeding south in the right lane. The witness honked his horn and flashed his lights to warn the driver that he was going the wrong way, but the pickup driver did not react to the warning. The witness then continued south to a weigh station to notify the police; however, the station was closed.

A man and a woman in a van (motorists) traveling northbound on I-71, stated that they saw a vehicle traveling northbound in the southbound lanes about the 38-mile marker. The woman motorist stated:

> We watched the vehicle [pickup truck] go down the hill, cars and trucks were dodging the vehicle. We kept thinking the person would realize they were going the wrong way and get off.

About 10:55 p.m., near mile marker 40.3, the pickup truck struck the church bus right front to right front in the left southbound lane of I-71. The pickup truck rotated clockwise and struck the left side of a southbound Cadillac occupied by a driver and a passenger. The Cadillac, which had been traveling in the right southbound lane just forward of the bus, veered leftward, crossed in front of the church bus, continued through the median strip, and stopped, straddling the northbound lanes while facing southeast. The driver turned the Cadillac around to face northbound and parked on the right shoulder. The Cadillac occupants stated that they thought that the bus hit the car; they did not recall seeing a pickup truck.

Both van motorists estimated that the pickup truck had been approximately 300 feet ahead of their car (on the opposite side of the highway) and traveling about 50 to 55 mph for about 1 1/2 miles before and until the collision. The woman motorist stated "as soon as they hit, the whole front inside of the bus burst into flames." She also said that the Cadillac crossed the median strip and almost hit their van.

The pickup truck underrode the front of the church bus and was driven backward by the bus. It came to a stop facing the median strip, straddling the white edgeline that divides the right lane from the right shoulder. The bus continued forward and came to a stop straddling the yellow edgeline dividing the left lane from the left shoulder of the southbound lanes of I-71. (See figures 1, 2, and 3.)

At 10:56 p.m. a couple who lived nearby called the Carrollton City Police Department, which immediately notified the Kentucky State Police (KSP); the KSP received the call at 10:59 p.m. and telephoned the Campbellsburg Fire Department (CFD). The husband then went to the accident scene to assist in pulling the bus passengers from the bus.

The CFD (which was located about 10 miles from the scene of the accident) arrived on scene about 11:10 p.m. Firefighters reported seeing flames at all windows and the rear emergency door. After suppressing the flames sufficiently to search the bus for survivors, they determined that

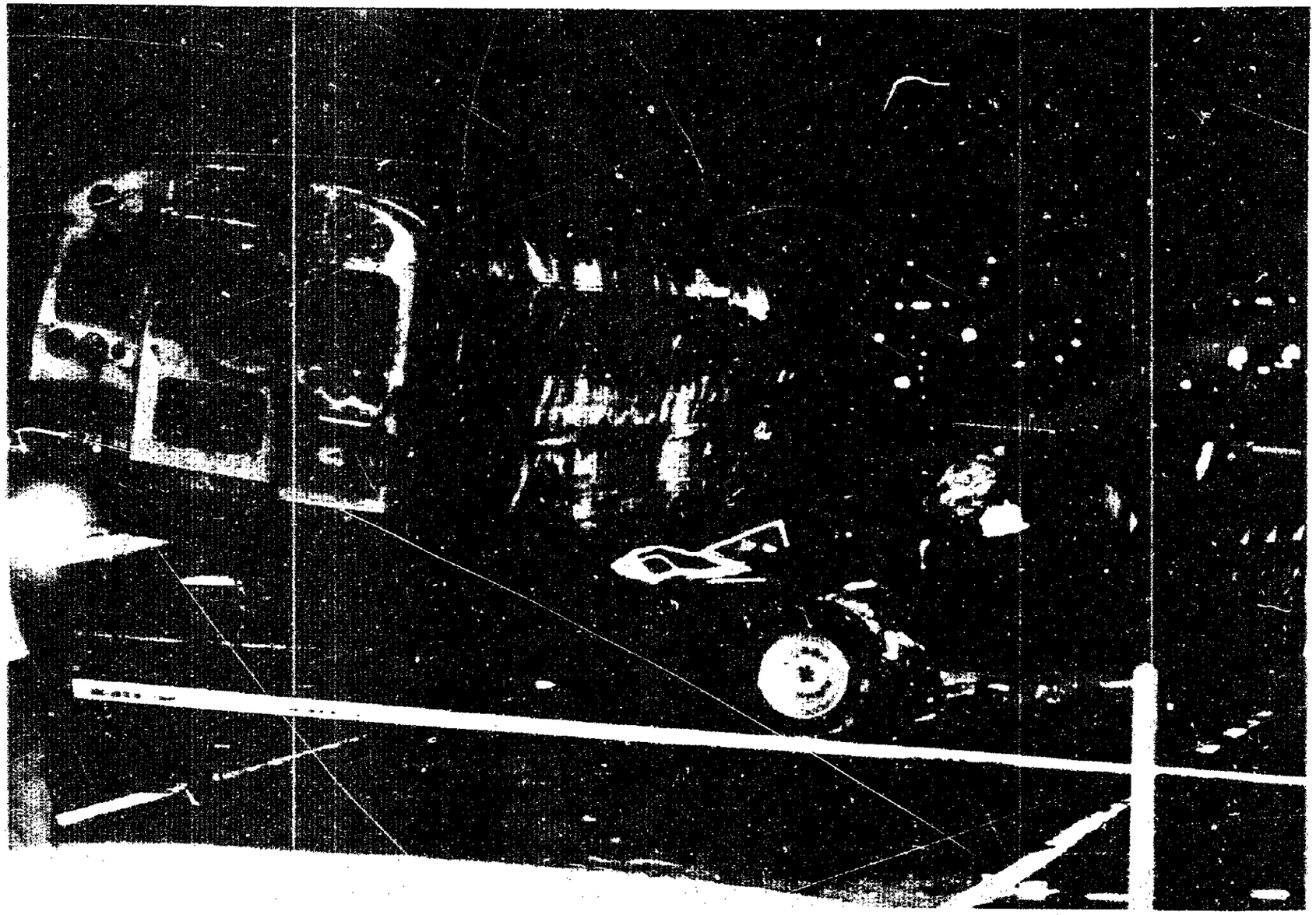

Figure 1.--Vehicles at accident scene

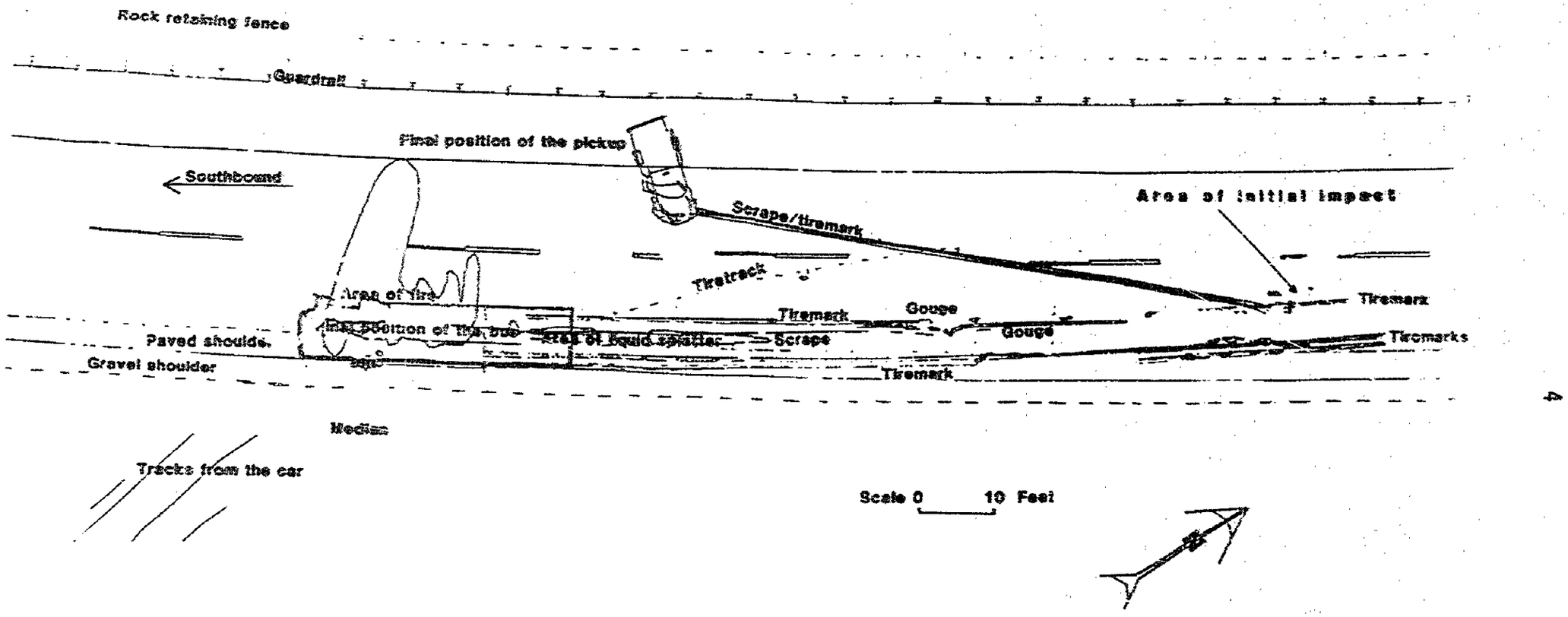


Figure 2.--Enactment of accident scene

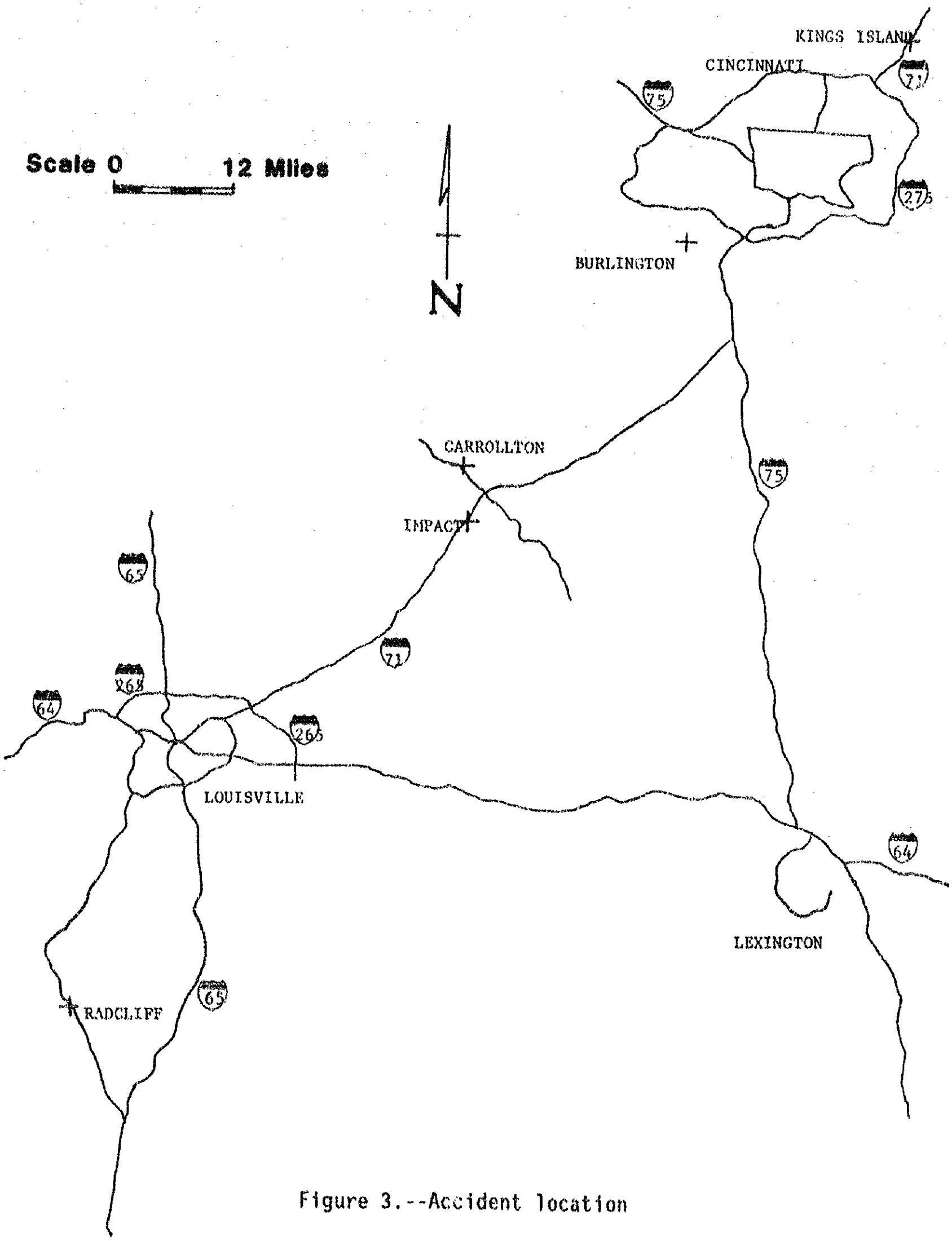


Figure 3.--Accident location

there were none. However, they requested additional emergency units. Two fire engines responded to extinguish fire, and eight state troopers responded to assist in the on-scene investigation and traffic control. Shortly afterward, a triage area was set up; a medical doctor, two registered nurses, two paramedics, and 81 emergency medical technicians treated the injured passengers. A medivac helicopter from Humana Hospital, the University of Kentucky, transported four patients during two trips to the hospital. By 2 a.m., 10 ambulances had transported 39 patients to five area hospitals.

## Injuries

International Civil Aviation Organization Injury Criteria

| | Drivers | Passengers | Other | Total |
|---|---|---|---|---|
| Fatal* | 1 | 26 | 0 | 27 |
| Serious | 1 | 13 | 0 | 14 |
| Minor | 0 | 21 | 0 | 21 |
| None | 1** | 7** | 0 | 8 |
| Total | 3 | 67 | 0 | 70 |

*Refer to Medical and Pathological Information, page 22, for injury causation.
**Includes occupants of the Cadillac.

Abbreviated Injury Scale (AIS)* Table

| | Drivers | Passengers | Totals |
|---|---|---|---|
| Fatally Injured | | | |
| Serious (AIS-3) | 1** | 26 | 27 |
| Nonfatally Injured | | | |
| Critical (AIS-5) | | 7 | 7 |
| Severe (AIS-4) | | 1 | 1 |
| Serious (AIS-3) | 1*** | 5 | 6 |
| Moderate (AIS-2) | | 2 | 2 |
| Minor (AIS-1) | | 19 | 19 |
| None (AIS-0) | 1**** | 7**** | 8 |
| Unknown (AIS-9) | 0 | 0 | 0 |
| Total | 3 | 67 | 70 |

*AIS refers to the abbreviated injury scale of the 1985 Association for the Advancement of Automotive Medicine.
**church busdriver
***pickup driver
****Cadillac occupants

## Church Bus Information and Damage

General.--The 8-foot-wide, 34-foot-long passenger school bus was equipped with a V-8 gasoline engine, automatic transmission, and air-mechanical service brakes. The body was manufactured on March 23, 1977, by the Superior Division of the Sheller-Globe Corporation which stopped manufacturing school bus bodies in March 1981. The 1977 Ford B-700 chassis was manufactured by the Ford Motor Company. The governed maximum within-gear speed at 3,400 revolutions per minute (rpm) is 53.70 mph. At the time of the accident, the bus had been driven about 113,000 miles. The gross vehicle weight rating of the bus was 24,500 pounds, and at the time of the accident, the estimated weight of the bus was about 22,500 pounds.

The bus was equipped with 22 regular bench seats (11 rows on each side) to accommodate a maximum of 66 passengers. The driver's seat was equipped with a lapbelt; there were no passenger seatbelts on the bus. The 39-inch-long, 15-inch-deep seat cushions were constructed of polyurethane foam filler covered with poly(vinyl)chloride material. The top of the seatbacks measured 37 1/2 inches above the floor.

One emergency exit door, 56 inches high and 36 inches wide, was located at the rear of the bus. The aisleway was 12 inches wide at the floor and the seat cushion level and 15 inches wide 30 inches from the floor. The glass in the windows on the sides of the bus were in two separate sections with an aluminum frame separation horizontally across the middle of each window. The top portion of the window glass slid downward, leaving an opening measuring 9 by 24 inches. There were no emergency pushout window exits[1] and none were required.

The Church purchased the accident bus from the Meade County (Kentucky) school district in May 1987 to replace a 1970 school bus. In August 1987, the bus was used by the Church to transport elementary school children daily to a church-operated school. The school was being held in a leased school building about 1 mile from the Church while a school building was being built on church property. The children were transported to the building in the morning, back to the Church for lunch, and on another round trip in the afternoon, a total of 4 miles daily. About twice a month, the bus was used on weekend trips to Louisville, Kentucky, a distance of about 35 miles, and two or three times a year, the bus traveled to Cincinnati, Ohio, and Nashville, Tennessee. The bus made other trips around the area during the year. The average yearly mileage for Church use was 4,000 miles. No bus evacuation drills were conducted by the Church.

On the morning of the accident, the driver and an adult chaperone conducted a pretrip inspection that included putting water and antifreeze in the radiator, checking the fluid levels in the engine, and walking around the bus checking the tires, the front suspension system, and the rear emergency door. Church officials stated that they had recently put new tires on the front wheels of the bus.

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[1] A vehicle window designed to open outward to provide for emergency egress.

Maintenance and Inspection.--The Kentucky Department of Education's (KDE) preventive maintenance program requires that all school districts conduct monthly inspections of all school buses during the entire time school is in session. During its 10-year use as school transportation, the accident bus received regular periodic maintenance work and was inspected monthly and annually by school district mechanics. At the time the Church purchased the accident bus, a safety inspection was performed to comply with the requirements of the Church's insurance company. The Church performed maintenance on the bus on an as-needed basis.

Vehicle Damage.--The right side of the front bumper, grille, and hood were pushed rearward approximately 4 feet. The hood was buckled upward and had a 12-inch-deep, "half-moon" shaped indentation in the front of it. The sheet metal surrounding the right front stepwell area was pushed rearward approximately 18 inches at the bottom skirt of the bus. The right front door came off the bus; however, because the stepwell area sheet metal was pushed upward and rearward, about 1/4 of the doorway opening was obstructed. The front axle had separated from the chassis and had been pushed rearward and had rotated clockwise underneath the bus.

The bus sustained extensive fire damage. The right front of the bus, the entire hood, and the entire roof had burn damage. The left side bumper and grille were not damaged by fire. Fire damaged the entire right side of the bus with the exception of a portion of sheet metal directly behind the right rear wheel well. The left side of the bus also was burned, except for sheet metal in the area directly in front of the left rear wheel well and the bottom panels of sheet metal which extended behind the left rear wheel well to the end of the bus. The top half of the rear emergency door sustained fire damage. The front tires and the right rear tires were burned. The entire interior of the bus was consumed by fire except for metal seat frames and walls. (See figures 4, 5, and 6.)

A 5-pound dry chemical fire extinguisher was mounted in its brackets near the right front area of the dashboard. It had been burned and the head assembly was missing. According to Church officials, the bus also had been equipped with an ax and a box of flares; the ax and flares were not found after the accident.

A 2-inch-wide separation in the floor joint between the first and second rows of seats extended the width of the interior directly above the displaced fuel tank. The first floor section forward of the joint separation was buckled and folded upward. Another opening, approximately 1 by 3 inches, was located at the forward inboard corner of the right rear wheel housing.

The king pin bushings on the front suspension system and the steering system tie rod and drag link were intact. The bus was equipped with nonradial, tube-type tires on all axles. The tire tread depth ranged from 4/32 to 14/32 inch. The pressure of the left rear outside tire was 76 psi. The remaining tires had been damaged by fire and were deflated. The bus was equipped with air-activated, S-cam brakes. Due to the damage, a functional test of the brake system could not be performed.

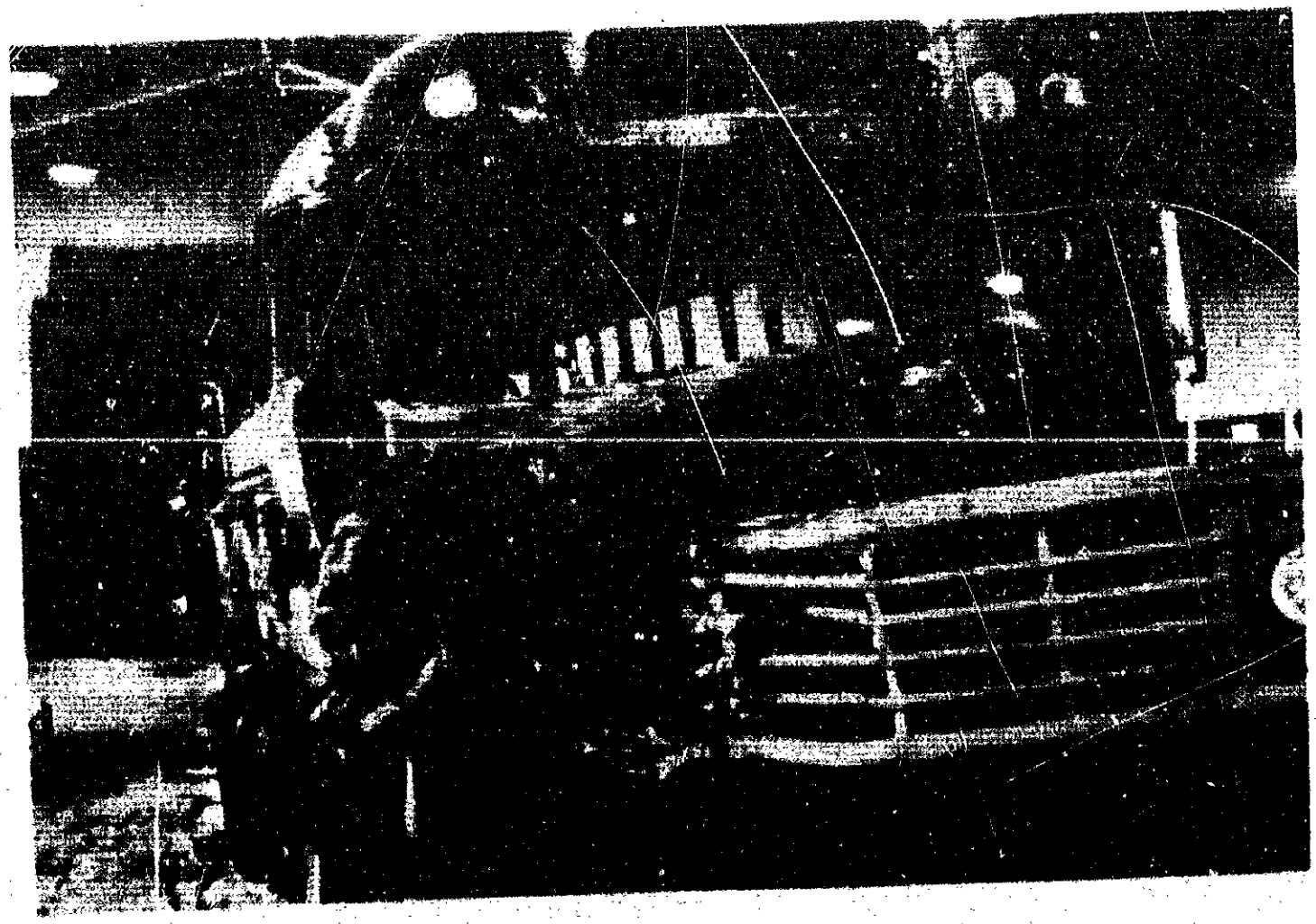

Figure 4.--Front and rear views of church activity bus

The rear axle brakes were inspected by looking through the backing plate openings. The drums were free of cracks and the linings were dry. None of the components were damaged. The brake lining thicknesses on the rear axle

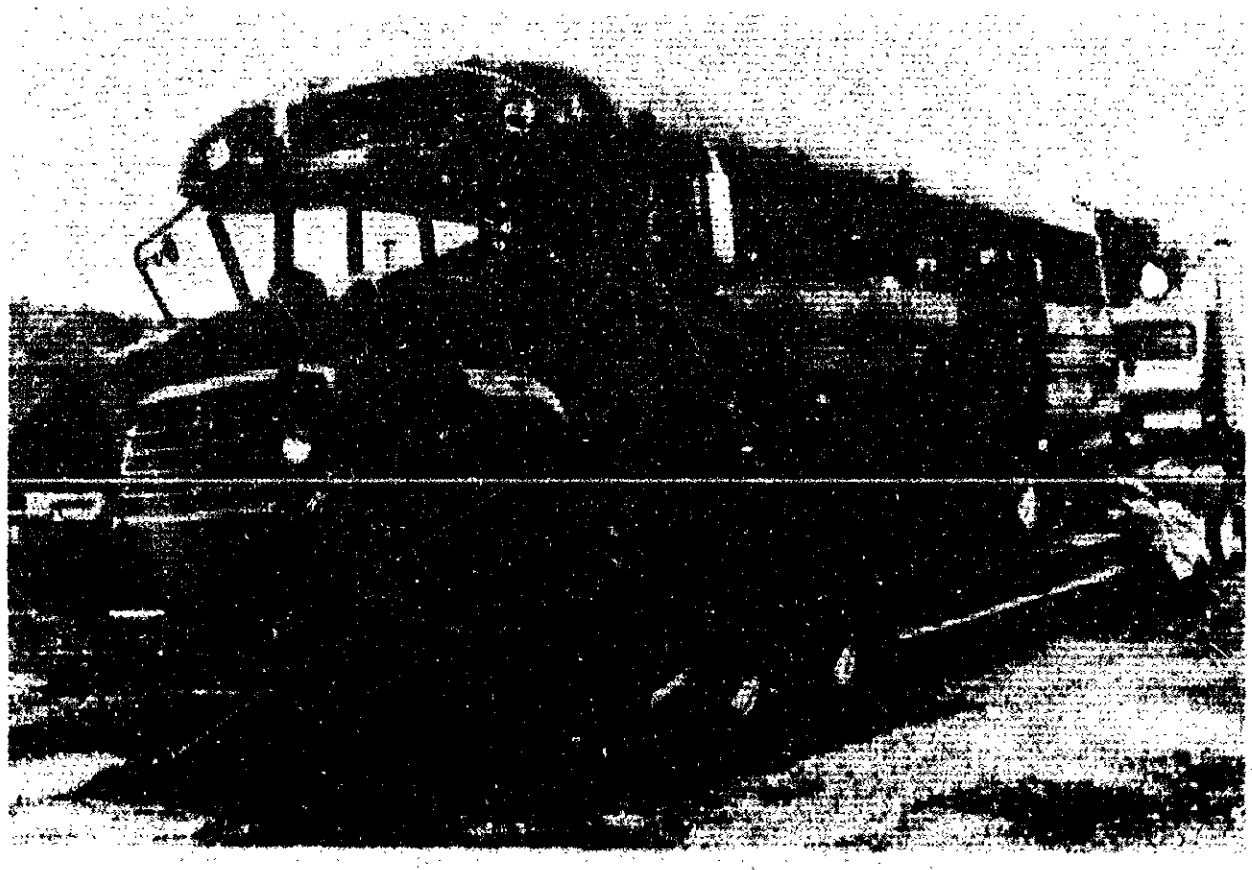

Figure 5.--Side views of church activity bus

brakes measured 12/32 inch. Type 30 brake chambers were installed on the rear brakes; the right rear slack adjuster measured 2 1/8 inch, and the left rear slack adjuster measured 1 3/8 inch. The recommended stroke at which the

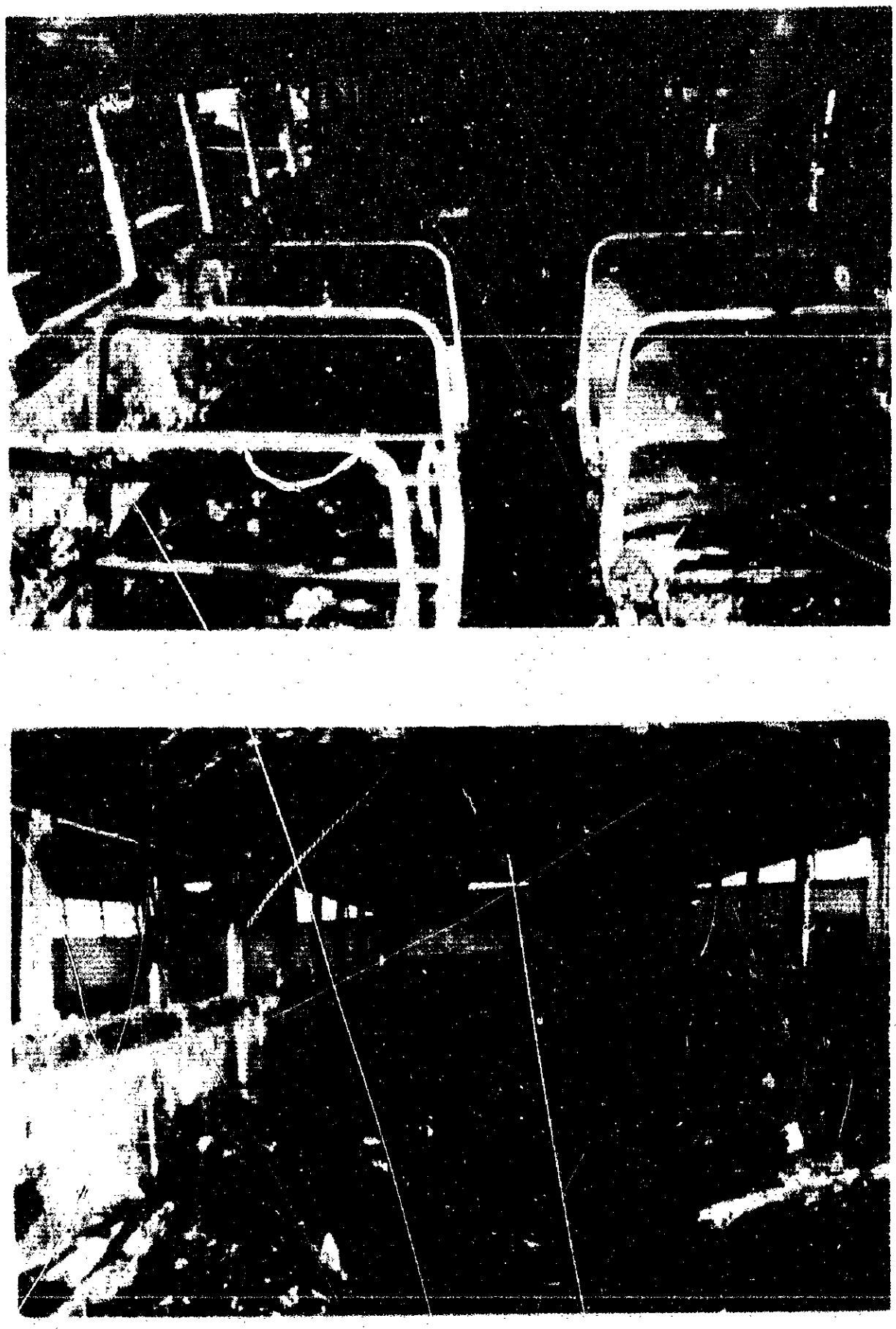

Figure 6.--Interior of church activity bus

brakes should be readjusted is 2 inches. The left front wheel and drum were removed; light surface cracks were found on the drum. The lining was dry and free of cracks. The left front brake lining thickness measured 2/32 inch;

the right front brake lining thickness could not be checked due to the accident damage. With type 24 brake chambers, the left front slack adjuster measured 1 1/4 inch. Brake manufacturers recommend that these brakes be readjusted before the stroke exceeds 1 3/4 inch. On the right front wheel, the S-cam bracket was separated and part of the slack adjuster clevis had been ground off. Pieces of asphalt were found imbedded in the clevis pin area.

The front leaf spring assembly packs on the bus consisted of nine leaves and a shock mount leaf. The upper six leaves of the spring pack were clamped together. Each steel leaf (190,000 pounds per square inch tensile strength) was 3/8 inch thick and 2 1/2 inches wide. The leaf lengths graduated from 19 to 54 inches. The longest leaf (main leaf) had a blunt cut at the front end of the pack, and at the rear end, the main leaf was rolled into a circle where a bolt passed through to attach the spring assembly to the rear hanger. An L-shaped bracket rear hanger was attached to the main frame rail with three rivets and a bolt on the lower flange and two rivets on the side of the rail.

The right front leaf spring and the right side of the front axle had separated from the chassis and had been pushed rearward. The left front leaf spring and the left side of the front axle were still intact but separated from the chassis. The rim on the outside right front wheel was pushed inward about 1 inch, and one lug nut and bolt was missing from the wheel. The automatic transmission oil pan was torn open at the right rear corner and the transmission fluid was missing. Grooves approximately 1/2 inch deep by 1 inch wide started at the front universal joint of the drive shaft and continued rearward approximately 24 inches, leaving a spiraling imprint to a point where the drive shaft had separated.

The fuel tank was found approximately 28 inches rearward of its original position as indicated by a mark made by the rear retaining strap. The forward strap was severed. The investigating police officer informed Safety Board investigators that part of the fuel tank rearward movement was caused by the tow truck operator as he attempted to secure chains to the fuel tank to remove the bus. The front of the tank contained a 5-inch-square dented (inward) area on the right midsection of the front end of the tank. A 3-inch-long horizontal gash was found in the middle of the dent.

**Fuel System.**--The church bus had been stopped to fill the gasoline tank after leaving the amusement park and had been driven approximately 22 miles before the accident. Based on information provided by the bus chassis manufacturer, an estimated 3 gallons of fuel would have been used in this distance, leaving approximately 57 gallons of fuel in the 60-gallon capacity tank.

The fuel tank had been certified that it met the testing requirements of 49 CFR 393.65, Fuel Systems, by its manufacturer, Kysor/Michigan Fleet Equipment, a Division of Kaiser Industries Corporation, Grand Rapids, Michigan. It was constructed of rectangularly shaped, 12-gauge steel with a filler neck attached to the top right side of the tank. A nonstandard fuel

cap[2] was installed on the filler neck. Two 1 1/2-inch-wide retaining straps held the fuel tank onto the chassis.

Ford Motor Company incorporated provisions to meet Federal Motor Vehicle Safety Standard (FMVSS) 301 during its production of the school bus chassis in 1976. A Ford Motor Company representative testified at the public hearing on this accident that Ford began production of the fuel systems in August 1976 to comply with the Federal changes required in 1977. (See Federal Activity on Bus Safety, page 29, for more information.) The accident bus was not equipped, nor was it required to be equipped, with a fuel tank guard to comply with the crash tests set forth in FMVSS 301 as of April 1977. (Fuel tank guards were not required by FMVSS 301 even as of April 1977; however, fuel tank guards are a very common means by which manufacturers meet the requirements of FMVSS 301.) However, a fuel tank guard was available as optional equipment before April 1977. Some Ford fuel tank guards are constructed of 1/4- to 1/2-inch-thick tubular steel. The tube widths are either 2 x 2 inches, 2 x 3 inches or 2 x 4 inches, depending on the tube's placement around the tank. (See figure 7.) The steel is hot rolled and then pickled in oil (or cleaned in hydrochloric acid) which makes it corrosion-resistant.

The forwardmost side of the Ford fuel tank (the side of the fuel tank that can be seen when looking from the front of the bus toward the rear) measures 218.6 square inches. About 116.3 square inches of this area is covered by the type of fuel tank guard used by Ford, and 102.3 square inches is left uncovered. Thus, for the forward side and the rearward side of a fuel tank, 46.8 percent of the tank is not covered by the tank guard. The inboard and outboard sides of the tank measure 866.6 square inches. (The inboard side of the fuel tank is the side adjacent to the frame rail.) About 565.9 square inches, or 65.3 percent of the outboard side of the tank is uncovered; more of the inboard side is covered because of its position next to the frame rail. The top and bottom of the fuel tank are not covered by the fuel tank guard.

Another Ford representative testified that in 1977 about 96 percent of the school bus-type chassis manufactured by Ford were gasoline-powered and 4 percent were diesel-powered. In 1988, about 1/3 of the engines were gasoline-powered and the remaining 2/3 were manufactured with diesels. Also, Ford manufactured a few liquefied petroleum fueled school bus chassis.

One Ford Motor Company representative testified, "Before 1977, 98 percent of the bus population that [Ford] built was for school buses, 2 percent were nonschool buses. In 1988, the current model, it is 98.7 percent as school buses and 1.3, very similar." The representative explained that Ford also receives orders for chassis for buses to be used for other than school transportation, such as transportation of prisoners and military personnel.

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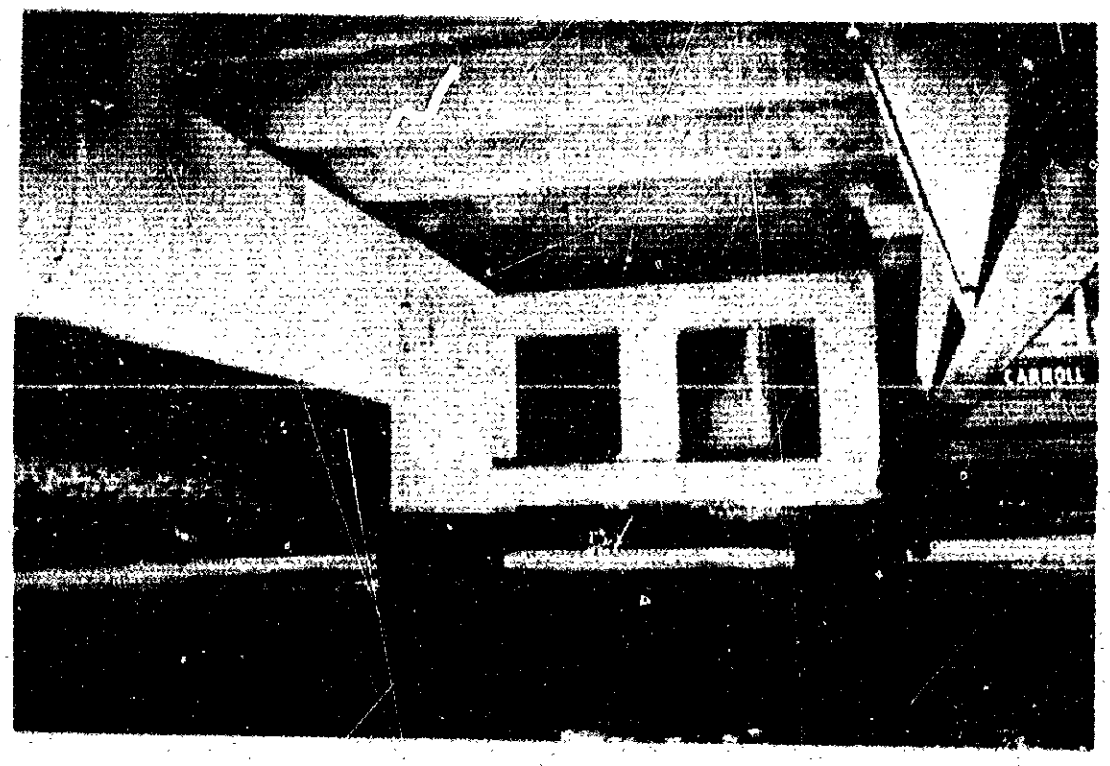
[2]On the accident bus, the fuel cap was actually a cap used for a plumbing pipe.



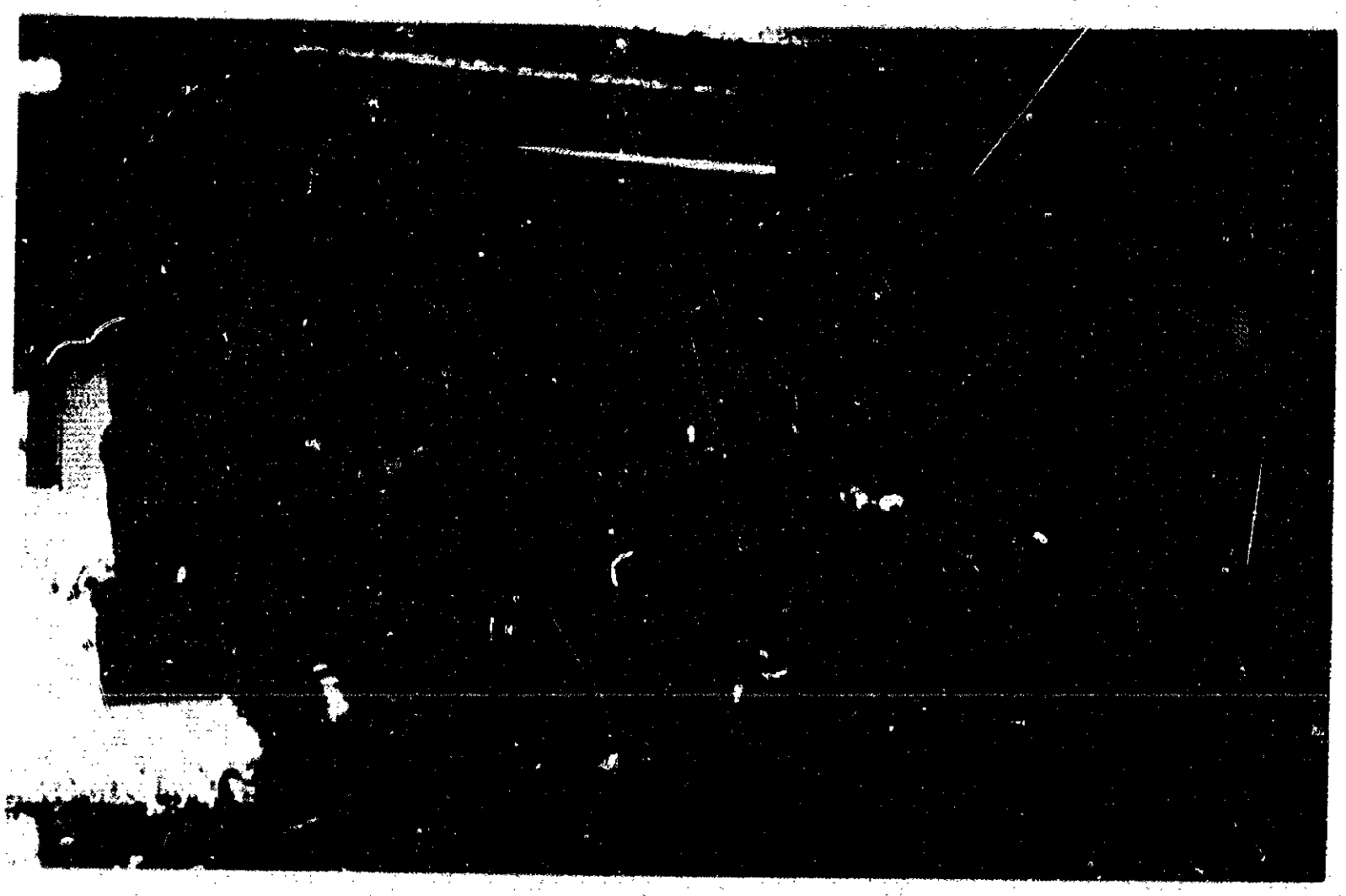


Figure 7.--Fuel tank guards

## Other Vehicle Information and Damage

Passenger Car.--The 1977, four-door Cadillac Sedan DeVille was equipped with a V-8 gasoline engine, automatic transmission, power brakes, and power steering. The vehicle was also equipped with lap and shoulder seatbelts. The driver owned the vehicle.

The left rear door was scraped and dented, with the damage extending diagonally upward to the left rear vinyl roof. The left rear door window was broken and pieces of glass along with broken pieces of red plastic taillight lens were strewn throughout the rear of the car. "Toyota" was printed on one piece of the taillight lens. Grass and mud were trapped near the front license plate of the car. Blue paint samples from the Cadillac were visually matched with blue paint chips found on the left rear of the pickup truck. Also, a piece of blue vinyl roof material imbedded in the left rear corner of the pickup truck was visually matched to the damaged blue vinyl roof material of the Cadillac. No mechanical inspection was conducted on the car. (See figure 8.)

Pickup Truck.--The 1987 Toyota 4x4 pickup truck was equipped with a four-cylinder gasoline engine, five-speed manual transmission, power brakes, and power steering. At the time of the accident, the odometer registered 32,082 miles. The estimated weight of the pickup truck was 3,415 pounds. The pickup truck was owned by the driver.

The entire front and right front side of the pickup truck were severely damaged during impact. The front hood had separated and the roof had buckled upward. The front engine compartment was depressed rearward. The right front A-pillar had been pushed rearward and outward, and the right front door was ajar and pushed rearward 18 inches. The right front dashboard was pushed rearward into the passenger seat. The right front wheel had separated from its axle and twisted to the right. Glass from the front windshield had shattered and folded downward, and glass from the right and left doors was missing. The left rear side body panel was scraped and dented, and the left rear corner of the bumper was pushed inward. The left rear taillight was broken off and a piece of blue vinyl material had snagged on the damaged bumper. Blue paint transfers were located on the left rear side of the truck and yellow paint transfers were located on the front bumper and grille area of the truck. The right front bumper was pushed rearward approximately 36 inches. A lug nut and bolt from the right front wheel of the bus was found in a crevice of a frame member and an imprint of the lug nut and bolt was located on the front bumper immediately to the left of the front license plate area. (See figure 9.)

The postaccident mechanical inspection revealed that the truck was in fifth gear at the time of the accident. The estimated maximum within-gear speed for fifth gear is 106.45 mph. The tires had adequate tread depth (7/32-9/32 inch), and although no functional tests of the brakes or the steering system could be performed due to the extensive damage, no apparent defects were noted.

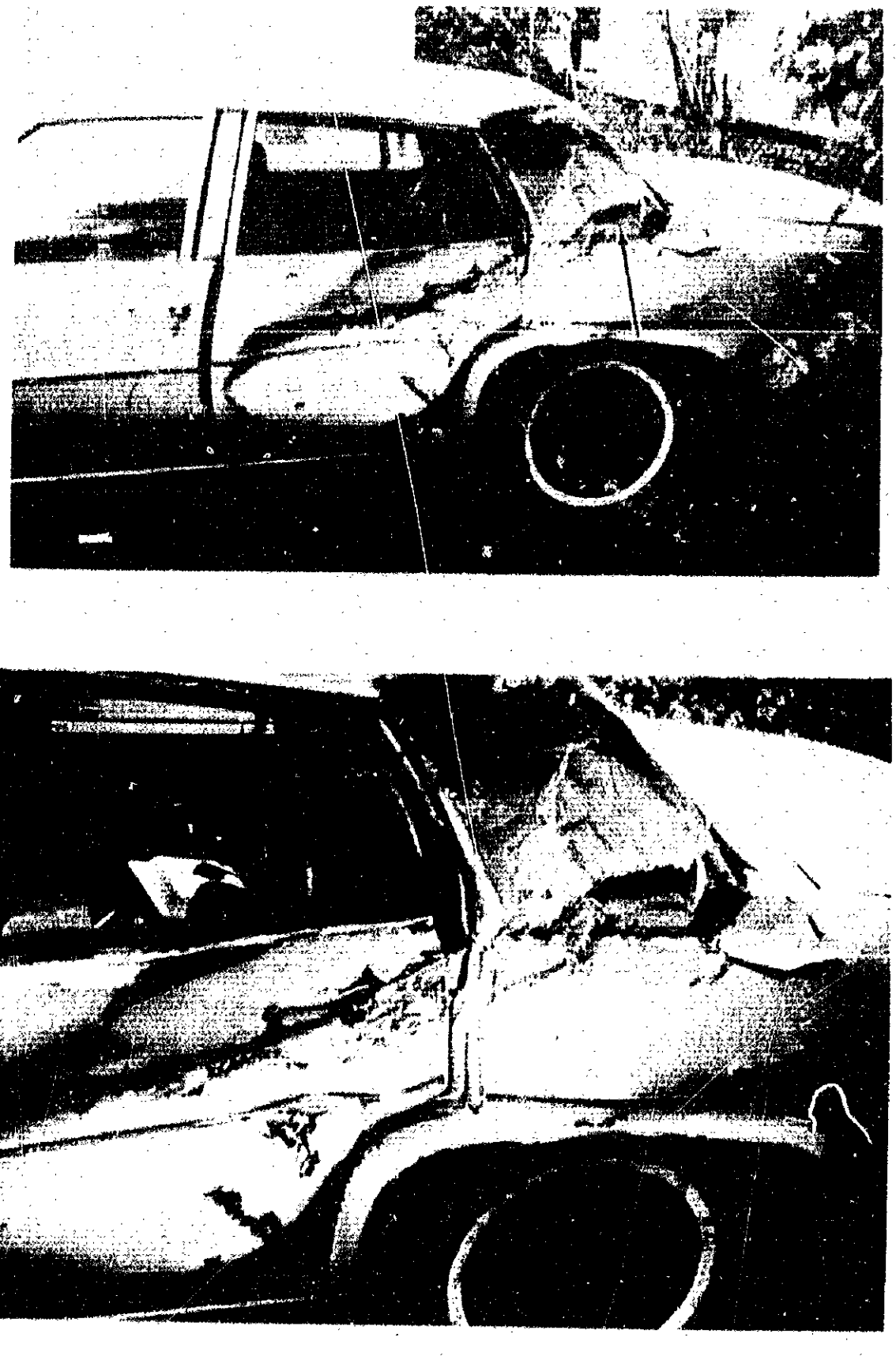
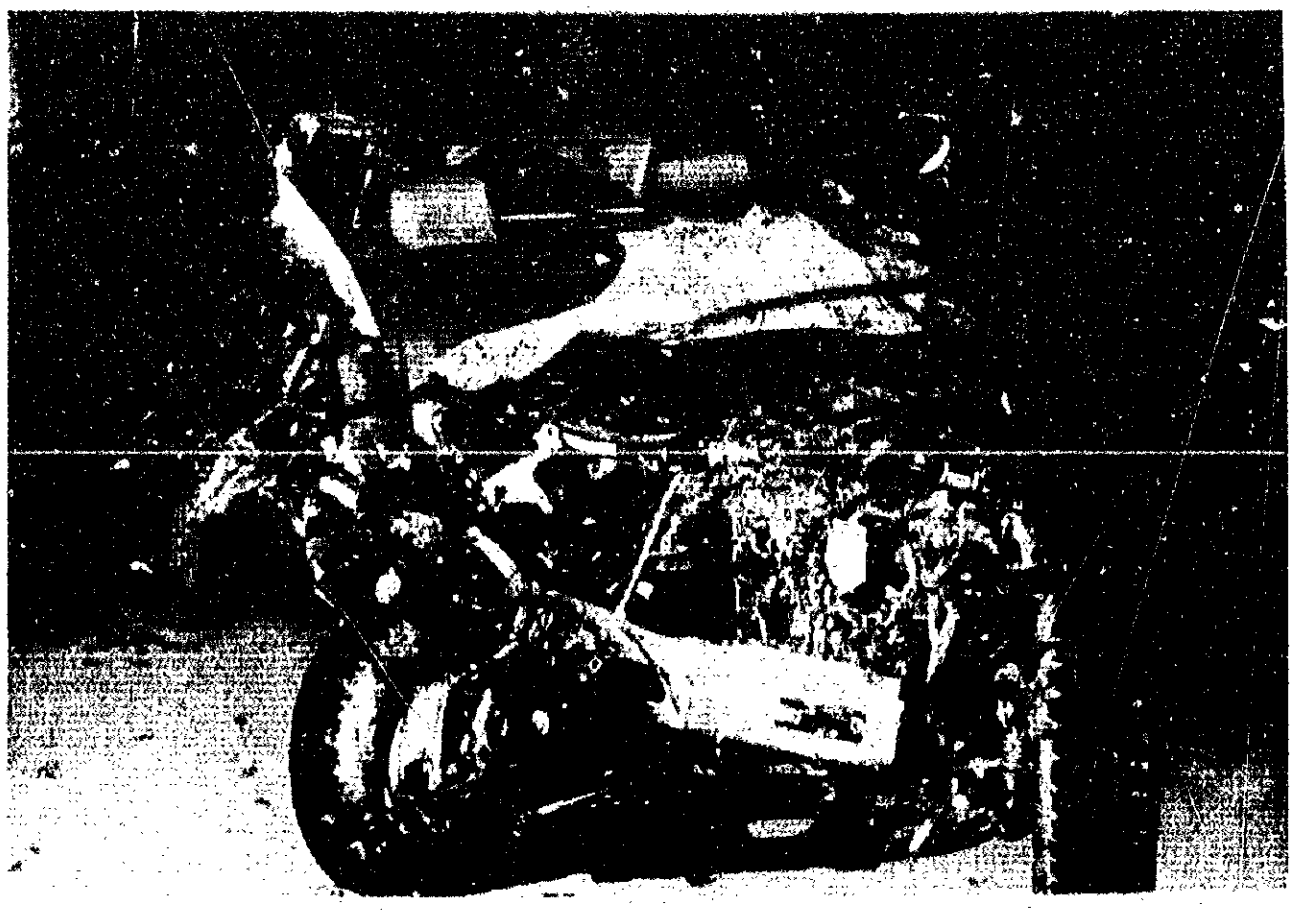


Figure 8.--1977 Cadillac.

**Driver Information**

Passenger Car Driver.--The 34-year-old Cadillac driver held a valid Ohio driver's license with a restriction for corrective lenses.

Busdriver.--The 36-year-old busdriver held a valid Kentucky driver's license with a restriction for corrective lenses. At the time of the accident, Kentucky did not require busdrivers to obtain a chauffeur's



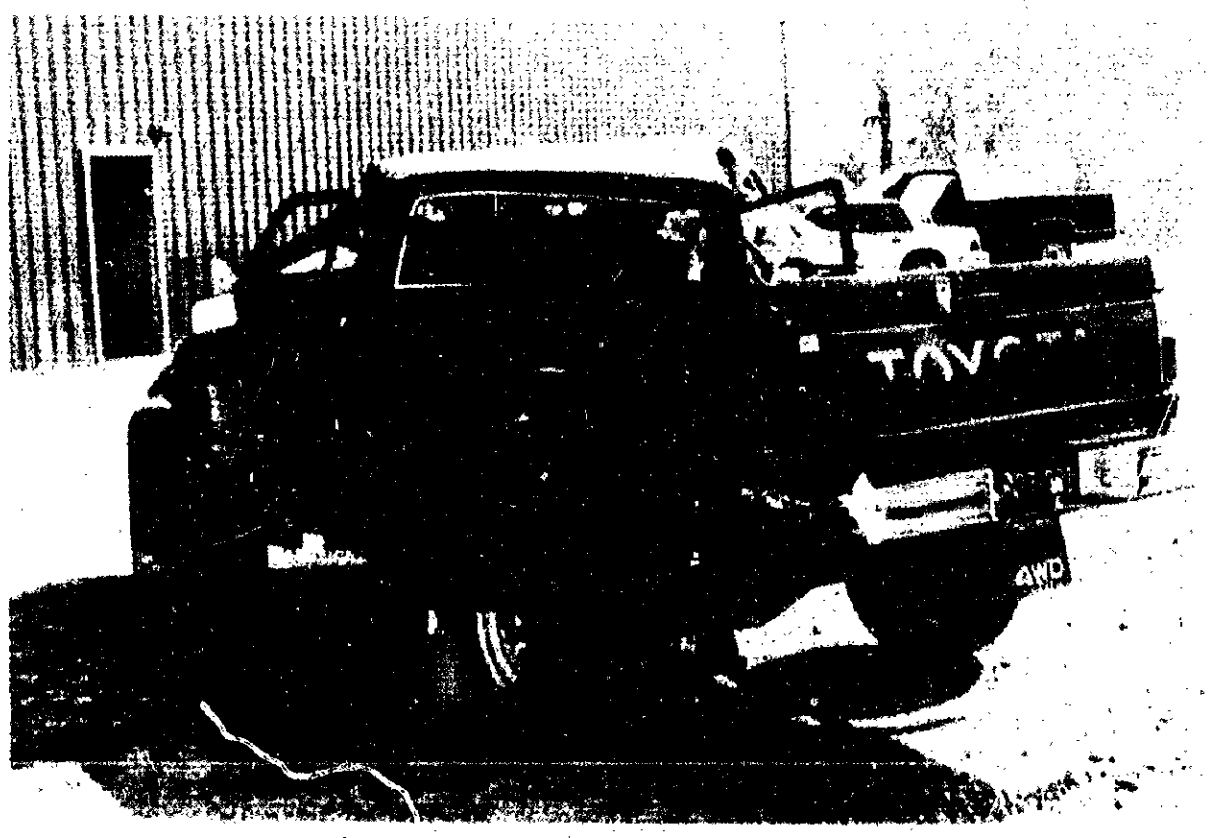


Figure 9.--Pickup truck

license. A review of the busdriver's driving record revealed no violations or accidents. The busdriver was employed by Hardin County Circuit Court as a clerk and served as an associate pastor at the First Assembly of God Church

in Radcliff, Kentucky. He had about 20 years of experience driving heavy lumber trucks and buses (about 3 times a week until the time of the accident). For the past 4 years, he had driven buses for the church; he had driven the accident bus since it was purchased in 1987.

The busdriver wore corrective lenses for a far-vision deficiency. Otherwise, according to his wife, he was in good health. His wife stated that he was wearing contact lenses on the morning of the accident.

After work on May 11-12, 1988, the busdriver supervised children at the Church school and on May 13, he coached a community girls' ball team after work. He reportedly arrived at the church grounds about 6 a.m. on May 14 to prepare for the trip to Kings Island Amusement Park. The bus was scheduled to leave about 7:30 a.m. but did not leave until 8 or 8:30 a.m.; it arrived at the amusement park at 11:40 a.m. The busdriver and other adult chaperones supervised the children while at the park. The busdriver was the only driver of the bus for the entire day.

Pickup Driver.--The 35-year-old pickup driver held a valid Kentucky driver's license with no restrictions; he had an endorsement on his license that allowed him to drive motorcycles. A review of his driving record showed that on March 24, 1984, the pickup driver was stopped for failing to dim his headlights and weaving. A breathalyzer reading of 0.16 percent blood alcohol content (BAC) was obtained and he was charged with driving under the influence (DUI) of alcohol. He was arrested and later released on $350 cash bond. On April 19, 1984, he pleaded guilty to the charge; he was fined $140 and was instructed to attend an Alcohol Driver Education (ADE) course, which he completed on July 28, 1984. On August 23, 1984, he was stopped at a roadblock (where the police were checking for drivers licenses and vehicle registrations) while operating a motorcycle and was cited for failure to possess a motorcycle operating permit. The pickup driver applied for and obtained a motorcycle permit on August 27, 1984, and the court dismissed the motor vehicle charge. On October 6, 1984, the pickup driver was involved in an accident when the motorcycle he was driving skidded out of control on wet pavement; no citation was issued as a result of the accident.

On February 28, 1980, the pickup driver was arrested for "terroristic threatening" and disorderly conduct as a result of a complaint from an ex-wife. In court on March 6, 1980, the charge of terroristic threatening was dismissed; he was found guilty of disorderly conduct and fined $50 plus court costs. On December 2, 1982, the pickup driver was again arrested for disorderly conduct in the parking lot of a pizza parlor. According to the complaint, he had been involved in a fight and, when the police arrived, he began using foul language in public. On January 6, 1983, he was found guilty and fined $100 plus court costs. On May 13, 1983, the pickup driver was charged with hunting raccoon during closed season with a gun in his possession. On June 3, 1983, he was found guilty and fined $50 which was suspended. He was charged $37.50 in court costs.

The pickup driver dropped out of high school in the 10th grade in 1969. He married in 1972, fathered a son, and was divorced in 1979. In 1982, he

remarried and fathered a daughter born with spina bifida.[3] As a result of his daughter's hospitalizations and operations, the pickup driver incurred substantial medical expenses, and in 1984, he declared bankruptcy. In 1987, the couple divorced, and the pickup driver was required to pay child support and alimony. In January 1988, he resumed living with his first ex-wife and their 15-year-old son in a rented trailer in Carrollton; he was living there at the time of the accident.

From 1979 to 1981, the pickup driver worked as a deckhand for Clean Coal Company, and from 1981 to 1984 he worked on a farm. From 1984 until the time of the accident, he was employed at M&T Chemical Company in Carrollton, where he was first employed as a laborer and later became a chemical operator. His job required that he make batches of chemicals and operate mixers, centrifuges, dryers, and other equipment. Several of the pickup driver's supervisors and co-workers said that he was a quiet person with a good attendance record and a hard worker. No one had noticed any mood changes in the pickup driver while he was at M&T Chemical Company.

The pickup driver's last routine physical examination was performed at his place of employment on October 14, 1987. His medical records indicated that at that time he smoked about 1 1/2 packs of cigarettes a day and he drank about 6 beers per week. His pulse and blood pressure were normal for his age. His glaucoma test was normal and he had uncorrected 20/20 vision.

Medical insurance records indicated that the pickup driver had been treated for a duodenal ulcer in March 1988. He had been prescribed Zantac 150, a basal gastric acid secretion inhibitor. The active ingredient in Zantac tablets is ranitidine hydrochloride, which is a histamine $H_2$ receptor antagonist;[4] the usual therapy for this is 4 weeks. The original prescription was for 20 tablets; the prescription was not refilled.

At 7 p.m. on the evening of May 13, 1988, the pickup driver began to work a 12-hour shift which ended at 7 a.m. on May 14, 1988. He worked similar 12-hour shifts on the three previous days. According to his first ex-wife, on May 12, he slept 3 hours; on May 13, he slept about 6 hours; and on May 14, he slept about 5 hours. According to coworkers and friends, the pickup driver's sleeping habits were unremarkable. When working the night shifts, he slept during the morning, and when working the day shifts, he slept during the night. Night and day shifts were alternated by the company every 6 weeks. Factory supervisors stated that the pickup driver was always alert when at work.

About 2 p.m. on May 14, a bar owner saw the pickup driver drinking beer at his bar in Carrollton. According to his father, the pickup driver stopped about 3 or 3:30 p.m. at his parents' house to pick up his mail. He was later

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[3]A developmental spinal anomaly characterized by defective closure of the encasement of the spinal cord.

[4]Physicians' Desk Reference, 42nd Edition, 1988. Medical Economics Company, Oradell, New Jersey.

seen by a co-worker from M&T Chemical Company about 3:30 or 4 p.m. at another bar in Carrollton where he drank one beer and left about 1/2 hour later. About 5 or 5:30 p.m., he stopped at a drugstore in Burlington, Kentucky (about 1 hour from Carrollton), where he visited a female friend for a few minutes. She said that the pickup driver told her that he needed to talk and that he was confused. She stated that she smelled alcohol on his breath but that he was not drunk and that she arranged to meet him that night at 10 p.m. in a local bar in Burlington.

About 7:30 p.m., he visited another friend, who lived a mile from the pickup driver. The friend stated that the pickup driver was in a good mood and that they ate pizza and drank beer until about 8:30 p.m. At that time, the pickup driver went to another friend's house and met other friends; they proceeded to still another friend's house at 9 p.m. According to two of the friends, the pickup driver got out of his pickup truck with a beer in his hand and was laughing, talking, and joking more than usual. Both friends testified that they could tell that he had been drinking. One friend testified that the pickup driver had wanted to meet a female friend in Burlington, but that he (the friend) removed the keys from the pickup truck to prevent the pickup driver from driving. The friend said that he figured that the pickup driver would get stopped for driving under the influence of alcohol and that he would go to jail. The friend returned the keys to the pickup driver about 45 minutes later because the pickup driver said that he was only going to his home, which was a short distance away. However, the friend said that when the pickup driver left about 10 p.m., he did not turn into the roadway toward his trailer.

As a result of the accident, on May 16, 1988, the pickup driver was charged with 27 counts of capital murder. On July 22, 1988, the grand jury indicted him on 27 counts of murder (not capital), 13 counts of first degree assault, 44 counts of wanton endangerment, and 1 count of driving under the influence of alcohol (second offense). Trial is still pending.

## Highway Information

General.--Interstate 71 is a four-lane highway that extends approximately 350 miles between Cleveland, Ohio, and Louisville, Kentucky. In the area of the accident, the roadway winds gently through hills and valleys with shallow radius curves connecting to straight or tangent sections with a series of spiral curves. Near the accident site, two lanes in each direction are divided by a 60-foot-wide sloped grass median strip. There was a large hill adjacent to the southbound lanes bordered by a rock retaining fence to prevent boulders from rolling onto the road. The 12-foot-wide lanes are bordered on the right side by a 10-foot-wide paved shoulder and on the left side by a 3-foot-wide paved shoulder. The accident occurred about 4 1/2 miles south of the Carrollton exit (mile marker 40.3) on the southbound side in a $3^{0}$ curve to the right (1,900-foot-radius). This portion of the roadway has a superelevation of 0.056 foot/foot and a 1.6 percent upgrade that begins 2,200 feet north of the impact area.

The section of I-71 at the accident site was opened to traffic on July 15, 1969. The pavement was last resurfaced in 1982. Raised pavement

markings were installed between the lane lines at 80-foot increments in April 1985. Thermoplastic pavement markings, including yellow and white edgelines and white, broken lane lines, were installed during August and September 1986. At the time of the accident, the pavement markings were in good condition.

The Kentucky Department of Highways (KDH) reported that the most recent average daily traffic count (ADT) for this section of I-71, had been performed in 1987 about 2 miles south of the accident site. The ADT was 7,361 vehicles northbound and 7,732 vehicles southbound, for a total ADT of 15,093 vehicles.

Highway Signing.--The speed limit at the accident site was raised from 55 to 65 mph in June 1987. On May 16, 1988, the KDH conducted an investigation of all interchange and interstate signing near the accident scene. The investigation found all required signing to be in place at the three interchanges near the accident location.

Safety Board investigators observed "Wrong Way" and "Do Not Enter" signs at several interchanges and turn prohibition signs at ramp locations; the signs were in fair to excellent condition. Also, "No U-Turn" signs were posted in the median strip at paved emergency vehicle turnarounds. No signs were posted at the gravel turnarounds in the median strip. The interchanges immediately adjacent to the accident site generally had the necessary signing specified in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD). "One-Way" signs and pavement markings specified in the MUTCD were not used near the interchanges.

Seven median turnaround areas were located in the 6-mile stretch of highway from the accident site south to the nearest exit (U.S. Route 421); four were paved turnarounds with U-turn prohibition signs and three were gravel turnarounds with no signs. A paved turnaround and an unpaved turnaround were located 2.4 and 4 miles north, respectively, of the accident site.

Accident History.--From 1985 through 1987, 29 accidents on I-71 occurred between mile markers 39 and 41: 1 resulted in a fatality, 12 resulted in 22 injuries, and 16 involved property damage. A check of KDH records back to 1982 revealed no wrong-way accidents on I-71 between mile markers 34 and 43 (U.S. Route 421 and the Carrollton exits, respectively).

Description of Accident Site.--The area of initial impact was about 1,717 feet north of mile marker 40 or about mile marker 40.325. Dual tire skidmarks began about 119 feet north of the final rest position of the bus. A 20-foot-long gap was found in the middle of these skidmarks. The right dual tiremark was lighter in color than the left dual tiremark. About 34 feet beyond the start of the tiremarks, a 2-inch-wide scrape mark became a gouge as it continued for about 24 feet before ending in a sharp hook shape. After a 9-inch-long gap, the gouge continued for another 15 inches. After this gouge ended, another 1-inch-wide gouge began and continued for 64 feet. Several short scrapes, gouges, and chop marks were found in the area of the initial impact. From the area of impact to the final rest position of the

pickup truck (about 78 feet), a scrapemark and tiremark appeared. Faint segments of a tiremark extended diagonally from the right lane to the left shoulder. Four deep tire tracks in the grassy median strip continued in the same path as the tiremark. The heaviest burn area on the pavement appeared to be under the bus in an area about 5 to 12 feet from the front of the bus and from the center of the bus to the right side. Also, several deep impressions were found in the burned pavement. (See figure 10.)

## Meteorological Information

At 10:50 p.m., the weather at Louisville was reported as clear with 7 miles of visibility; temperature--68° F; dewpoint--61°, and winds were from the northwest at about 3 knots.

## Medical and Pathological Information

The pickup driver was admitted to the hospital with head and chest injuries and abdominal trauma. Neither occupant of the Cadillac was injured.

Twenty-seven bus occupants, including the busdriver were fatally injured. Thirty-four bus passengers, including one adult, sustained minor to critical injuries. Six bus passengers were not injured. The most seriously injured passengers sustained thermal burns on the head, neck, shoulders, and arms as a result of the fire. A number of the survivors were treated for smoke inhalation (acute respiratory distress) and corneal burns. While several passengers said they struck the seatbacks in front of them during the impact, none received any serious or incapacitating injuries from the collision. However, many passengers received minor injuries while attempting to exit the bus. (See figure 11.)

According to the autopsy summaries provided by the State of Kentucky medical examiner, the fatally injured bus occupants had carboxyhemoglobin saturation (measure of carbon monoxide in the blood) ranging from 26 to 78 percent. Twenty-four fatally injured occupants had a carboxyhemoglobin saturation of less than 60 percent. The generally accepted fatal level for carboxyhemoglobin saturation is 60 percent or greater.[5] Fires generally produce other toxic products besides carbon monoxide that contribute to death. However, fire fatality studies show that carboxyhemoglobin saturation is frequently 50 percent or greater.[6] At 50 percent carboxyhemoglobin saturation, carbon monoxide victims may lose consciousness when standing erect or on exertion. Nine fatally injured bus occupants had a carboxyhemoglobin saturation above 50 percent. The medical examiner indicated that there was no correlation between the location of the victim and the carboxyhemoglobin saturation. Toxicological analysis of four of the victims revealed alcohol in their blood. The medical examiner listed the

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[5] Smith, H., Glaister's Medical Jurisprudence and Toxicology, 13th Edition, Churchill Livingstone, London, 1973, pp. 565-70.

[6] Birky, M. M.; Halpin; B. Kaplan; Y. et. al., Fire Fatality Study, Fire and Matter, Volume 3, pp. 211-217, 1979.

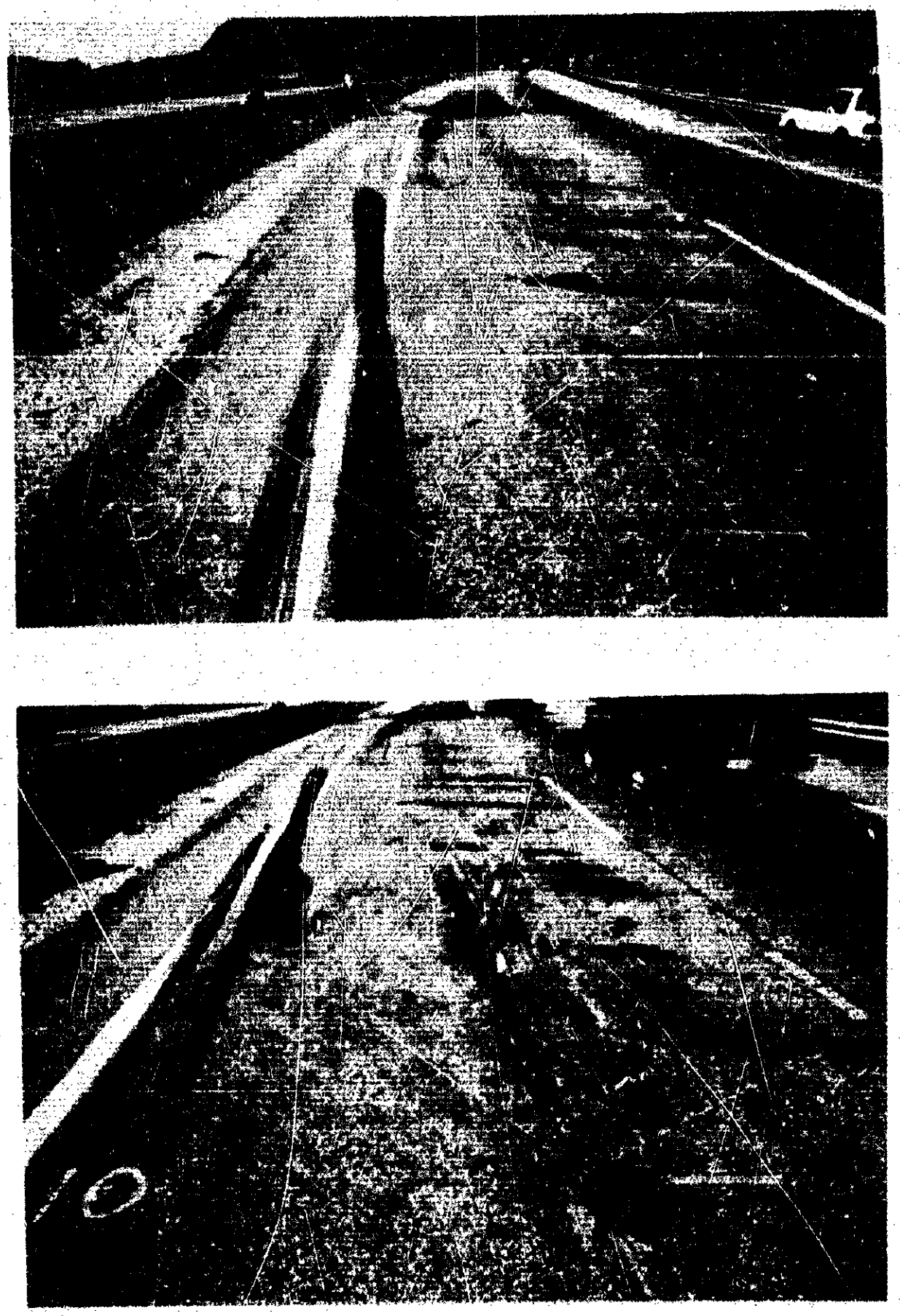

Figure 10.--Highway site

cause of death of all fatalities as "smoke inhalation"; none of the fatalities were caused by crash injuries.

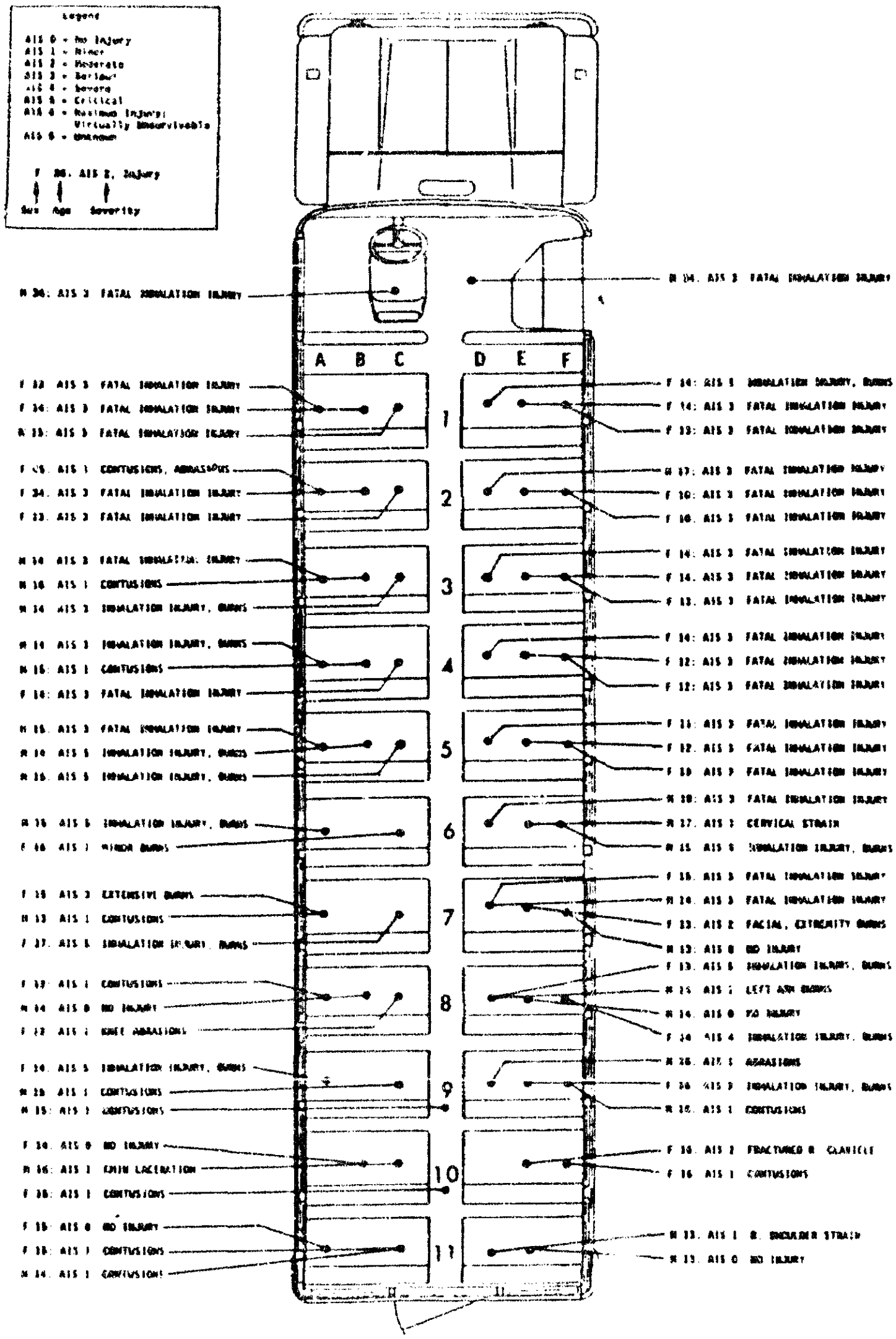


Figure 11. Bus seating and injury chart.

Toxicological tests of tissue taken from the busdriver for alcohol and other drugs were negative. A sample of the pickup driver's blood taken about 1 1/2 hours after the accident tested positive for ethyl alcohol at 0.26 percent and negative for other drugs. The tests were performed by the Center for Human Toxicology at the University of Utah. A blood sample taken at the same time by Humana University Hospital was tested by the KSP; it was positive for ethyl alcohol at 0.24 percent.

## Survival Information

General.--Twenty-eight bus passengers were interviewed by Safety Board investigators. Many said that they were awakened just before impact. They stated that they felt the brakes being applied and the bus swerve to the left before impact. They saw flames which they described as an "orange glow" and the thick smoke between 1 and 5 seconds after impact. A passenger seated in the left side aisle seat of the last row stated that she did not see the fire from the front but that she saw a trail of fire on the road through the bottom window of the emergency door "about 3 to 4 seconds after we hit. It was after we were still skidding that I [saw] it."

Passengers had carried onto the bus small, 6-pack ice coolers; stuffed animals; balloons; hats; bags of snack foods; and purses. At least four cans of hair spray were on the bus. Some coolers were under the seats, some were in between the seats, and at least one was in the aisle. None of the passengers remembered seeing the coolers when they attempted to exit the bus and they assumed that they had been kicked under the seats. Passengers stated that none of the items struck them during the collision. They also stated that before the collision, a boy in the rear of the bus had been lying down in the aisle and a girl had been sitting in the aisle on a cooler. Several passengers were sitting on each other's laps.

According to rescue personnel, neither the pickup driver nor the occupants of the Cadillac were using seatbelts at the time of the accident. It could not be determined if the busdriver had been using his seatbelt during the collision. After the accident, the busdriver was found in the aisle between the fourth and fifth rows. An adult chaperone, who had been standing in the stepwell at the time of the accident, was found on the front floor of the bus facing the right front entrance door.

Emergency Egress.--A passenger seated in the 11th row pulled the handle for the rear emergency door, kicked it once and the door opened. Two passengers attempted to kick out windows from the inside but were unsuccessful. The only surviving adult passenger, who had been seated in the second row, escaped through an open side window. Fourteen of the 28 passengers interviewed stated that they were pulled from the bus by other people; six passengers said that they "passed out." Passengers described others as screaming and running toward the rear exit door and pushing and shoving to get out of the bus. Passengers said that their egress was hampered by smoke, flames, and other passengers. Passengers in the rear of the bus estimated that it took 10 to 15 seconds to exit the bus. Passengers near the middle of the bus estimated that it took about 45 seconds to exit the bus.

The survivors seated at the rear of the bus said that they were able to exit the bus immediately after it stopped; other passengers said they stood up and were pushed back down again by other people. Some said that they started climbing over the seatbacks to get to the rear, but that the seats got too hot and they had to go into the aisle which was blocked by other passengers trying to get to the rear. Some survivors said that they climbed over other passengers to get out. One passenger described plastic dripping on them from the ceiling.

Witnesses who had stopped at the accident site said that two or three bus passengers climbed out the windows and that several passengers exited the bus through the rear emergency door.

The woman van motorist stated:

> . . . several kids came out the back door running down the road away from the bus. The back door was open before we got to them and no one else was there. At the time we got to the bus, the kids were packed in the door all trying to get out at once and couldn't go anywhere.

The nearby resident who had reponded to the scene stated:

> Well, they would come in spurts. . . . it seemed like [there] would be three or four coming at a time, and then--well, it seemed like forever before any more would come out.

One witness climbed on the bus bumper and pulled passengers from the top of the rear door exit. In all, three witnesses assisted passengers through the rear emergency door until flames prevented them from returning to the bus.

Although the church had not conducted emergency evacuation drills, most of the passengers had participated in drills conducted by their school districts. However, having experienced the evacuation from the accident bus, many of the survivors stated that the emergency evacuation drills held at school were not realistic.

The bus rear door was about 56 inches high and about 36 inches wide. However, the two rear bench seats infringed on the emergency exit door space as much as 24 inches in width leaving an aisle width leading to the rear exit door of 12 inches at the floor and 15 inches at the top of the seatback. (See figure 12.)

Passengers on the accident bus ranged from heights of 5 feet 2 inches to 6 feet 5 inches and weighed 98 to 168 pounds. According to the Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design, 1977, the 95th percentile male is 6 feet 1 inch tall and weighs 190 pounds. The seated hip width for the 95th percentile male is 14.7 inches and 15.8 inches for 95 percentile female; the average for male and female is 15.3 inches.


Figure 12.--Prestandard school bus emergency exit doorway

## Test and Research

Dry Surface Friction and Night Visibility Tests.--On May 18, 1988, dry surface friction and visibility tests were conducted at the accident site using a passenger car equipped with radar. The surface friction tests resulted in a range of coefficients of friction between .63 to .68.[7]

Because of the curvature of I-71 and the large hill adjacent to the southbound lanes near the accident site, two night visibility tests were conducted about 11 p.m. with a pickup truck and a school bus similar to those

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[7]A number representing the resistance to sliding two surfaces in contact; the drag factor of a vehicle or other object sliding on a roadway or other surface which is level. Baker, J. Stannard, Traffic Accident Investigation Manual, 1975.

involved in the accident (including age, make and model). Observers and videocamera equipment were placed in both vehicles. The headlights of the pickup truck were on high beam, the position in which the switch on the accident pickup truck was found after the accident. For the same reason, the headlights of the test bus were on low beam during the tests. In the first test, both vehicles were placed in the southbound lanes about 500 feet on either side of the collision area. The pickup truck was moved forward at 100-foot increments until it was positioned 100 feet from the collision area while the school bus remained stationary at the 500-foot-mark north of the collision area.

In the second test, the school bus was moved to stationary positions 400 and 300 feet north of the collision area while the pickup truck was moved forward from the 500-foot position in 100-foot increments during each of the school bus placements. When the school bus was 300 feet north of the collision area and the pickup truck was 400 feet south of the collision area, the headlights on the pickup truck were dimmed for comparison. The pickup truck moved into the right southbound lane at the same position and then back into the left southbound lane; both were moved up to 200 feet and 100 feet on either side of the collision area.

The night visibility tests revealed:

-- At 800 to 900 feet apart, the headlights were visible on both vehicles.

-- At 600 to 700 feet apart, although observers on the bus could see the headlights of the pickup truck, they could not differentiate when the pickup truck changed position from the left lane to the right lane.

-- At 700 feet apart, the difference in light intensity was not discernible to observers on the bus when the headlights of the pickup truck were changed from low to high beam.

-- At 400 to 500 feet apart, observers on the bus determined that the pickup truck was on the southbound side of the highway.

-- At 200 feet apart, observers on the bus could clearly see that the pickup truck was in the southbound lanes of the highway.

-- The observers in the pickup truck could perceive the bus about 100 feet sooner than the observers on the bus could perceive the pickup truck because of the height and additional lights on the school bus.

-- The observers on the bus noted that the pickup truck headlights blended with the oncoming northbound traffic

because of the curvature of the roadway despite the 60-foot-wide median strip.

Metallurgy Tests.--The right front leaf spring and its rear hanger were examined by a Safety Board metallurgist. The metallurgist found that fracturing and deformation of the leaf spring assembly was consistent with a rearward and inboard force applied to the spring attachment point on the hanger. Grinding marks were found on the first and third leaves of the leaf spring assembly. Removal of the hanger bolt and bushing revealed moderate wear on the bolt shank near the threads and two longitudinal cracks in the bushing.

Vehicle Examination.--Safety Board investigators compared the visual evidence (witness marks) on various components of the bus and pickup truck to determine what may have produced the damage. In particular, investigators were interested in determining what may have produced the damage patterns, including the puncture, on the fuel tank, the drive shaft, the leaf spring assembly, and the transmission oil pan.

Witness marks on the damaged right leaf spring assembly were compared with scrapes and gouges in the road. The marks on the third leaf tab appeared to be compatible with the gouges in the road surface. Asphalt deposits were found on the leaves at the front end of the leaf spring assembly. The damaged (abraded) end of the right front leaf spring assembly was compared with damage patterns on the fuel tank. (See figure 13.) The size and shape of the area of penetration of the fuel tank were consistent with the damaged end of the leaf spring assembly. Other areas of damage (deformation) on the forward side of the fuel tank could not be readily reconciled with the leaf spring assembly, especially given the absence of surface abrasion marks in certain areas. (See figure 14.)

## Federal Activity on Bus Safety

Federal Motor Vehicle Safety Standards.--The National Traffic and Motor Vehicle Safety Act of 1966 authorized the National Highway Traffic Safety Administration (NHTSA) to establish Federal Motor Vehicle Safety Standards (FMVSS) (49 CFR Part 571) for vehicle manufacturers. From 1967 to 1973, the NHTSA issued 19 safety standards on school buses that covered such critical items as brakes, window glazing, seat systems, and flammability. In 1974, Congress directed the NHTSA to establish or upgrade school bus standards in eight areas, including emergency exits, interior occupant protection, floor strength, seating systems, crashworthiness of the body and frame, vehicle operating systems, windshields and windows, and fuel systems.

In response to Congress, the NHTSA added school bus provisions to existing standards for buses and multi-purpose vehicles and instituted certain new standards applicable to school buses only. These changes and additions were in effect for school buses manufactured after April 1, 1977; a few had been phased-in before this date.

Federal school bus standards, like most FMVSS, are performance-related standards. That is, manufacturers must design the vehicle subsystems in such

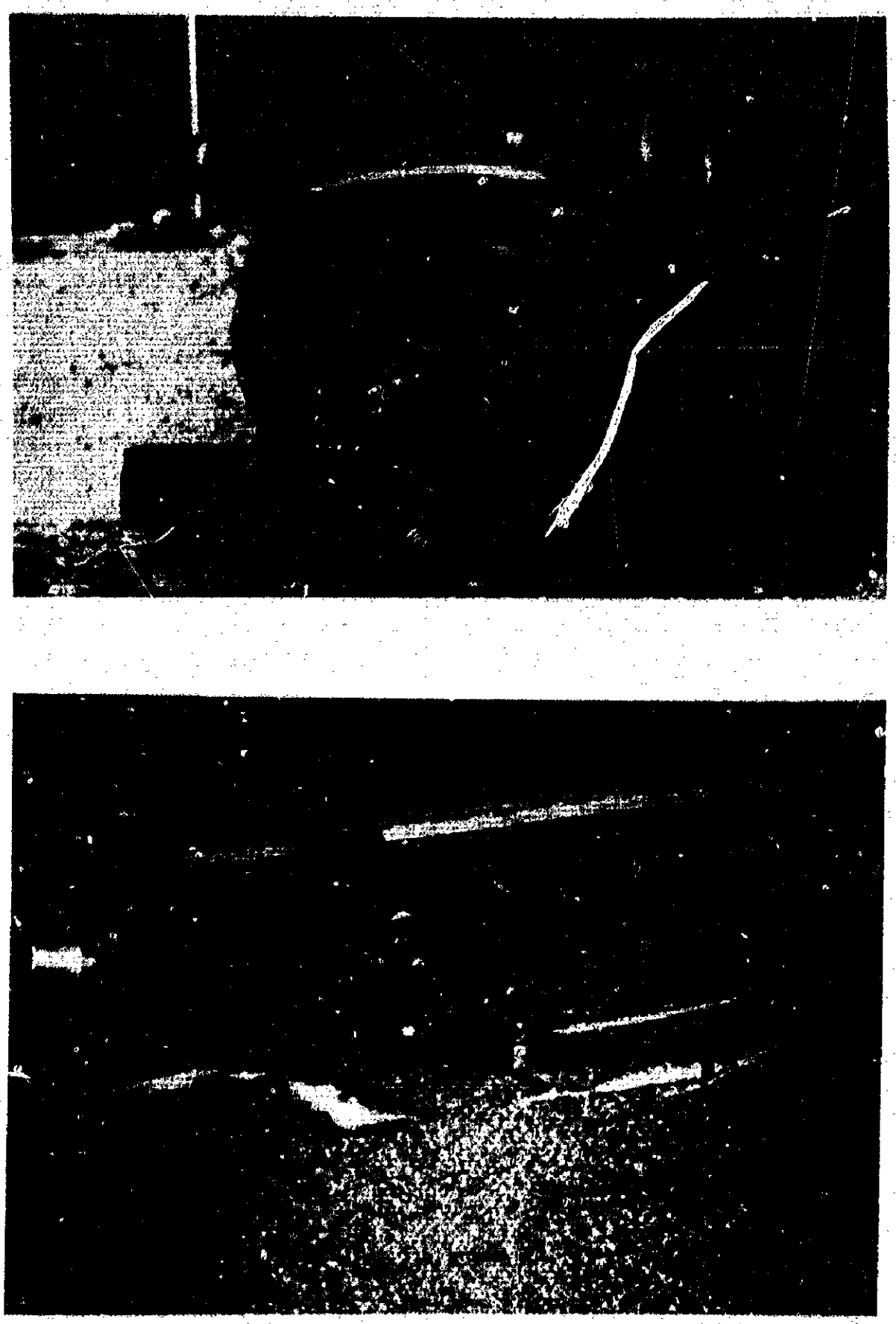

Figure 13.--Damaged fuel tank and leaf spring being compared to the roadway

a manner that they can pass specific performance tests outlined in the standard. The school bus standards establish the minimum level of performance acceptable, with certain exceptions (i.e., maximum seat spacing, minimum seatback height, rear emergency door clearance); the standards do not establish manufacturing design specifications.

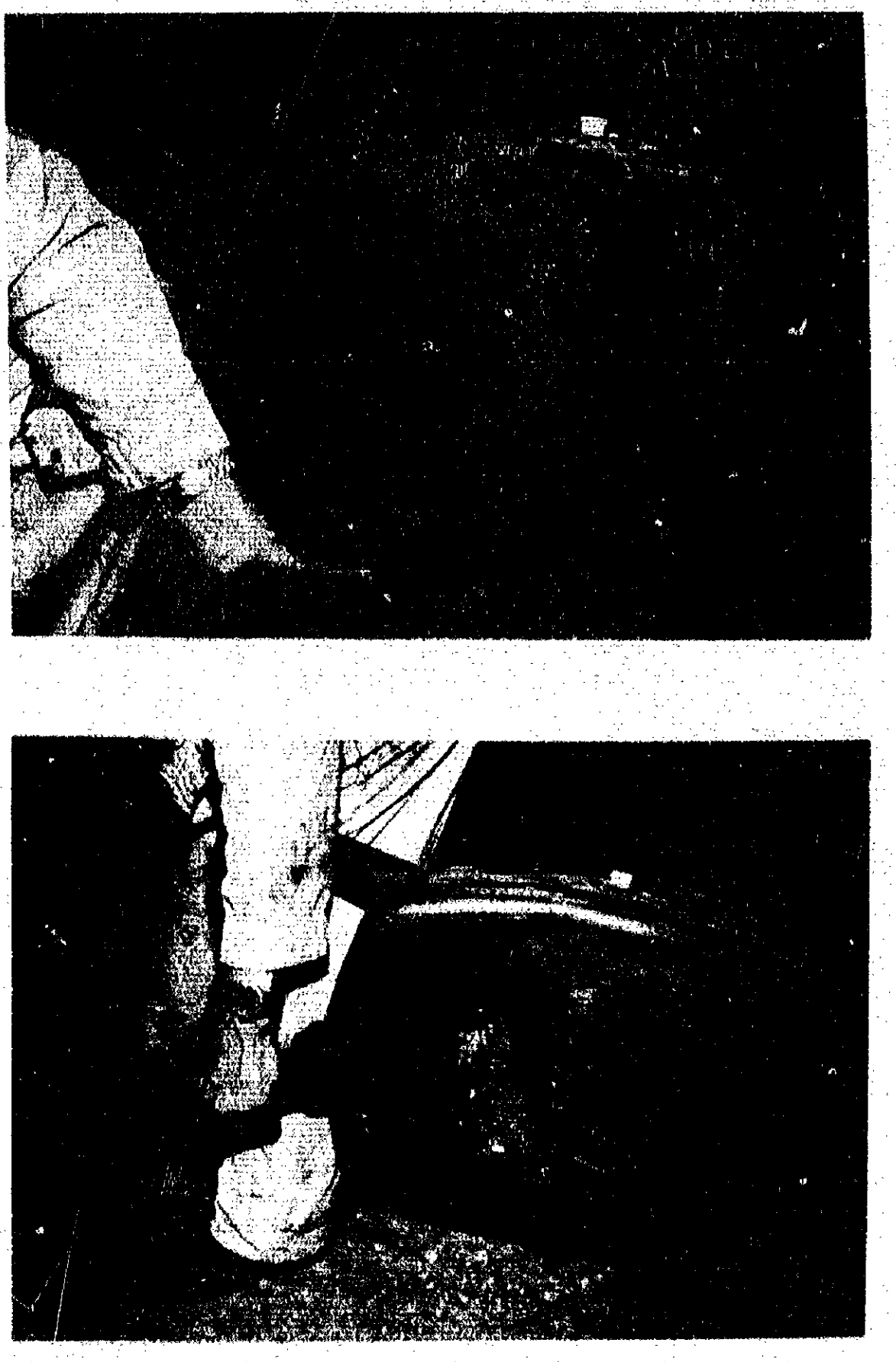

Figure 14.--Leaf spring being compared to the fuel tank

Four Federal standards (FMVSS 217, 301, 302, and 222) are especially pertinent to a discussion of this accident. These standards establish requirements for school bus emergency exits, interior flammability, seat design and performance, and fuel system integrity. An outline of these standards as they exist today follows. Of these four standards, only one,

FMVSS 302, Flammability of Interior Materials, was in effect as described for school buses at the time the accident bus was manufactured.

1. FMVSS 217, Bus Window Retention and Release, establishes requirements for the retention of windows other than the windshields in buses, and establishes operating forces, opening dimensions, and markings for pushout windows and other emergency exits. It also sets the emergency egress requirements for school buses and buses other than school buses.

FMVSS 217 requires that each school bus comply with one of the following minimum emergency exit provisions:

> (a) One rear emergency door that opens outward and is hinged on the right side. (either side in the case of a bus with a GVWR of 10,000 pounds or less); or
>
> (b) One emergency door on the vehicle's left side that is in the rear half of the bus passenger compartment and is hinged on its forward side, and a pushout rear window that provides a minimum opening clearance 16 inches high and 48 inches wide. This window shall be releasable by operation of not more than two mechanisms . . .

Part S5.4.2.1 of FMVSS 217 requires school buses with a gross vehicle weight rating of more than 10,000 pounds to have:

> (a) In the case of rear emergency door, an opening large enough to permit unobstructed passage of a rectangular parallelepiped 45 inches high, 24 inches wide, and 12 inches deep, keeping the 45-inch dimension vertical, the 24-inch dimension parallel to the opening, and the lower surface in contact with the floor of the bus at all times.

A portion of the standard provides for buses other than school buses and does not require a rear emergency door, but instead states:

> Buses, other than school buses, shall provide unobstructed openings for emergency exits which collectively amount, in total square inches, to at least 67 times the number of designated seating positions on the bus. At least 40 percent of the total required area of unobstructed openings, computed in the above manner, shall be provided on each side of a bus. However, in determining the total unobstructed openings provided by a bus, no emergency exit, regardless of its area, shall be credited with more than 536 square inches of the total area requirement.

2. FMVSS 301, Fuel System Integrity, specifies requirements for the integrity of motor vehicle fuel systems. According to FMVSS 301, each school bus with a gross vehicle weight rating greater than 10,000 pounds manufactured on or after April 1, 1977, shall meet the requirements of paragraph S6.5, which states:

> S6.5 - Moving contoured barrier crash. When the moving contoured barrier assembly [4,000 pounds] traveling longitudinally forward at any speed up to and including 30 mph impacts the test vehicle (school bus with a GVWR exceeding 10,000 pounds) at any point and angle, under the applicable conditions of [the test conditions] fuel spillage shall not exceed the limits of S5.5.
>
> * * * * *
>
> S5.5 - Fuel spillage: Barrier crash. Fuel spillage in any fixed or moving barrier crash test shall not exceed 1 ounce by weight from impact until motion of the vehicle has ceased, and shall not exceed a total of 5 ounces by weight in the 5-minute period following cessation of motion. For the subsequent 25-minute period . . . fuel spillage during any 1-minute interval shall not exceed 1 ounce by weight.

3. FMVSS 302, Flammability of Interior Materials, specifies burn-resistance requirements for materials used in the occupant compartments of all motor vehicles. The standard states that when tested horizontally, the material specified shall not burn nor transmit a flame front across its surface at a rate of more than 4 inches per minute. For self-extinguishing materials, if, from the start of timing, a material stops burning within 60 seconds and it has not burned more than 2 inches, it shall be considered to meet the burn-rate requirements.

The test is conducted in a metal cabinet built to certain specifications. A specimen is put into the cabinet in a U-shaped frame and a flame from a bunsen burner is applied at a certain flame temperature and height.

4. FMVSS 222, School Bus Passenger Seating and Crash Protection, specifies minimum seatback height, surface area, seat cushion retention, restraining barrier requirements, and seat performance when a seat is subjected to certain application forces, both forward and rearward. FMVSS 222 states:

> S4.1 The number of seating positions considered to be in a bench seat is expressed by the symbol W, and calculated as the bench width in inches divided by 15 and rounded to the nearest whole number.

Federal Motor Carrier Safety Regulations.--Since most front engine conventional school buses are constructed on medium-duty truck chassis, the

chassis are built to comply with the Federal Motor Carrier Safety Regulations (FMCSR). Title 49 CFR 393.65 through 393.69 address all fuel systems and provide information about fuel tank locations, fuel tank construction, and specifications for fittings, fuel lines, safety venting systems, pressure resistance, air vents, and required performance during testing procedures.

The FMCSR specify that liquid fuel tanks be capable of passing a safety venting system test and a leakage test. All side-mounted liquid fuel tanks must be capable of passing the drop test and the fill-pipe test. The drop test procedure includes filling the tank with a quantity of water equal to the weight of the maximum fuel load of the tank and dropping the tank 30 feet vertically onto an unyielding surface so that it lands squarely on one corner. Neither the tank nor any fitting may leak more than a total of 1 ounce by weight of water per minute.

Also during the fill-pipe test, the tank must be filled with a quantity of water equal to the maximum fuel load of the tank and dropping the tank 10 feet onto an unyielding surface so that it lands squarely on its fill-pipe. Neither the tank nor any fitting may leak more than a total of 1 ounce by weight of water per minute.

Highway Safety Program Standards.--Congress enacted the Highway Safety Act of 1966 which established a national program to reduce motor vehicle crashes, injuries, and fatalities. The legislation required the establishment of uniform Highway Safety Program Standards (HSPS) which States and communities were to use to organize their safety programs. By 1972, 18 program standards had been established. Since then, Congress, on several occasions, has modified the program to provide more flexibility to the States and to permit the targeting of resources on the most pressing highway safety problems. In 1987, Congress officially changed the highway safety "standards" to "guidelines" to reflect more accurately the true nature of the highway safety program.

Highway Safety Program Standard 17, Pupil Transportation Safety, promulgated in May 1972, presented procedures dealing with the identification, operation, and maintenance of school buses; training of personnel; and administration.

Section IV of HSPS 17, Pupil Transportation, states that:

> one emergency evacuation drill should be held during the first week of school each semester. If unexpected problems develop, a make-up drill should be scheduled as soon as possible. The following guidelines are given for conducting the emergency evacuation drills:
>
> (1) Be sure there is a written policy covering these drills.
>
> (2) Permission to hold drills should be given by school authorities well in advance.

(3) Initial practice drills should be held on school grounds, during school hours, in a safe place and under supervision.

(4) Allow for individual differences in jumping out the emergency door. Instruct helpers to offer a helping hand palm up and avoid grasping a child's hand or arm. Children will hold on if they want help.

(5) Time each drill.

(6) Additional guidelines may be found in A School Bus Driver's Manual produced by Eastern Michigan University, Ypsilanti, Michigan 48197.

A newly proposed version of HSPS 17, dated October 28, 1988, states:

> Time each drill. No more than one and one-half minutes should elapse from the start of the drill to the time all passengers are safely evacuated.

**State Activity on Bus Safety**

At the time of the accident, the State of Kentucky did not require privately owned and operated vans and buses to be inspected. However, on June 14, 1988, the State legislature passed an "emergency regulation" that requires all privately owned (not-for-hire) buses that carry nine or more passengers including the driver, to be inspected under the annual Kentucky Bus Inspection Program. The regulation became effective immediately and all privately owned and operated buses were required to be inspected by October 1, 1988. All inspections were free of charge.

The Kentucky Vehicle Safety Inspection Report revealed that, as of October 1, 2,557 vans and 1,704 buses had been inspected. Of the total, 417 vans and 353 buses failed the inspection; 73 vans and 97 buses were removed from service. Vehicles failed the inspection due to minor safety violations, such as lights out, cracked windshields or mirrors, and inadequate tire tread depth; when the violations were corrected the vehicles were re-inspected. The vehicles that were taken out of service had major defeciencies, including steering or braking problems. These vehicles were not allowed to be driven away and mechanics were brought in to repair the defects.

In January 1989, Kentucky passed another emergency regulation requiring all owners of private buses and vans to furnish proof that their vehicles have been inspected annually before registration can be renewed. A Kentucky official stated that he believed the vehicle figures cited in the completed inspections represents close to 100 percent of all private buses and vans; however, requiring proof of inspection to renew vehicle registrations will ensure vehicle inspections.

Approximately 7,500 school buses are operated within the Kentucky school districts; 462 school buses are prestandard.[8] According to an official of the Kentucky State Department of Education (KDE), prestandard school buses are being phased out, and they are used only when necessary (such as to replace a vehicle that has become inoperative). According to the KDE, when school buses are purchased they comply with the existing Kentucky Minimum Specifications for School Buses (KMSS) prepared by the KDE. Under General Provisions, the KMSS states that ". . .all new school bus chassis sold in Kentucky for use in transporting pupils to school shall be certified by the manufacturer as meeting all of the applicable FMVSS." The KMSS requires each seat to be a minimum of 15 inches deep and 39 inches long. The KMSS states:

> In rating the normal seating capacity of the bus body, the allowable rump space shall be 13 inches. All seating in the conventional school bus body shall be the 3-3 plan.

Regarding seat cushion construction, the KMSS states:

> Padding and covering on all seats shall be of such materials as will not flash or explode upon contact with a spark or open flame. Seat covering for both cushions and backs shall be heavy grade high quality artificial leather known as "Koroseal," "Naugahide," or similar indicative trade names of coated fabrics.
>
> Pupil seat cushions shall be "front-rise tapered" of polyurethane foam or approved equal material.

KDE representatives stated that the KMSS does not require greater fire-resistant capabilities than required by FMVSS 302. The KDE has extensively evaluated seat materials, consulted with the manufacturing industry with regard to seat materials and has not yet found seat materials offering greater fire-resistance capabilities while meeting other necessary requirements, such as the energy absorbing requirements found in FMVSS 222. Kentucky and the Southeastern Pupil Transportation Association is petitioning the NHTSA to strengthen the fire-resistant specification for school buses.

The KDE requires each school district to conduct emergency evacuation drills, and all school bus drivers must be trained in emergency evacuation procedures. KDE representatives stated that studies show driver training provides the most deterrence to accidents and that the KDE places great emphasis on driver training and driver responsibility for student control and safety. The Kentucky School Bus Driver's Curriculum states:

> In an emergency, it is possible for children to jam the emergency door by all trying to get out of the door at

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[8]School buses built before April 1, 1977. The chassis manufacture date dictates the date of manufacture and not the manufacture date of the schoolbus body.

the same time. To help avoid this situation, you and the school administration should organize and conduct emergency evacuation drills for all pupils who ride school buses. These drills should be conducted at least twice during each school year.

The KDE plans to conduct evacuation time studies and incorporate the results into its procedures. Also, a policy has been written outlining the types of articles students may carry onto the school bus. Consideration by the KDE is also being given to reducing the passenger seating capacity of its bus below that which it now permits. Side emergency doors and roof hatches have been reviewed and evaluated, and Kentucky has no plans to require installation of either type of exits.

Officials from the Office of the Director of Pupil Transportation said that the department is installing pushout windows in the 1989 model school buses. The department has further recommended to Kentucky school districts that pushout windows be considered for installation in existing school buses that are going to be used for trips outside the school district. On February 9, 1989, a school official said that 95 percent of the school districts have retrofitted with pushout windows those school buses that are used for extracurricular activities. Also, by 1990, Kentucky plans to be using school buses equipped with diesel engines.

On July 27, 1988, the governor of Kentucky established a Task Force on School Bus Safety. The task force was charged with the responsibility for conducting a study of the safety of buses designed for the transportation of school students. As a result of the study, the task force presented to the governor recommendations which included a number of changes pertaining to new school bus specifications. The governor has not yet acted on these recommendations, and Kentucky's legislature will not convene again until January 1990. (See appendix C.)

A representative of the Blue Bird Body Company testified that six States, including New York, Oregon, Indiana, West Virginia, California, and Washington, specify that school buses have emergency exits in addition to those mandated by the Federal government as minimum standards for school buses. Also, all the provinces of Canada, in accordance with The Canadian Standards Association specifications, have an additional pushout window. Other school districts within other States have voluntarily ordered school buses with more exits than are required by State and Federal standards. According to the President of the National Association for Pupil Transportation, these school districts have found either through accident experience or disaster drills that two exits are not sufficient for emergency evacuations, especially when one or more of the doors are blocked or when rescue personnel need to enter the bus and treat injured occupants.

School bus manufacturers and school bus districts have expressed concerns about pushout windows being misused while buses are in transit and also being used as a means to vandalize school buses. There is also a lot of concern about passenger ejection from pushout windows during school bus rollover accidents. However, the Safety Board is not aware of any instance where

pushout windows on poststandard school buses have become ajar during a collision sequence and caused injuries to passengers inside.

## National Minimum Standards Conference

The National Minimum Standards Conference[9] develops nationwide "standards" (guidelines) for school buses and school bus operations. Seven delegates from each State participate in the conference. Conference resolutions are published and are generally recognized by the school bus industry as recommended minimum "standards." Many States adopt all the standards, and some States adopt some of the standards.

During the 1985 Conference, the subject of flammability was recognized as an issue that needed further attention. The Conference urged school bus manufacturers and replacement equipment suppliers to develop, test, certify, and offer for sale seating materials with improved fire resistance.

## Research on Bus Seating Materials and Passenger Evacuation

Bus Seating Materials.--Most school bus seating materials are constructed of a polyurethane foam cushion covered by a poly(vinyl)chloride material. The polyurethane foam enables the seat cushions to meet the requirements set forth in FMVSS 222, School Bus Passenger Seating and Crash Protection. Human and animal studies[10] have demonstrated the toxic effects of polyurethane in fires. Flexible polyurethane also produces some hydrogen cyanide when burned in laboratory studies.[11] Hydrogen cyanide produces severe irritation and chemical acid burns when it contacts the moist mucous membranes of the eyes, nose, throat, and lungs.

A study conducted on Metro rail cars for the Washington Metropolitan Area Transit Authority (WMATA)[12] concluded that results from small-scale tests do not predict the fire performance of the complete assembly (seats). Furthermore, the study found that hazardous levels of smoke developed principally from the polyurethane seating material. The study also showed

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[9] Co-sponsored by the National Association for Pupil Transportation, the National School Transportation Association, the National Safety Council, the Association of State Director's of Pupil Transportation, the School Bus Manufacturer's Institute, and Central Missouri.

[10] Birky, M. M., Toxicity and Incapacitation Due to Hydrogen Chloride, Fire and Materials, Vol. 10, pp. 125-132 (1986).

[11] Levin, B. C.; Fowell, A. J., Birky, M. M., Paabo, M., Stolte, A., and D. Malek, Further Development of a Test Method for Assessment of the Acute Inhalation Toxicity of Combustion Products, Center for Fire Research, National Bureau of Standards, NBSIR 82-2535, 1982.

[12] Braun, E., A Fire Hazard Evaluation of The Interior of WMATA Metrorail Cars, National Bureau of Standards NBSIR 75971, Final Report Prepared for Washington Metropolitan Area Transit Authority, December 1975.

that urethane seat material will not pass one of the criterion in FMVSS 302, that a test fire shall not spread fire from the seat of origin.

Another fire study conducted on Metro bus interiors by the National Bureau of Standards (NBS)[13] concluded that visibility within the bus would be zero within 1 to 2 minutes after urethane padding of the seat ignited.

As a result of a 1975 accident investigation of a prototype bus fire[14] the Safety Board recommended that the Urban Mass Transportation Administration (UMTA):

> H-75-39
>
> Burn one or more of the prototype buses to establish the rate which nonlife-supporting environments develop in the bus' passenger compartment. The recommended test fire should simulate actual traffic accident involvement. All combustible materials should be pretested to determine their ability to meet Federal Motor Vehicle Safety Standard 302, "Flammability of Interior Materials.

In response to Safety Recommendation H-75-39, UMTA stated that it was in the process of preparing flammability, toxicity, and smoke producing guideline specifications for these materials and that it planned to make the conformance to the specifications one of the conditions for approval of the funding for vehicle procurements. On August 14, 1984,[15] UMTA published guidelines for testing flammability and smoke emission characteristics of materials to be used in rail rapid systems; similar guidelines are under development for rapid transit buses. On July 1, 1987, the Safety Board classified Safety Recommendation H-75-39 as "Closed--Acceptable Alternate Action." UMTA guidelines are significantly more stringent than those used in school buses.

Fire test studies conducted by Thomas Built Buses, Inc., on a school bus upholstered with the same type of seats in the accident bus confirmed the flammability of the bus interior materials and the necessity of rapid evacuation. In addition, these tests showed that thick black smoke is produced rapidly from the combustion of poly(vinyl)chloride seat cover and polyurethane padding. Tests conducted by Thomas on poly(vinyl)chloride show that hydrogen chloride was released from the material at a temperature as low as 250° F which occurred before thick black smoke was produced.

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[13] Braun, E., Report of Fire Test on an AM General Metro Bus, National Bureau of Standards NBSIR 75-718, June 1975.

[14] Special Investigation--"UMTA Prototype Bus Fire near Phoenix, Arizona, May 13, 1975" (NTSB/HAR-75-08).

[15] Federal Register, Volume 49, No. 158, pp. 32482-32486, August 14, 1984.

Bus Evacuation.--A 1978 report prepared for the Federal Highway Administration (FHWA),"Evacuation of Intercity Buses,"[16] recommends that:

> A standard should be considered for maximum bus evacuation time. The current FAA standard for aircraft evacuation[17] is an example of a potential standard. The standard should also require that evacuation be conducted with no more than minor injuries sustained by the passengers.

A 1980 report contracted by the NHTSA[18] states that:

> Presently there is much confusion about the high temperature hazards of plastic materials, especially from the standpoint of transportation system safety design. The basic question of what constitutes a fire hazard in a passenger vehicle has yet to be answered. Even the most elementary aspects of the safety design problem (e.g., time required for emergency evacuation, etc.) have not been defined, although a need for such information has been recognized. Some work was done recently by [Metro] to obtain some idea of the basic time requirements for an emergency evacuation of a Metro bus. An evacuation test was conducted with Metro employees, under normal (non-hazardous) conditions to determine a lower bound on the required time for an emergency evacuation time.
>
> It was determined that under this "ideal" condition approximately 45 seconds was required for evacuation. It was readily conceded, however, that this test was not realistic and under panic conditions or conditions causing incapacitation of occupants the evacuation time would be considerably longer.

The 1980 report further states that:

> . . . the FMVSS 302 standard does not guarantee a satisfactory design against fire hazard. It was determined by Braun that most of the materials used for

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[16]Pursuell, J., Dorris, A., and Stephens, R., Evacuation of Intercity Buses, January 1978.

[17]Title 14 CFR 25.853, Emergency Evacuation, requires that evacuation demonstrations be held for all airplanes having a seating capacity of more than 44 passengers and that all passengers be able to escape within 90 seconds using only 50 percent of the exit doors.

[18]Pauls, Lonny S., Identification of Superior Energy-Absorbing Materials for School Bus Interiors, Volume III, prepared for NHTSA, January 1980.

the interior of the Metro buses satisfied the existing FMVSS-302 standard, yet devastating results occurred in both the real life and simulated fire environments. It was determined by Braun that fire growth and spread in the buses was primarily through the involvment of the seat cushions (a urethane foam material). The fire tended to spread from seat to seat with little direct involvement of other interior materials. In all three tests conducted by Braun, between one and two minutes after the urethane ignited, dense smoke filled the bus space seriously reducing visibility. Spread of fire beyond the seat of origin was not necessary for the level of smoke to be formed. The time required for the urethane to ignite ranged from 5 seconds to 4 minutes depending on the method for ignition (i.e., use of lighter fluid resulted in 5 second ignition time, use of bag comprising a total of 30 grams (1 ounce) of paper placed at junction between two adjacent seat cushions resulted in 4 minute ignition time).

As a result of the studies and testing conducted on Metro buses, the Safety Board recommended that the NHTSA:

H-75-12

Develop a separate requirement applicable to the interior material of all vehicle types in accident induced attitudes which provides sufficient time for occupant evacuation before the creation of a lethal environment resulting from fire.

H-75-13

Expand Motor Vehicle Safety Standard No. 302 testing procedure to include a vertical burn test of all vehicle interior materials and to establish an acceptable vertical flame spread index similar to that prescribed by the Federal Aviation Administration in 14 CFR 25.853, as appropriate.

In its June 22, 1976, response to these recommendations, the NHTSA stated that "FMVSS 302 was designed to require a burn rate low enough to permit occupants sufficient time to evacuate the vehicle-auto-bus-van. It is not designed to fireproof an interior or to be a countermeasure against a determined arsonist or a fuel initiated fire." Safety Recommendation H-75-12 was classified as "Closed--Reconsidered" on September 5, 1985, based on the fact that FMVSS 302, which established a horizontal burn rate of not more than 4 inches per minute for interior materials, was in effect at the time the safety recommendation was issued. The letter of recommendation transmitting Safety Recommendations H-75-12 and -13 contained only a cursory review of FMVSS 302 and did not discuss the specific reasons for issuing the recommendations. In fact, the NHTSA maintains that the 4-inch per minute

burn rate does provide ". . . sufficient time for occupant evacuation before the creation of a lethal environment . . ." as suggested in the recommendation. For these reasons, the Safety Board decided not to pursue the issue further. Safety Recommendation H-75-13 was classified as "Closed--Reconsidered" on April 21, 1986, based on the NHTSA contention that ground vehicles should not be encumbered with the economic burden of an aviation flammability standard because there is the possibility of escape/evacuation from ground vehicles involved in accidents. Since the basis for the burn rate of 4 inches per minute--horizontal flammability standard in FMVSS 302--is time allowed for escape, the Safety Board decided not to pursue this issue.

As a result of the Carrollton, accident, the National Association of Governors' Highway Safety Representatives (NAGHSR) called on the NHTSA to amend the existing standards and promulgate new standards as necessary to accomplish the following:

-- Establish a common set of Federal Motor Vehicle Safety Standards applicable to all vehicles intended for use in the transportation of ten or more passengers of the general public, whether by Government, non-profit, private, religious, or any other organizations that employ vehicles in their transportation programs or activities. It is suggested that these changes particularly address the supply and equitable distribution of emergency exits based on passenger capacity and required evacuation time, as well as fuel system integrity and flammability of interior materials.

-- Establish a common set of requirements for proper inspection and operation of such vehicles, including driver qualifications.

-- Complete the Study authorized and ordered by the United States Congress, Public Law 94-346, Section 121, as amended July 8, 1976, wherein the NHTSA was directed (Sec. 3, Section 103(i) para. (3)B) to ". . . study and report to Congress on . . . an examination of the extent to which the age of school buses increases the likelihood of accidents and resultant injuries."

In 1977 the NHTSA conducted a study and found that there was no correlation between the age of school buses and school bus accidents.

In January 1989, the NHTSA contracted with the National Institute of Standards and Technology (NIST)[19] to study the flammability of current materials used in the construction of school bus seats and to develop guidelines for material acceptance criteria intended to limit the rate of fire growth in school buses. The study will be directed toward

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[19] Formerly the National Bureau of Standards.

defining material selection parameters that affect the rate of development of hazardous conditions in a school bus geometry. Material fire parameters will be recommended that can be used to limit or control the development of hazardous conditions. The proposed study will be limited to currently used and state-of-the-art material assemblies for school bus seats. Representative assemblies will be tested in small- and large-scale tests as well as full-scale bus configurations.

Small- and large-scale tests will be performed to characterize material fire performance (e.g., lighter fluid, gasoline, and diesel fuels) in easily measured parameters. Several of these parameters could ultimately be used to screen materials for acceptance into the design and construction of school buses. Parameters to be investigated include ignitability, flame spread, rate of heat release, gaseous species (i.e., CO, $CO_2$, HCN, etc.), smoke development, and toxicity. The outcome of this work will be a laboratory-scale protocol for evaluating the fire performance of materials used in school bus seats which will predict the results of large-scale tests.

## Accident Statistics

School Bus Statistics.--According to nationwide FARS data,[20] 14 school bus occupants were killed in 1987. In contrast, 38,544 occupants of passenger cars, vans, trucks, motorcycles, other buses, and on/off road vehicles were killed that year; 5,663 were children ranging in age from 5 to 18 years.

Of the 1,511 fatalities involving vehicles categorized as school buses from 1977 through 1987, 162 were occupants aboard school buses. During that period, the FARS[21] reflected only one accident (in 1984) that involved a fire;[22] nine persons died as a result of the accident. The nine fatalities were the direct result of the severe crash forces involved in the accident and not the result of the fire. A tractor-semitrailer struck the bus and the aluminum cargo tank ruptured, spilling aviation fuel into the bus.

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[20]According to FARS, school bus is defined by bus body type, not vehicle use. Therefore, schoolbuses used by schools, churches, or civic groups are included in these data.

[21]FARs did not contain data on other fatal school bus accidents in which fires had occurred; however the data base did not reflect the fact that fire was involved in these accidents.

[22]Highway Accident Brief--Essex, Montana, January 21, 1984 (Brief No. NXC-84-H-S018).

Since 1981, the Safety Board has previously investigated at least seven accidents[23] in which some part of a school bus or school van has been involved in fire. In five of these accidents, fires originated in the engine compartment and were extinguished before spreading to the passenger compartment. In a sixth accident fire originated in the other vehicle involved in the accident and spread into the passenger compartment of the school bus. An engine compartment fire in a seventh school bus accident entered and burned the passenger compartment. However, in all of the accidents, none of the fatalities and/or serious injuries were attributed to the fire inside the bus.

On March 16, 1989, the Safety Board investigated an accident involving a 1986, 71-passenger AmTran (Ward) school bus with a General Motors Corporation chassis. The school bus veered off the roadway and struck the left rear of a tractor-semitrailer stopped on the right shoulder of I-470 near Kansas City, Missouri. After the collision, the school bus traveled about 90 feet forward before coming to a rest alongside the truck tractor. A fire erupted and spread through the interior of the bus and also into the truck tractor. The school bus driver, who was the only person aboard the school bus, sustained burn injuries over 10 percent of her body and suffered smoke inhalation. The truckdriver was not injured in the accident.

The school bus sustained severe damage to the engine compartment, right front side, and body stepwell area. The front axle was separated from the chassis during the collision; however, the leaf spring assembly remained attached to the chassis. The sheet metal from the stepwell area was crushed rearward to the front of the fuel tank. The fuel tank and fuel tank guard were pushed rearward about 8 inches from their original positions. After removing the sheet metal from the fuel tank, investigators determined that there were no punctures or cracks in the fuel tank. However, the three fuel lines that should have been attached to the top of the fuel tank had separated from the tank.

The fire entered the passenger compartment and a substantial portion of the bus interior was burned. All the seating material in the first six rows of seats was completely burned leaving only the metal seat frames. On

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[23]Highway Accident Reports--"Pattison Head Start Center School Van Run-Off Bridge and Fire Near Hermanville, Mississippi, December 17, 1981" (NTSB-HAR-82-5); "Jonesboro School District Schoolbus Run-Off Road and Overturn, State Highway 214 at State Highway 18 Near Newport Arkansas, March 25, 1983" (NTSB/HAR-83/3); "Collision of G & D Auto Sales, Inc., Tow Truck Towing Automobile, Branch Motor Express Company Tractor-Semitrailer, Town of Rehobeth Schoolbus, Rehobeth, Massachusetts, January 10, 1984" (NTSB/HAR-84/5); "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-85/2); "Multiple Vehicle Collision and Fire, U.S. 13, Near Snow Hill, North Carolina, May 31, 1985" (NTSB/HAR-86/2); and Highway Accident Briefs--Caldwell, Texas, April 23, 1985 (Brief No. FTW-85-H-SB32); and Essex, Montana, Brief No. 84-M-ESB18.

the last few seat rows, the vinyl covering of the seats was burned away and the seat cushion material (polyurethane) was completely charred.

Several passersby stopped and used their fire extinguishers to keep the fire away from the busdriver who was pinned in her seat due to the sheet metal damage. The fire department, which was nearby, responded in 9 minutes and extinguished the fire before the interior of the bus had been completely burned.

The KDH reported the following school bus injury and fatal accidents:

| Year | Number of Accidents* | Number of Injury Accidents | Number of Fatal Accidents |
|---|---|---|---|
| 1985 | 654 | 96 | 0 |
| 1986 | 678 | 85 | 3*** |
| 1987 | 631** | 84 | 4*** |

Note: Data are based on police reports of "school bus" accidents--those involving a vehicle with the word "school bus" printed on it, including school vans.

*Caution is needed in the use of these data. There is no national data base for all motor vehicle accidents. The definition of an accident differs from State to State and the collection and storage of data on accidents can be inconsistent, even within a State; these deficiences in the collection of accident data exist with school buses. Further, the definition of school buses differs from State to State. Thus, these data cannot be used to compare the number of school bus accidents in Kentucky with those of other States.

**In 1987, the KDH added a category in the accident reporting data to include fires. One of the property damage school bus accidents involved a fire, and one of the injury accidents involved a fire.

***According to the KDE, none of these fatalities were persons on board a school bus.

Wrong-Way Driving Accidents.--According to FARS, nationwide, in the last 5 years, an average of 272 fatalities per year occurred as a result of wrong-way driving on the interstate system. Forty-nine percent of these fatal accidents involved alcohol. Only 5.3 percent of the wrong-way fatal accidents on the interstates are reported to have occurred at interchanges, entrances, or exits.

The FARS data were used to identify the States with the highest incidence of reported fatal accidents involving wrong-way driving on interstates during 1986. Because of the difference in the accident numbers and accident rates per mile, the 12 States with the highest number of fatal accidents were selected. (In those States with 6 or less fatal accidents, there was a large variation from year to year). (See table 1.)

Table 1.--1986 data on wrong-way fatal accidents on interstates in 12 States

| State | Number of Fatal Accidents | Miles of Interstate | Fatal Accidents per Mile Interstate |
|---|---|---|---|
| Texas | 24 | 3,126 | 0.0077 |
| North Carolina | 23 | 796 | 0.0289 |
| California | 20 | 2,380 | 0.0084 |
| Georgia | 18 | 1,219 | 0.0148 |
| Indiana | 15 | 1,112 | 0.0134 |
| Illinois | 11 | 1,718 | 0.0064 |
| Florida | 9 | 1,302 | 0.0069 |
| Alabama | 7 | 857 | 0.0081 |
| Arizona | 7 | 1,140 | 0.0061 |
| New Mexico | 7 | 1,000 | 0.0070 |
| South Carolina | 7 | 784 | 0.0089 |
| Tennessee | 7 | 1,031 | 0.0068 |

Table 2.--1983-87 highway statistics for the State of Kentucky

| | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|
| DUI Arrests | 43,042 | 48,795 | 42,117 | 44,487 | 42,798 |
| DUI Convictions | 20,978 | 31,426 | 30,217 | 32,643 | 29,903 |
| Total Crashes | 127,278 | 137,277 | 141,803 | 140,421 | 142,300 |
| Total Fatal Crashes | 700 | 686 | 641 | 726 | 737 |
| Fatalities | 790 | 767 | 715 | 808 | 849 |
| Alcohol-Involved Fatalities | 365 | 315 | 289 | 343 | 359 |
| Percentage | 46 | 41 | 40 | 42 | 42 |
| Alcohol-Involved Crashes (Police Reported) | 9,693 | 8,640 | 7,744 | 7,761 | 7,671 |
| Percentage | 7.6 | 6.3 | 5.5 | 5.5 | 5.4 |

Source: Kentucky Division of Driver Licensing

## Alcohol-Involved Fatal Accidents

In the early 1980s, there was considerable public concern about drunk driving. This concern led virtually every State to establish a high level task force or committee to review what was needed to strengthen its system for dealing with this problem. This resulted in every State passing improved laws and implementing new countermeasures to reduce drinking and driving. Nationwide, hundreds of new laws were passed. Public media attention also

increased as did the formation and activism of citizens groups.[24] The result was a decline in the number of alcohol-related fatalities. The biggest drop occurred between 1982 and 1985, when the alcohol-related fatalities fell from 25,170 to 22,360. In the last few years, evidence indicates that media attention to the DUI problem is waning,[25] and there has been relatively little significant new drunk-driving legislation enacted by the States. As a result, the drop in alcohol-related highway fatalities has leveled off in 1986 and 1987 (24,050 in 1986 and 23,630 in 1987).

The 1987 State statistics indicate that 42 percent, or 359, of the 849 highway fatalities in Kentucky occurred in alcohol-involved accidents. (In comparison, FARS reported that in 1987 approximately 51 percent of the fatal accidents nationwide were alcohol-involved). According to State accident records, alcohol involvement in fatal highway crashes has declined since 1983 from a level of 46 percent. (See table 2.) The largest drop (46 to 41 percent) occurred between 1983 and 1984 after the passage of major DUI legislation in 1984. However, Kentucky alcohol-related fatalities, after dropping from 365 in 1983 to 315 in 1984 and to 289 in 1985, have started to increase and in 1987 reached 359.

In 1987, Kentucky tested for and reported on alcohol use in 77 percent of the fatally-injured drivers. Nationwide, in 1987, 72.9 percent of the fatally-injured drivers were tested for alcohol involvement. The testing of drivers who survive a fatal crash is much lower, with only 22.2 percent of these drivers nationwide tested for alcohol.

A major obstacle to determining the full scope of the DUI problem in this country is the fact that most States do not test for impairment all drivers involved in fatal accidents. The Safety Board addressed this problem in a letter dated December 6, 1985, to the governor of Kentucky and the nation's other governors; the Board recommended that the States:

> H-85-49
>
> Initiate legislation or take the necessary administrative action to require alcohol testing of all drivers involved in fatal highway crashes.
>
> H-85-50
>
> Establish formal procedures to ensure that quantitative tests of the blood alcohol concentration of all drivers involved in fatal highway crashes are performed and

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[24] Hingson, R.; Howland, J.; Heeren, T.; and Levenson, S., "Effects of Legal Penalty Changes and Laws to Increase Drunken Driving Convictions on Fatal Traffic Crashes," Symposium on Motor Vehicle Injuries, New York Academy of Medicine, 1987.

[25] Fell, J., and Nash, C., "The Nature of the Alcohol Problem in U.S. Fatal Crashes," Health Education Quarterly, Spring, 1989.

reported to the agency responsible for maintaining such records.

Also, the Board noted that complete testing was vital to understanding the nature and extent of alcohol involvement in highway crashes and for evaluating, accurately, the effectiveness of the many programs and tremendous resources being applied by States and communities to reduce the problem.

In a response dated January 10, 1986, the Secretary of the Justice Department, State of Kentucky, stated that it was the intention of the Governor's Task Force on Drunken Driving to recommend that the Kentucky Revised Statute be amended to mandate that the coroner of authority shall conduct an examination to determine if there were substances in the victim's body which would impair his ability to operate a motor vehicle and that these findings would be forwarded to the Central Repository for blood alcohol results. Based on this response, on September 16, 1986, the Safety Board classified Safety Recommendations H-85-9 and -50 as "Open--Acceptable Action." The Safety Board has not received any further information from the State of Kentucky regarding these two recommendations.

**State DUI Laws**

DUI Laws.--The DUI law in effect in Kentucky before 1984 provided the following sanctions for a first offense conviction: (1) a fine of not less than $100 nor more than $500 and/or (2) a 6-month license suspension. However, a court could suspend any or all of the fine. In addition, the license suspension order could be amended to a 30-day suspension with a license restricted to travel to and from work and alcohol education or treatment. Amendment was conditioned on attendance at an alcohol driver education program, which required payment of a $25 fee. The law contained no imprisonment sentence for a first offense conviction.

A second offense conviction carried the following penalties: (1) a fine of not less than $100 nor more than $500, (2) a 1-year license suspension, and/or (3) imprisonment from 3 days to 6 months. These penalties could be subject to probation or suspension by the court.

A third, or subsequent, offense conviction carried the following penalties: (1) a fine of not less than $100 nor more than $500, (2) a 2-year license suspension, and/or (3) imprisonment of 30 days to 12 months. These penalties were also subject to probation or suspension by the court.

In July 1984, the Kentucky legislature enacted new DUI legislation that changed the law in several respects. First, if a defendant's BAC is 0.15 percent or more, plea bargaining is prohibited. If a defendant's BAC is between 0.10 percent and 0.15 percent, a DUI charge may be changed provided the prosecutor gives reasons for such action to the court and the court records the reasons for the change in the case record. Second, if the offender's BAC level is 0.15 percent or more at the time of arrest, the offender can be detained for at least 4 hours.

Penalties for a DUI conviction were also increased in the 1984 legislation. A first DUI offense conviction now carries the following penalties: (1) a fine of not less than $200 nor more than $500; (2) a 6-month license revocation or a mandatory 30-day license suspension and an alcohol education or treatment program; and/or (3) an imprisonment from 48 hours to 30 days. A convicted offender can also be sentenced to 2 to 30 days of community service in addition to any other sanctions imposed, or in lieu of imprisonment if no injury is involved. If the court imposes a community service sentence, the 1984 law mandates that the minimum term be served. Restitution in the form of payments to a victim's compensation board also is authorized. Finally, the convicted offender is required to pay a $150 service fee in addition to any other fine.

A second offense conviction within 5 years carries the following penalties: (1) a fine of not less than $350 nor more than $500; (2) a mandatory 1-year license revocation; and/or (3) an imprisonment from 7 days to 6 months, 7 days of which is mandatory. In addition, a convicted second offender may receive a community service sentence of 10 days to 6 months. The service fee, victim's compensation, and mandatory minimum community service (when ordered) also apply to second and subsequent offenders. For second and subsequent DUI offense convictions, the defendant must be sentenced to an alcohol or substance abuse program.

A third or subsequent offense conviction includes the following penalties: (1) a fine of not less than $500 nor more than $1,000; (2) a mandatory 24-month license revocation; and/or (3) an imprisonment from 30 days to 12 months, 30 days of which are mandatory. In addition, the court may order a community service sentence of 10 days to 12 months.

Kentucky law has no provision for administrative license revocation. (See Licensing Penalties, page 56.) However, a court may suspend a driver's license from 14 to 60 days following a DUI arrest and before adjudication if there is probable cause that the offender committed the DUI offense and the DUI charge was associated with a physical injury accident or the defendant's traffic violation record demonstrates a lack of regard for the safety of others. Also, Kentucky law does not mandate a presentence investigation (PSI) or an alcohol assessment.

DUI Enforcement.--Law enforcement in Kentucky is the responsibility of a variety of agencies, including the KSP, the county police, the sheriff's departments, and city police departments. According to information from the NHTSA, the majority of Section 402 Federal highway safety grant funding provided to the State has been and continues to be applied to DUI enforcement and related activities. Kentucky State officials say that enforcement of DUI laws by the KSP has been a priority for many years. Of the 44,487 DUI arrests made by all Kentucky police agencies in 1986, the KSP made approximately 18,000 arrests. State Police troop 5 (which encompasses six counties, including Carroll County) arrested 495 persons for DUI in 1986 and 505 persons in 1987. In 1986, of the 139 persons arrested within Carroll County for DUI, 83 were arrested by the State police.

The City of Carrollton Police Department (CPD) made 56 of the 139 total DUI arrests in 1986. The CPD made 65 DUI arrests in 1987. The average BAC for DUI offenders arrested by the CPD was 0.18 percent in 1987.

As a result of its 1984 study on repeat offenders,[26] the Safety Board recommended that the governors of Kentucky and the other 49 States:

H-84-77

Encourage the use by all traffic law enforcement agencies in your State of preliminary breath test devices and the NHTSA-recommended three-part field sobriety test, including the horizontal gaze nystagmus test.

On July 8, 1985, the Secretary of the Justice Cabinet, State of Kentucky, replied that preliminary breath test (PBT) devices are allowed under Kentucky's new DUI law (KRS 189A.100(1)). Some law enforcement agencies have already purchased these devices. The KSP has recently secured some PBTs and about 45 local police and State police have been trained to use the devices. According to the KSP, preliminary breath test devices and the horizontal gaze nystagmus test are being used by some police agencies on a limited basis. Based on Kentucky's response, the Safety Board classified the recommendation as "Closed--Acceptable Action."

The KSP maintains and certifies evidential breathalyzer equipment used throughout the State. It reports that approximately 51 preliminary breath test devices are in use in the State: 20 in Jefferson County, including 10 in Louisville, and the balance throughout the rest of the State.

In its 1984 safety study on the deterrence of drunk driving,[27] the Safety Board noted that the sobriety checkpoint is a key component of an effective DUI enforcement and deterrence program, a component that warrants broader application in Kentucky and all States. Also, as a result of its deterrence study the Safety Board recommended that the governors of Kentucky and 19 other States and territories:

H-84-11

Institute the use of sobriety checkpoints on a periodic and continuing basis by appropriate enforcement agencies under your jurisdiction as part of a comprehensive Driving While Intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.

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[26] Safety Study--"Deficiencies in Enforcement, Judicial, and Treatment Programs Related to Repeat Offenders Drunk Drivers" (NTSB/SS-84/04).

[27] Safety Study--"Deterrence of Drunk Driving: The Role of Sobriety Checkpoints and Administrative License Revocation" (NTSB/SS-84/01).

H-84-12

Encourage local law enforcement agencies within your State to institute sobriety checkpoints on a similar basis.

In responding to Safety Recommendation H-84-11 in a letter dated May 11, 1984, the governor of Kentucky stated:

> The Kentucky State Police is currently using roadblocks as part of their enforcement efforts. This practice has been upheld by the Kentucky courts and has been very successful in both deterring and apprehending drunk drivers. Sobriety checkpoints are also used by a number of law enforcement agencies in the Commonwealth in a similar manner."

On August 28, 1984, the Safety Board classified recommendation H-84-11 as "Closed--Acceptable Action."

In the same letter, the Safety Board classified Safety Recommendation H-84-12 as "Open--Acceptable Action" and asked that Kentucky send information on its efforts to convince additional local agencies to use sobriety checkpoints. In a letter dated September 13, 1984, Kentucky assured the Safety Board that it would continue to convince additional local law enforcement agencies to institute sobriety checkpoints. Based on this information, the Safety Board classified Safety Recommendation H-84-12 as "Closed--Acceptable Action" on January 10, 1985.

During the investigation of the Carrollton accident, the KSP told the Safety Board that it uses sobriety checkpoints occasionally, as do, on a limited basis, local police agencies in Jefferson County, Lexington, and Louisville. "Mini-checkpoints" for driver's license checks, during which drivers are checked for signs of impairment, also are used by the KSP.

Citizen Reporting Systems.--In 1982, the Safety Board wrote many States, including Kentucky, recommending that the States "implement a citizen awareness and citizen drunk driver reporting program" (Safety Recommendation H-82-35). The Board closed the recommendation to Kentucky on the grounds that the Kentucky State Police (KSP) had introduced the "Action RAPID" (Report a Problem Intoxicated Driver) program. Under this statewide citizen reporting program, drivers are encouraged to call an "800" telephone number to report suspected drunk drivers. The KSP reports that for every 10 citizen calls received, about one DUI arrest is made. In 1987, 1,838 calls were received, 325 reported DUI drivers were stopped, and 169 DUI arrests were made. Other Kentucky alcohol enforcement programs include the Traffic Alcohol Program, which is operated statewide; the Special Traffic Enforcement Program; and "D" Day (a special emphasis program with 57 other police agencies).

Prosecution/Adjudication.--For DUI offenses in Kentucky, cases are initially tried in the district court and then followed by appeals, if any,

in the circuit court. The Kentucky Appellate Court has discretionary review of the Court of Appeals. Prosecution of all DUI offenses in the district court is the responsibility of the county attorney in whose district the offense occurs. Prosecution of felony DUI offenses, such as DUI-related manslaughter and DUI appeals from the district court, are the responsibility of the commonwealth attorney for each district.

According to the Carrollton Police Department, the conviction rate for DUI charges was 72 percent in 1987. Twenty-one percent of the DUI charges were reduced to some other offense (typically reckless driving), and 7 percent were dismissed.

Plea Bargaining and Reduced Penalties.--According to KSP officials and a researcher from the University of Kentucky, the practice of reduced DUI charges was common throughout the State before passage of the current DUI law. The typical plea bargain reduced the charge to "reckless driving" with an "HBD" (had been drinking) notation sometime entered on the court transcript. However, reckless driving convictions (with or without the HBD) were not considered as prior alcohol-related offenses for the purpose of license sanctions or enhanced repeat offender penalties. The current DUI law also permits some degree of plea bargaining, though its use is more restricted.

The Safety Board discussed the practice of plea bargaining in its 1984 repeat offender study. The Board recommended that the governors of Kentucky and the other 49 States:

> H-84-80
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> Take steps to preclude reduction of an alcohol-related charge to a nonalcohol-related charge and to require in all cases that the defendant's driving record reflect the original charge.

The Board noted that plea bargaining not only reduces the sanctions on the drunk driver, but it distorts the driver's records, particularly when an alcohol-related charge is reduced to a nonalcohol-related charge. When a charge is reduced, the first alcohol offense does not appear on the record, leading the court in subsequent cases to believe that the defendant is a first offender.

In a July 8, 1985 letter, the Secretary of the Justice Cabinet, writing on behalf of the governor of Kentucky, pointed out the provisions of the 1984 DUI law that restricted the ability of the prosecutor to amend the charge. In its May 28, 1986 reply to the governor, the Safety Board acknowledged that while Kentucky's new law does not preclude the reduction of an alcohol-related charge to a nonalcohol-related charge, it does appear to make it more difficult. Based on that fact and on the law's requirement that a defendant's driving record reflect the original charge, the recommendation was "Closed--Acceptable Action."

In the same 1984 study, the Safety Board recommended, among other things, that the States not permit diversion into education or treatment programs in lieu of license revocation or suspension (Safety Recommendation H-84-85). Kentucky's July 8, 1986 response did not fully address that issue, and the Board's May 28, 1986 letter kept the recommendation in an "Open--Acceptable Action Status." The Board requested Kentucky's position on the use of diversion programs to replace license suspension/revocation. In a letter dated June 12, 1986, Kentucky indicated that there were no diversion or suspension programs currently functioning in that State. On July 30, 1986, Safety Recommendation H-84-85 was classified as "Closed--Acceptable Action."

The Safety Board's view on substitution of alcohol education treatment is shared by other organizations. The Presidential Commission on Drunk Driving noted:

> Rehabilitation and education programs . . . should be provided as a supplement to other sanctions, and not as a replacement for those sanctions . . . Education and treatment programs are not substitutes for appropriate penalties to be assessed upon those who violate the law. Rather, they should be looked upon as adjuncts to legal and administrative sanctions, intended to address the knowledge, attitude, and behavioral problems that may underlie driving under the influence.[28]

Presentence Investigations.--Neither Kentucky's current DUI law nor the previous law, under which the pickup driver was convicted in 1984, included a statutory requirement to conduct a presentence investigation (PSI) into an offender's alcohol/drug dependency. According to the NHTSA, PSI alcohol assessments are widely used throughout the country to guide courts in referring offenders to the most appropriate education and/or treatment program for their level of alcohol/drug dependency. Typically, those persons assessed as "social drinkers" (no or low alcohol dependency) are referred to alcohol education (DUI schools). Convicted offenders who have moderate-to-severe alcohol dependency are referred either first to a DUI school and then to an appropriate treatment program (group therapy, in-patient treatment, and alcoholics anonymous) or directly to treatment programs.

In 1984, the Michigan Alcohol Screening Test (MAST), an alcohol dependency assessment questionnaire, was commonly administered to all convicted DUI offenders who elected to attend the ADE program operated by the Kentucky Justice Cabinet, Division of Driver Licensing. Based on a review of 1982 MAST test results, the Kentucky Governor's Task Force on Drunken Driving (June 1983) reported that "47 percent of the persons attending the alcohol driver education (school) tested as alcoholic, 34.5 percent tested as probable alcoholic, and only 18.5 percent tested as non-alcoholic." The task

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[28]Presidential Commission on Drunk Driving, Final Report, Washington, D.C., April 1983.

force concluded that "the majority of the persons found guilty of driving under the influence have a drinking problem."

Based on its findings, the task force stated that:

> It is critical to incorporate alcohol screening of all first time offenders in any program proposal. By utilizing a screening/testing mechanism, the court can obtain the necessary information to determine if the driving under the influence offender needs additional treatment.

In September 1984, as a result of the repeat offender study, the Safety Board recommended that the governors of the 50 States and the mayor of the District of Columbia:

> H-84-84
>
> Require that appropriate alcohol problem evaluations of persons charged with alcohol-related traffic offenses be conducted and made available to judges hearing these cases.

On July 8, 1985, the governor of Kentucky responded that the State provides alcohol abuse assessment after conviction and upon sentencing. Therefore, on May 28, 1986, the Safety Board classified Safety Recommendation H-84-84 as "Closed--Acceptable Action."

Alcohol Education/Treatment.--The ADE program was the principal DUI school authorized for convicted DUI first offenders at the time of the pickup driver's first DUI arrest. In 1984, the ADE program was optional for first offenders, but it was elected by the vast majority of persons convicted of DUI because completion of ADE resulted in no loss of license. The ADE school consisted of three 3-hour sessions. The course curriculum presented information on the State DUI law, physiological effects of alcohol, alcohol dependency/alcoholism, and self-evaluation.

The pickup driver was referred by the court to the ADE program on April 19, 1984. He attended three 3-hour sessions in Carrollton on July 14, 21, and 28, 1984. The certified instructor who taught that particular ADE school did not remember the pickup driver specifically. He stated that all the students were given the MAST along with other questionnaires to help the offenders assess their own degree of alcohol dependency. (The Safety Board issued a subpoena to Kentucky for the MAST results and other papers from this ADE class attended by the pickup driver; however, State officials have told the Safety Board that they have been unable to locate the documents.) Based on the MAST results and other information and guidance provided in class, offenders were asked to examine their own level of alcohol dependency and were encouraged to seek additional help beyond the ADE school if they felt it was needed. A list of mental health agencies, Alcoholics Anonymous groups, physicians, and clergy in the Carrollton area was provided to each student. There is no evidence that the pickup driver attempted to seek assistance from

any of these agencies. The ADE instructor, who had 9 years of experience teaching DUI offenders, concluded that the pickup driver, with a BAC of 0.16 percent (in 1984), was "probably a problem drinker." He said that in some Kentucky counties in 1984, "when you get a DUI that sticks, he [the DUI offender] has a real problem."

The current project manager of the ADE program stated that in 1984 only two State agencies provided alcohol education or treatment--the ADE and the "Comprehensive Care Program" (known as "Comp Care"). The 1984 legislation provided for a third source of education/treatment; private, for-profit, education/treatment companies.

Comp Care, a statewide public mental health program, is staffed by Kentucky Department of Human Resources employees and contract personnel. The Comp Care programs throughout the State do not use a standardized curriculum but generally use a group counseling or therapy technique. The qualifications of counselors vary from ministers to those who have masters degrees in social work.

Approximately 15 private companies throughout Kentucky provide alcohol education services for convicted defendants. These companies are subject to some degree of regulation by the Division of Driver Licensing. The companies are required to provide 9 hours of alcohol education; they do not have a standard curriculum across the State nor is their curriculum similar to the ADE program.

There have been no evaluations of the effectiveness of the Kentucky ADE program. Evaluations of similar short-term educational programs, such as the 35 Alcohol Safety Action Programs sponsored nationwide by NHTSA in the 1970s, have shown that there were only isolated reports of treatment program effect on crash or arrest recidivism. More recent controlled studies carried out in California have found small decreases in arrest recidivism, but no effect on subsequent crash involvement[29] or no impact at all.[30]

Other studies have compared the effectiveness of rehabilitative programs to that of other sanctions, specifically, license penalties. A 1984 study found that license suspensions have a significant positive effect on crash rates and recidivism, more so than did the treatment programs studied

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[29] R.E. Reis, Jr., "The Traffic Safety Effectiveness of Education Programs for First Offense Drunk Drivers," Final Report, Comprehensive Driving Under the Influence of Alcohol Offender Treatment Demonstration Program, County of Sacramento [CA] Health Department, June 1982.

[30] K. Stewart, L. Epstein, P. Gruenewald, S. Laurence, and T. Roth, "The California First DUI Offender Evaluation Project," Final Report, Pacific Institute for Research and Evaluation, 1987.

(although the treatment programs did have statistically significant effects on alcohol-related crashes and arrests).[31]

Licensing Penalties.--As a result of his conviction for a DUI offense in 1984, the pickup driver's license was subject to suspension for up to 6 months. However, the license suspension could be waived for first offenders who opted to attend the ADE program. The pickup driver exercised this option and, as a result, did not lose his driver's license after his 1984 DUI conviction.

Research indicates that administrative license revocation permits the immediate removal of a DUI offender's driving privilege; it helps remove dangerous drivers from the road quickly, not allowing them to drive with a valid permit while awaiting a court trial sometimes 6 months or a year later. In its 1984 deterrence study, the Safety Board concluded that "the sobriety checkpoint and administrative license revocation procedures are potentially effective deterrent measures that warrant broader application by the States and that these two measures should be an integral part of a State's comprehensive alcohol and highway safety program."

Furthermore, a study recently conducted for the Department of Justice found a reduction in re-arrest recidivism in some States after the adoption of administrative license revocation.[32] The most significant effect was found in North Dakota where the recidivism rate was reduced by about 40 percent. A study conducted in Wisconsin also showed a decrease in subsequent convictions and crashes.[33] In a 1987 study, the authors interviewed New Mexico drivers whose licenses had been suspended or revoked for drunk driving.[34] They found that while "driving is not eliminated, . . . it is modified, specifically, [it was] reduced in quantity and improved in quality." This finding is consistent with other studies which indicate that, even though some drivers continue to drive after revocation, they tend to drive less frequently and more cautiously.

Administrative license revocation also has been shown to be effective in deterring drivers from driving while impaired in the first place. This" general deterrence" effect is even more significant than the reduction in

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[31]D.D. Sadler and H.W. Perrine, "The Long-Term Traffic Safety Impact of a Pilot Alcohol Abuse Treatment as an Alternative to License Suspension," California Department of Motor Vehicles, 1984.

[32]Stewart, K., Grunewald, P., and Roth, T., "An Evaluation of Administrative Per Se Laws," Pacific Institute for Research and Evaluation (final report to the National Institute of Justice, U.S. Department of Justice, February 1989.

[33]Preusser, D., Blomberg, R., and Ulmer, R., "Evaluation of the 1982 Wisconsin Drinking and Driving Law," Journal of Safety Research (in press).

[34]Ross H.L. and Gonzales, F., "The Effects of License Revocation on Drunk-Driving Offenders," IIHS, October 1987.

recidivism. In its 1984 deterrence study, the Safety Board reviewed national and international efforts to control drunk driving. The Board concluded that "general deterrence programs afford the most promising approach for the short-term reduction in alcohol-related deaths and injuries on our highways." As a result of the study, the Board recommended that the governors of Kentucky and 32 other States and territories:

> H-84-13
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> Enact legislation or utilize existing authority to provide for administrative revocation of licenses of drivers who refuse a chemical test for alcohol or who provide a result at or above the State's presumptive limit.

More recently, in a letter dated July 28, 1988, the Safety Board indicated to the governor of Kentucky that it continues to regard the adoption of administrative license revocation procedures as one of the most effective steps that States can take toward reducing alcohol-related highway casualties. The Board pointed out that this view has been reinforced by several new studies that appear to support the effectiveness of administrative revocation laws in improving highway safety.

For example, the Insurance Institute for Highway Safety (IIHS) recently released a study which examined the effects of administrative revocation, first-offense jail sentencing and illegal per se laws on fatal crashes in selected States. The IIHS claims that in 1985 an estimated 1,560 fewer drivers were involved in fatal crashes because of these three laws. Moreover, the IIHS claims that if all States were to adopt these measures, another 2,600 fewer drivers would be involved in fatal crashes each year. Of special interest is the report's conclusion that administrative revocation was the most effective of the three laws studied, and that during hours when more than half of all fatally injured drivers have BACs over 0.10 percent, administrative revocation is estimated to reduce the involvement of drivers in fatal crashes by 9 percent.[35]

Wisconsin also examined the general deterrence effects of its 1982 law mandating 3- to 6-month license suspensions for first-time convicted drinking drivers. General deterrence effects were measured by examining a surrogate measure for alcohol-involvement--late-night, single-vehicle, injury crashes involving male drivers--both before and after the law. The results showed a substantial reduction in this surrogate measure for alcohol-involved crashes.

A companion study of those drivers actually suspended under the law indicated that they had fewer subsequent convictions and crashes. The study concluded that "100 percent mandatory license suspension is an effective

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[35] Zador, Paul; Lund, Adrian; Fields, Michele; and Karen, Weinberg, "Fatal Crash Involvement and Laws against Alcohol-Impaired Driving," IIHS, February 1988.

legal sanction against drinking and driving." Building upon the success of license sanctions under their 1982 law, Wisconsin adopted a full administrative revocation law in 1987.[36]

A time-series analysis of alcohol-related fatal crashes in New Mexico before and after implementation of its law found that the percentage of fatally-injured drivers with a BAC greater than 0.05 percent fell from 66 to 56 percent.[37]

On October 11, 1988, the State of Kentucky responded to the Safety Board's July 28 letter stating that it is currently reviewing the "1984 Slammer Bill" drunk driving law to determine its effectiveness. The administrative sanctions process has also recently been modified to provide a greater percentage of suspensions among violators refusing the chemical test. The letter also stated that Kentucky is reviewing "all enforcement mechanisms available to remove drunk drivers from the public highways as soon as possible following an arrest for drunk driving, including the possibility of a prehearing license suspension . . ."

Evaluation of Kentucky DUI Laws.--After the Carrollton accident, the governor of Kentucky formed a committee composed of various members of the Justice, Transportation, and Human Resources Cabinets, to study Kentucky's current DUI laws along with those of the States adjacent to Kentucky. A December 12, 1988 letter to the Safety Board from the committee chairman listed some of the committee's recommendations to the Kentucky legislature; these recommendations included:

-- Enactment of the illegal per se law;

-- Enactment of the administrative per se (administrative license revocation) law;

-- Passage of an implied consent law plus an amendment to current law to require suspects to consent to two tests (instead of one test);

-- Enactment of one comprehensive license suspension law (currently there are three statutes);

-- Overhauling of current education and rehabilitation procedures and adoption of an assessment and educational agenda for the convicted DUI offender and the general public; and

-- Development of a standard unified set of laws for administering the breathalyzer test.

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[36] Evaluation of the 1982 Wisconsin Drinking and Driving Law.

[37] Ross, H.L., "Administrative License Suspension in New Mexico: An Evaluation," Laws and Policy 9:5-16. 1987.

On March 27, 1989, the Safety Board received a letter from the governor of Kentucky which stated that the recommendations are to be proposed at the next meeting of the Kentucky General Assembly as legislative and administrative amendments.

## The Physiological Effects of Alcohol

Research on the physiological effects of alcohol by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) indicates that as a person's BAC content rises, so does the time it takes a person to respond to a visual or auditory stimulus. Alcohol also impairs the sensory abilities. Although visual acuity remains essentially normal, the ability to discriminate between different intensities of light and resistance to glare (that is from looking into a bright light, such as oncoming headlights) decreases. Moderate to high doses of alcohol lower the ability to distinguish among sounds. A tendency to underestimate both the speed of moving objects and distance traveled over time also results from alcohol intoxication. Tracking and coordination functions of the eyes become progressively hindered as the BAC rises, increasing the dangers of operating machinery or driving an automobile. Regardless of whether a person feels more relaxed or confident in his or her driving, the deficiencies in skill, judgment, and reaction time that alcohol produces place him or her at higher risk for making a mistake and having an accident.

According to the NIAAA, the effects that drinking alcohol will have on a person depends on how much alcohol has built up in the person's blood stream. How high the BAC goes and how rapidly it rises and falls depends on how much alcohol is consumed, how fast it is absorbed from the gastrointestinal tract (stomach and small intestine), how it is distributed in the body, and how quickly it is eliminated from the body.

According to testimony by Dr. Herbert Moskowitz[38] at the Safety Board's public hearing on the Carrollton accident, the pickup driver was massively impaired and intoxicated at a blood alcohol concentration of 0.26 percent. Dr. Harvey Seigel, a certified alcoholism counselor, testified at the Safety Board's public hearing on the accident that:

> [The pickup driver] in no sense of the word, could be considered a social or a . . . "normal" drinker. I would amplify to probably say that, based upon some of the material that I have read and some of the information that I have heard from previous witnesses, that [the pickup driver's] use pattern emphasized episodic loss of control in which he would just drink larger amounts of alcohol than he normally would. I would say that this was not something that had happened quite recently, but that this was something that he had been working [on] for years.

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[38]Professor of Psychology at the University of California, Los Angeles, California, and researcher in the areas of psychopharmacology and human factors.

## Surgeon General's Workshop on Drunk Driving

On December 14-16, 1988, the Surgeon General conducted a workshop on drunk driving in Washington, D.C. Experts in the field were invited to serve on various panels and provide recommendations for inclusion in a final report to be issued by the Surgeon General. The Treatment Panel stated that treatment should not ". . . routinely be used as a substitute for legal sanctions but can be an important component of a comprehensive traffic safety program." The panel noted that the potential effect on traffic safety of specific deterrence is very limited. The Panel recommended that:

> Rehabilitative countermeasures, even if 100 percent successful, can have only a limited impact on traffic safety and the main approach to eliminating alcohol/drug related injuries or fatalities must be focused on prevention.[39]

The following recommendations that resulted from the workshop pertain to the issues in the Carrollton accident:

-- Encourage stronger law enforcement and adjudication of existing drinking and driving laws.

-- Reexamine the effectiveness of drinking and driving education to improve its effectiveness.

-- Make license revocation "hard" (i.e., no exceptions for hardship, occupation, or other reasons); minimum of 90 days; for repeat offenders, substantially longer.

-- No license shall be reinstated without the offender providing proof of compliance with an alcohol assessment and any court order.

-- An alcohol assessment shall be completed and available to the judge prior to sentencing.

-- Plea negotiations shall be strongly discouraged and all negotiations shall be placed on the record in open court and all proceedings shall be in open court.

-- Adopt administrative per se driver's license law (administration license revocation).

-- Provide sufficient funding for judges and prosecutors for continuing education in alcohol-related driving offenses.

-- Implement DUI checkpoints in those jurisdictions currently not using this technique, and expand their use

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[39]Prevention is defined as including public education approaches, public policy, and general deterrence.

in those jurisdictions where they are currently in use. To enhance the efficiency and effectiveness of checkpoints, we advocate the use of breath alcohol testing (BAT) mobiles, passive sensors, and/or preliminary breath testing (PBT) devices and the adoption of legislation to permit sobriety checkpoints, where necessary. These strategies should be used in accordance with the standards set forth by the United States Supreme Court and/or respective State Courts. Also, research data on the effectiveness of checkpoints should be broadly disseminated.

-- Develop enforcement, public information and education efforts designed to maximize public perception of the risk of arrest and punishment for driving under the influence.

-- The mandatory BAC testing of all drivers and non-motorists involved in fatal and serious injury motor vehicle crashes should be required.

## ANALYSIS

### The Accident

General.--Neither the weather nor the condition of the highway caused or contributed to the accident. None of the three accident vehicles--the church bus, the pickup truck, or the passenger car--had preexisting mechanical discrepancies that were causal to the accident.

Accident Dynamics.--The witness statements, the physical evidence, and the vehicle damage patterns indicate that the right front of the northbound pickup truck struck the right front of the southbound church bus in the left southbound lane. About 11.5 feet north of the dual tire skidmarks left by the bus at the 40.3 mile marker, a number of short scrapemarks, chopmarks, and gouges were caused by the underside of the pickup truck as it underrode the bus. The Safety Board concludes that the bus and the pickup truck collided in this area. No fuel or other kind of liquid splatter was found on the roadway in the area of impact. None of the witness statements nor the physical evidence on the roadway indicated that the pickup driver attempted to brake before striking the bus. After impact, the bus continued forward in the left southbound lane about 140 feet before coming to rest straddling the left shoulder and travel lane. The Safety Board believes that the fire entered the bus about the time the bus came to rest.

After striking the church bus, the pickup truck ceased all forward motion and began rotating clockwise as it was being pushed rearward by the bus. The left rear corner of the pickup truck struck the left rear door of the Cadillac traveling in the southbound right lane. The pickup truck continued to rotate clockwise while it was pushed rearward after the second collision and came to rest about 78 feet from the initial area of collision on the right shoulder of the southbound lanes.

Based on its maximum within-gear speed and on this terrain, the church bus could have been traveling as high as 54 mph just before collision. Because the bus decelerated after the collision with the pickup truck, the Cadillac, after having been sideswiped by the rear of the pickup truck, was able to cross in front of the the other vehicles without further contacting either vehicle.

The Safety Board calculated the speed of the Cadillac before it was struck as between 47 and 50 mph. Using linear conservation of momentum[40] and an estimated speed of 54 mph for the church bus, the speed of the pickup truck before collision was between 52 and 58 mph.

Motorists who had been traveling northbound on I-71 and had observed the pickup truck in the southbound lanes for about 1 1/2 miles estimated the speed of the pickup truck to have been between 50 and 55 mph before the

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[40]Conservation of momentum is the principle that in a collision of two solid bodies, no momentum (mass times velocity) is lost, the sum of the momentums of the two bodies is the same before and after the collision.

collision. Taking into account the physical characteristics of the terrain and the witness statements that they kept sight of the pickup truck and saw it strike the bus, Safety Board investigators calculated that the pickup truck could not have been traveling more than 61 mph. Thus, the Board concludes that the pickup truck was probably traveling between 52 and 61 mph at the time of the accident.

The Safety Board believes that the busdriver had a very short time to take evasive action before the collision. The closing speeds for the bus and the pickup truck may have been as high as 115 mph (54 + 61 mph). Also, the range of visibility based on the visibility tests for the accident curve was limited to between 400 and 500 feet. Thus, the busdriver had between 2.4 and 3.0 seconds to perceive, react, and take evasive action. Because the physical evidence and the passenger statements indicate that the busdriver steered to the left and applied his brakes just before the collision, the Safety Board concludes that the busdriver initiated appropriate evasive action given the short period of time he had to execute these manuevers.

During the collision between the pickup truck and the church bus, several front suspension and chassis components separated from the bus. The right portion of the front axle and the right front leaf spring assembly separated from the chassis. The fuel tank on the bus was found after the accident approximately 28 inches rearward of its installed position and it was punctured. However, the Safety Board does not know how much of this 28 inches was the result of the process of removing the bus from the scene of the accident. The Safety Board believes that the right front leaf spring assembly from the bus may have struck and punctured the fuel tank because one end of the leaf spring matched the configuration of the fuel tank puncture, the leaf spring was in close proximity to the fuel tank, and the leaf spring was strong enough to penetrate the fuel tank. The Board examined a number of different theories on the kinematics of the components in an attempt to reconstruct the sequence of events that occurred during the collision. However, while most damage and witness marks on the pertinent vehicle components and the roadway were consistent with the leaf spring puncturing the fuel tank, certain marks on the fuel tank and the angle at which they had been made could not be fully explained by the various reconstructions of the kinematics of the leaf spring and the fuel tank. Therefore, although the Safety Board believes it is likely, it has been unable to determine conclusively that the leaf spring assembly punctured the fuel tank.

Although the Carrollton accident occurred under certain circumstances, the type of damage resulting from the collision with the pickup truck is not uncommon. The Safety Board has previously investigated at least 13 accidents in which large poststandard school buses were involved in frontal collisions in which the front axle of the bus was struck and pushed rearward during the collision dynamics.[41] In 11 of these accidents, the postaccident examinations did not reveal any punctures/ruptures of the bus fuel tank or postcollision fires. However, in one accident the school bus collided into a

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[41] Safety Study, "Crashworthiness of Large Poststanderd Schoolbuses," (NTSB/SS-87/01).

roadside embankment, and fire erupted in the engine and spread to the passenger compartment. In the remaining accident, the fuel tank of a school bus involved in a multiple vehicle collision was punctured. However, no fire occurred.

In the school bus fire in Kansas City, Missouri, the fuel tank, tank guard, and attaching fuel lines were subjected to severe collision forces. In the accident, the tank was severely deformed and both the fuel tank and tank guard were pushed rearward. The Safety Board believes that the fuel tank performed adequately in the accident (it was not punctured nor did it leak); however, the structural integrity of the tank guard was compromised during the collision. This allowed the fuel tank to be severely dented and pushed rearward about 8 inches. Consequently, the fuel lines separated from the tank as a result of the tank's rearward movement providing the fuel source for the fire that spread into the front of the bus through the deformed stepwell area.

**Ignition Source for Fire**

The Safety Board considered four possible sources of ignition of the bus fire: the electrical system; a heat source, such as an exhaust pipe; friction caused by damaged metal parts scraping against the roadway; and friction heat from the metal that punctured the fuel tank itself. The electrical system was eliminated as an ignition source because the battery and associated wiring was destroyed in the initial impact. The exhaust system, while several feet from the spillage area, could not be eliminated as an ignition source. However, the Board believes that because of the distance between the exhaust system and the spillage area and the short amount of time that the fire erupted, the exhaust system was not the ignition source. The Board believes that the most likely source of ignition was the scraping of the heavy metal leaf spring on the roadway which generated considerable heat and most likely a shower of sparks. Also, it is possible that the hot end of the leaf spring could have punctured the fuel tank in the final moments before the bus came to rest. Thus, either the sparks or the hot end of the leaf spring could have provided a likely source of ignition. The fire then entered the passenger compartment through the damaged right front floor and stepwell area of the bus and spread rapidly throughout the interior of the bus.

Some school transportation officials expressed concern that the fire may have been avoided had the bus been equipped with a diesel-fuel engine because the flashpoint (temperature) of diesel fuel is higher than the flashpoint of gasoline.[42] (Some school transportation officials, as well as school bus manufacturers, have stated that the industry is phasing out gasoline engine

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[42] The flashpoint (the lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air) for gasoline is about -36° F and its auto ignition temperature is 853° F. The flashpoint for diesel fuel ranges from 100° F to 125° F, and its auto ignition temperatures range from 350° F to 545° F. The flashpoint and auto ignition temperatures depend on the grade of fuel.

and using diesel engines not because of concern for fires, but rather because it is more economical.) Because the flashpoint (temperature) of gasoline is lower than that of diesel fuel, the probability of ignition is higher for gasoline. However, hot engine manifolds, exhaust systems, and vehicle components can ignite the vapors of diesel fuel under certain conditions. Therefore, while it is less likely that diesel fuel vapors will be ignited during an accident, the Safety Board cannot rule out the possibility of a fire if the accident bus had been a diesel-powered engine instead of a gasoline engine.

## Human Performance Considerations

Busdriver.--The busdriver was properly licensed to drive the bus. His previous experience of driving heavy trucks and church activity buses and the absence of violations and accidents on his driving record suggest that he was competent to operate the bus for this activity trip.

At the time of the accident, the busdriver had been awake for more than 17 hours; during this time, he had driven the bus to the amusement park near Cincinnati, had spent the day at the park with other adults in the group supervising the children, and had driven the return trip continuously for nearly 2 hours except for a fuel stop. The Safety Board believes these circumstances could have resulted in some lessening of the driver's vigilance. However, since the busdriver apparently perceived the danger and reacted to it with a steering correction in approximately 2 seconds, it appears that the driver was vigilant. The Safety Board concludes that the busdriver could not have avoided the collision given the darkness, the curvature of the roadway, and the limited sight distance. Accordingly, the Safety Board believes that the busdriver's performance was not a factor in this accident.

Pickup Driver.--Test results on a blood specimen taken from the pickup driver about 1 1/2 hours after the accident indicated a BAC of 0.26 percent, which is more than 2 1/2 times the legal limit at which a person is generally presumed intoxicated. With such a high BAC, the pickup driver would have been extremely intoxicated. Considering the average rate of metabolism for ethyl alcohol (0.015 percent per hour) and assuming the pickup driver was in the elimination phase, his BAC would have been 0.28 percent at the time of the accident. However, based on the driver's drinking history, a rate of elimination of 0.015 percent per hour is a conservative estimate of his rate of alcohol metabolism, and his BAC at the time of the collision may have been higher than 0.28 percent.

The witness who had been driving southbound on I-71 9 miles north of the accident site said the pickup truck was being operated erratically. He also said that he passed the pickup truck and a tractor-semitrailer in an effort to keep away from them in case of an accident. The witness had observed the pickup truck cross the median strip north of the accident site, had later observed the pickup truck going northbound in the southbound fast lane, and had tried to alert the pickup driver by blowing his horn and flashing his lights. Two other witnesses who saw the collision said that before the accident the pickup truck was driving northbound in the southbound lanes.

Based on the results of controlled studies of the effects of alcohol on human behavior and performance, the Safety Board believes that the pickup driver's high alcohol level diminished his awareness of his surroundings, his abilities to recognize the extremely hazardous situation, and his ability to avoid the collision. Therefore, the Safety Board concludes that the physical impairment of the pickup driver, as a result of alcohol intoxication, caused the accident.

The exceptionally high concentration of ethyl alcohol in the pickup driver's blood prompted the Safety Board to conduct an extensive background investigation into the lifestyle and personal circumstances of the pickup driver in an attempt to determine if any underlying human factors may have contributed to the accident.

Interviews with immediate family members, his friends and work associates provided inconsistent evidence as to how often he drank alcoholic beverages. Most indicated that occasionally he would drink a lot (normally when he was off work for the weekends). His prior DUI conviction in 1984 and his arrest records suggest several occasions in recent years in which he was or may have been intoxicated. Based on the accumulated evidence, the Safety Board believes, and independent experts corroborate, that the pickup driver had an alcohol problem and that he had used alcohol abusively for many years.

Other aspects of the pickup driver's personal situation are relevant to the circumstances of this accident. Reportedly, major medical bills led to his earlier declaration of bankruptcy; his modest income, his continuing expenses for alimony, car payments and other living expenses could reasonably be expected to place him in continuing financial difficulties. Moreover, in addition to his earlier difficulties in his marital relationships, according to his father, he was planning to re-marry his first wife. These circumstances in combination could prove to be stressful; and his medical history of a duodenal ulcer suggests the possibility of such a stressful reaction on his part.

Because these kinds of life events and circumstances also can in some cases lead to depression and anxiety reactions in persons, the Safety Board also considered the possibility that the pickup driver's actions which led to the collision may have been prompted by an intent to commit suicide. Shortly after the accident, the Safety Board learned that, at the direction of the Kentucky Commonwealth's Attorney, the pickup driver underwent psychological testing intended to assess his mental state and his fitness to stand trial. Due to the pending criminal charges against the pickup driver, the Safety Board was not permitted access to the results of these tests. Nevertheless, the Safety Board's own inquiry into the pickup driver's background and the results of interviews with coworkers and acquaintances did not disclose evidence to suggest acute depression, recent personality changes, a history of suicidal attempts or other indicators which would suggest such tendencies. Therefore, the Safety Board believes it is unlikely that the pickup driver knowingly drove the wrong way on the highway with the intent to kill himself.

## Vehicle Factors

According to church members who had operated the bus, the front tires were new and there were no noticeable steering or braking problems with the bus. During the accident sequence, in a very short amount of reaction time, the busdriver was able to steer the vehicle to the left in an attempt to avoid the pickup truck. Therefore, the Safety Board believes that the steering system was functioning properly at the time of the accident.

The Safety Board does not believe that any of the mechanical discrepancies noted on the church bus (the out-of-adjustment brake, the condition of the bracket rivets, or the nonstandard fuel cap) caused or contributed to the accident. The postaccident inspection of the bus revealed that the slack adjuster on the right rear wheel exceeded the manufacturer's recommended adjustment stroke by 1/8 inch (the slack adjuster on the left rear wheel was well within the recommended limits). However, the intense heat generated by the fire (especially when the tires were burning near to the brake chambers) could have resulted in internal damage to the brake chamber. Therefore, the Safety Board cannot conclude that the measurements taken after the accident were representative of the preaccident condition of the brakes. However, the 119-foot-long postimpact rolling tire skidmarks left by the bus indicate that the bus brakes were probably operating adequately.

The metallurgist's report indicated that the fracturing and deformation forces resulted in a downward rotation of the front of the hanger which caused a tensile fracture of the forward fasteners as indicated by the upward deformation of the hanger plate. The grinding marks on the leaves were consistent with abrasive contact with a flat object, such as the road surface. The rivets of the right front mounting bracket that attached the leaf spring assembly pack to the right frame rail were not fractured before the accident. They were, instead, fractured in shear due to collision forces.

Although preexisting wear damage was found on the spring attachment bolt, the wear was not sufficient to have been a factor in this accident. No other evidence was found of preexisting damage to the leaf spring assembly pack and hanger.

A nonstandard fuel tank filler cap installed on the bus was not a "venting" cap and, thus, was not designed to allow the vapors to escape. However, the improper fit of the cap nevertheless permitted fuel vapors to vent.

## School Bus Crashworthiness: Prestandard vs. Poststandard School Buses

The fuel tank of the accident school bus complied with FMVSS 301, Fuel System Integrity. At the time the accident school bus was purchased, Ford offered the fuel tank guard as an option, and holes for a fuel tank guard had been drilled in the bus chassis. However, the KDE did not order school buses with the optional fuel tank guards.

Due to the complex crash kinematics in this accident, it is difficult to predict if and how the results of the accident may have differed if the bus had been equipped with a fuel tank guard. The guard may have withstood the impact and prevented the fuel tank from being pushed rearward or it may have permitted the fuel tank to be pushed rearward somewhat. It is unlikely that a tank with a guard would have moved relative to the chassis precisely as did the tank (without a guard) in this accident.

A tank guard would have caused the kinematics of the tank relative to the chassis to have differed from this accident; therefore, it is not possible to state, conclusively, where the tank would have been struck. The Safety Board's examination of a poststandard bus equipped with a fuel tank guard revealed that a Ford fuel tank guard would have covered the area punctured on the accident fuel tank. Portions of the dented and scraped areas of the accident fuel tank, however, would not have been covered by a Ford fuel tank guard. Although fuel tank guards are not designed to protect fuel tanks from punctures, had the tank been equipped with a guard and in the unlikely case the fuel tank had been struck in the same location as in this accident, it is possible that a guard could have prevented puncture of the fuel tank. It is also possible that the tank may have been struck with sufficient energy that a guard could not have prevented the puncture.

In a slightly different accident, an object could puncture a fuel tank equipped with a Ford fuel tank guard in an unprotected location. However, because a fuel tank guard may cover as much as half of the front, rear, and sides of a fuel tank and is made of heavy gauge steel, the fuel tank guard provides protection not afforded to tanks without the guards. Certainly, fuel tank guards offer greater protection against penetration (and spillage) than fuel tanks not equipped with guards (such as was the case in this accident).

Although the national statistics suggest that the incidence of fire in school buses is relatively rare, the Safety Board is concerned that the fires could spread to the occupant spaces of school buses and cause injuries and deaths. The Safety Board is not aware of any other accident in which fatalities resulted from a fuel tank rupture on a school bus. However, based on the Board's investigation of 10 school bus and school van accidents that involved fires (including the most recent school bus fuel-fed fires at Carrollton, Kentucky, and Kansas City, Missouri), there is a significant potential for fire to spread inside the passenger compartment.

Current Federal fuel system integrity requirements provide adequate protection for large school buses in most accidents. However, additional improvements to the fuel system are needed to prevent fires in severe accidents such as those at Carrollton and Kansas City. For severe accidents in which the crash forces are transferred to the chassis structural members, but damage to the fuel tank and tank guard is minimal, improvements are needed to prevent leakage of fuel from separated fuel lines. Possibly, the use of frangible shutoff valves in critical locations could prevent the spillage of all but a minor amount of fuel in the accidents in which the fuel lines have been separated from the tank or engine during collisions.

In severe accidents in which sufficient crash forces are absorbed by the fuel tank and the tank guard which breach the tank, improvements are needed to preclude or to minimize the amount of fuel leakage and, if fire erupts, to delay its spread into the passenger compartment. Research and testing is needed to evaluate the merits of relocating the fuel tank possibly between the frame rails or further rearward of the entrance door area, or of providing additional structure or shields in front of the existing tank to better protect it from crash forces that occur in severe frontal collisions, and to deflect heat buildup beneath the tank in the event of a fire. Because of the significant potential for fire in school buses, particularly in severe frontal crash situations, the Safety Board believes that NHTSA needs to strengthen FMVSS 301 to provide additional protection from fire.

Survival Factors

Seat Flammability and Toxicity.--The poly(vinyl)chloride-covered and polyurethane padded seat cushions provided the source of fuel for the fire once it spread inside the bus. Hydrogen chloride is a toxic product that is produced when this material is burned. The surviving passengers described extremely difficult conditions on the bus, including thick, black smoke; hot seats and floor; and plastic dripping from the ceiling. Many complained of the limited visibility due to the thick black smoke and some lost consciousness because of the smoke/fumes.

Heat and toxic products accumulated first in the ceiling area of the bus. Assuming that a carboxyhemoglobin saturation of 50 percent is fatal, only 33 percent (9) of the deaths from the accident could be attributed to fatal carbon monoxide exposure alone. Thus, at least 66 percent of the victims must have died from other factors, such as heat and/or other toxic gases. Inhalation injuries are symptomatic of exposure to a strong irritant, such as hydrogen chloride which produces severe irritation and chemical acid burns when it contacts the moist mucous membranes of the eyes, nose, throat, and lungs. The corneal burns were most likely due to exposure to hydrogen chloride. The Safety Board concludes that the exposure to hydrogen chloride and black soot most likely contributed to the inhalation injuries of survivors as well as those fatally injured. The alcohol found in four of the bus passengers' bodies most probably was due to postmortem generation from bacterial growth.

The Safety Board is aware of bus upholstery material that is less flammable and less toxic than the current untreated poly(vinyl)chloride/polyurethane material. According to several school bus seat manufacturers, some fire-retardant and flame-blocking materials, such as fiberglass-woven materials or aramid nonwoven blends, when tested, will reduce the rate of spread of fire from seat to seat over materials currently used.

The Safety Board is aware that the NIST is currently developing acceptance criteria to limit the rate of fire growth in school buses. The study will be directed toward currently used and state-of-the-art material assemblies for school bus seats. The Board urges the NHTSA, when the study

is completed, to incorporate the NIST recommendation concerning the new material acceptance criteria to reduce the rate of fire spread in all buses.

Emergency Egress.--According to survivors, passengers crawled over seatbacks and on top of each other in an attempt to reach the rear exit door. Some survivors stated that the seats became so hot that the passengers were forced into the crowded aisle. By the time they did reach the exit door, which was blocked by other passengers trying to exit at the same time, many could not get out before being overcome by smoke.

The main problems during the evacuation were the insufficent number of exits and the rearmost bench seats which intruded into the opening at the rear exit. The opening at the rear exit provided about 14 square feet of exit area. However, the two full-length rear bench seats overlapped the rear exit opening by as much as 24 inches in width, leaving a space of only 15 inches wide at the top of the seats and 12 inches wide toward the bottom of the seats. Had the full length rear seats been replaced by smaller seats, the aisle between the last two bench seats would have been 36 inches wide allowing more passengers to exit the bus. Thus, the reduced exit opening resulted in the occupants being exposed for a prolonged time to the toxic environment and increased the severity of injuries.

Two survivors stated that they escaped through a window, and others stated that they tried without success to kick out the windows. Had the passengers been able to escape from more than just two windows, it is very likely that more passengers would have survived this accident.

Since 1969, the Safety Board has investigated four accidents[43] and issued five safety recommendations to the FHWA, the NHTSA, and the bus manufacturing industry urging them to provide for additional emergency exits to facilitate escape from and access to buses regardless of the vehicle's attitude following a collision or overturn. The four accident investigations involved one school bus and three charter buses. In each accident, the Safety Board concluded that the lack of adequate exits hampered emergency egress.

FMVSS 217 requires a certain specified opening for emergency egress. Therefore, in poststandard buses, if the last row of seats is less than 1 foot forward of the rear exit door, one of the bench seats must either be shortened or completely removed. However, the standard does not require more than one emergency exit. Currently, FMVSS 217 provides for more emergency exit area for nonschool buses than the amount of area required for school

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[43] Highway Accident Reports --"Interstate Bus-Automobile Collision, Interstate Route 15, Baker, California, March 7, 1968" (unnumbered); "Tractor-Semitrailer/Schoolbus Collision and Overturn, Rustburg, Virginia, March 8, 1977" (NTSB-HAR-78-01); "Chartered Interstate Bus Crash Interstate Route I-80S, Near Beaver Falls, Pennsylvania, December 26, 1968" (unnumbered); "Greyhound Lines Bus Collision with Concrete Overpass Support Column on I-880, San Juan Overpass, Sacramento, California, November 3, 1973" (NTSB-HAR-74-5); Washington, D.C. June 9, 1975 (NTSB-HAR-74-5).

buses. The minimum standard for school buses requires a set number of openings at a particular place in the bus. The minimum standard for nonschool buses requires an amount of exit area per passenger seating position with a set maximum amount of area at any given location, which forces the manufacturers to divide the exit area into different locations in the bus. Thus, the provisions for nonschool buses in FMVSS 217, to some degree, govern the number and locations of emergency exits throughout the bus. NHTSA officials have been unable to explain to the Safety Board the reasons for the differences in the standards for school buses and nonschool buses.

Currently, the provisions for school buses in FMVSS 217 do not address the anthropometric population of bus occupants or the passenger seating capacity. In most instances, to increase the seating capacity in school buses, manufacturers either extend the body length or reduce the aisle width. Both plans can adversely affect a bus passenger's ability to enter the aisleway and exit the bus.

Current guidelines established by the Minimum Standards Conference specify that the aisle in school buses be at least 12 inches at the floor and 15 inches at the top of the seatbacks. This guideline is applicable to all bus sizes. Thus, a 24- and a 90-passenger school bus can have the same aisle width and one emergency exit in the rear, and both would be in full compliance with the guidelines and the current egress requirements for FMVSS 217.

Interviews with the surviving passengers did not indicate that the aisleway impeded their egress. However, some passengers began climbing on the seats almost immediately to get to the rear of the bus, and when they reached the emergency door, not only was the aisle full, but the seats on either side of the doorway were crowded with people trying to get out. Seven to eight people crowded into the doorway at one time. Many passengers would make some progress toward the exit but were then pushed down into a seat or stepped on. The Safety Board concludes that had the aisle been wider, more passengers could have stood in the aisle (rather than climbing on the seats) and exited the bus more rapidly. The Board believes that the aisle width of buses should be commensurate with bus seating capacity to accommodate the maximum number and size of passengers. Further, proposed changes to FMVSS 217 to address this issue should also be incorporated in the existing provisions for nonschool buses. Thus, the Safety Board believes that the NHTSA should revise FMVSS 217 to ensure that bus exit requirements are based on bus capacity and be no lower than those for nonschool buses.

Before 1977, when a series of special Federal motor vehicle safety standards became effective which mandated a higher level of safety for school buses compared to other buses (except for emergency exit requirement), school buses were required only to meet the minimum standards required of all multipurpose passenger vehicles. The Safety Board believes that the safety record for prestandard buses is relatively good. Because, in part, of the large size and mass of school buses relative to passengers cars, station wagons, and vans, often used to transport children to school, prestandard buses provide safer transportation for school children than these other types

of passenger vehicles. However, as a result of its investigation experience involving prestandard and poststandard school buses, the Safety believes that the improved protection (which the FMVSS relating to school buses requires) is responsible for saving lives and preventing many more serious injuries. Therefore, the Board believes that all government agencies, churches, and other private organizations should purchase buses for passenger use which meet the safety standards set for school buses in April 1977. The Safety Board also believes that the States should propose legislation establishing a date by which school buses manufactured before April 1977 will be phased out of use for public transportation purposes.

On November 4, 1988, the NHTSA published Advance Notices of Proposed Rulemaking (ANPRM) relating to FMVSS 217, Bus Window Retention and Release, and FMVSS 302, Flammability of Interior Materials. The ANPRMs requested comment by January 3, 1989 on cost, the latest technology, information on flammability and toxicology, injury data, occurrence of fire on buses, and States' experiences which led them to require additional emergency exits on school buses. The Safety Board urges the NHTSA to expedite completion of the proposed rulemaking.

The Safety Board supports NAGHSR's request to the NHTSA to establish FMVSS applicable to all vehicles intended for use in the transportation of 10 or more passengers and recommends that NHTSA eliminate the existing provisions within FMVSS 217 that permit different egress requirements for school buses and nonschool buses.

**Kentucky DUI Program**

Drunk Driving in Kentucky.--The most direct measure for comparing the magnitude of the drunk driving problems among States is the percentage of alcohol involvement in fatalities or fatal crashes, or other types of crashes. However, comparison between States on their level of alcohol involvement in accidents are impeded by a number of technical difficulties. The most important threat to the validity of such comparisons is the failure to test for and the underreporting of alcohol involvement in highway fatalities in many States. Keeping in mind the limitations of the data on alcohol involvement in fatal crashes, there are some general indications of the relative level of Kentucky's DUI problem compared to the nation at large.

The level of alcohol involvement in Kentucky highway fatalities is less than the national average (for 1987, 42 percent compared to 51 percent). In 1987, at least 359 lives were lost in Kentucky and 23,630 nationwide, and the tragic consequences of these fatal crashes and many other alcohol-involved crashes were suffered by the families and communities involved.

The Safety Board believes the 1984 DUI legislation improved Kentucky's existing laws. However, while the number of alcohol-related fatalities declined in 1984 and 1985, they have increased in 1986 and 1987. Despite the improvements that have been made, the large number of alcohol-involved fatal crashes that still occur in Kentucky and nationwide points to a need for greater action to address DUI drivers not only in Kentucky but throughout the country.

If the nation is going to resume the progress made in reducing the incidences of drinking and driving, there needs to be a refocusing on this issue at all levels, especially at the local and State level. The Safety Board believes that the magnitude of the problem demands that additional attention be given to dealing with the DUI issue.

Kentucky has been generally responsive to Safety Board recommendations concerning citizen reporting programs, testing and reporting of drivers involved in fatal crashes, use of breath test devices, field sobriety tests, sobriety checkpoints, and alcohol evaluations. However, the results of this accident investigation indicate that additional steps must be taken. The areas that need special attention include license sanctions, reduction of penalties for enrolling in driver education or treatment programs, enhanced DUI enforcement, reduction of alcohol-related charges to nonalcohol-related charges (plea bargaining), and presentence investigations.

License Sanctions.--The Safety Board continues to believe the adoption of administrative license revocation procedures is one of the most effective steps that States can take toward reducing alcohol-related highway crashes. The effects of administrative license revocation are two-fold--the licenses of dangerous drivers are revoked more quickly, and the likelihood of receiving a penalty for drunk driving is dramatically increased. The general deterrence benefits of an administrative license revocation program and the reduced recidivism rates among DUI offenders indicates potential for a long-term impact.

Results from States with administrative revocation indicate that adoption of such a measure in all States would be a significant advance in our nation's efforts to deter people from driving after drinking by ensuring a swifter and more certain punishment for those who drink and drive. Therefore, the Safety Board urges Kentucky and all States to adopt administrative revocation legislation.

The Safety Board is not alone in advocating the implementation of administrative revocation laws. The NHTSA and many highway safety experts also support such laws. In addition, passage of administrative revocation laws was one of the main recommendations of the December 1988 Surgeon General's Workshop on Drunk Driving. The Congress also recognized the importance of administrative revocation laws by including in the Anti-Drug Abuse Act of 1988 (P.L. 100-690) (Title IX--The Drunk Driving Prevention Act of 1988) incentive grants to States that pass these laws.

Plea Bargaining and Reduced Penalties.--Kentucky's 1984 DUI legislation prohibits plea bargaining when a person's BAC is above 0.15 percent and requires that prosecutors introduce into court records the reasons for reducing charges when the BAC is below 0.15 percent. Even though the Safety Board closed Safety Recommendation H-84-80 to Kentucky based on the State's partial compliance with the intent of the recommendation, charges of an alcohol-related offense should not be reduced to charges of a nonalcohol-related offense. It leads to reduced penalties for drunk drivers and distorts their records. In Kentucky in 1987, 69.5 percent of those charged with DUI were convicted. However, some part of the remaining 30.5 percent of those

charged with DUI had those charges reduced to some other offense. Therefore, the Board urges the State of Kentucky to review what is actually occurring since passage of the 1984 DUI law to determine whether persons charged with alcohol-related offenses are being allowed to plea bargain to a nonalcohol-related offense.

Of equal concern is the provision in the DUI law that a 6-month license suspension may be reduced to a 30-day suspension if the defendant attends a 9-hour alcohol education course. ADE programs can be counterproductive when misused in this way and can reduce the deterrence effect. The pickup driver's license was not revoked after his 1984 DUI offense because he elected to attend the ADE program. Studies have shown that license revocation is more effective in reducing arrest recidivism than education or treatment programs. The Safety Board believes that an education or treatment program should not replace licensing sanctions. If an education/treatment program is to be part of the sentence prescribed by the court, it should be in addition to the licensing sanction and not in lieu of it. The Board urges the State of Kentucky to modify its DUI law to prohibit the practice of reducing the period of license suspension if an alcohol education course or treatment program is undertaken by a convicted DUI offender.

Enhanced DUI Enforcement.--The Safety Board notes that preliminary breath test devices and the horizontal gaze nystagmus test are used by some police agencies in Kentucky. However, the Board is concerned that the breath test devices and the horizontal gaze nystagmus test are not being employed to a greater extent. The Board therefore urges the KSP and other Kentucky traffic law enforcement agencies to reconsider Safety Recommendation H-84-77 and expand the use of these devices and techniques in their law enforcement operations.

The Safety Board also notes that sobriety checkpoints are used occasionally by the KSP and, on a limited basis, by local police agencies in Jefferson County, Lexington, and Louisville. "Mini-checkpoints" for driver's license checks also are used by the KSP, during which drivers are checked for signs of impairment. The Board believes that the sobriety checkpoint is a key component of an effective DUI enforcement and deterrence program and that it warrants broader application in Kentucky and all States. The Board therefore urges Kentucky to expand the use of sobriety checkpoints and to encourage and assist traffic law enforcement agencies at all levels to adopt their use.

Kentucky introduced the "RAPID" (Report of Problem Intoxicated Driver) program about the time the Safety Board recommended such programs to all States (Safety Recommendation H-82-35). The KSP reports that the program has been a success, and statistics made available to the Board appear to support their conclusion. Based on interviews with KSP representatives, the Board was given the impression, however, that the emphasis placed on the RAPID program has waned in recent years, particularly the effort to increase public awareness of this program. The Board, therefore, encourages Kentucky to renew its effort to publicize and to encourage citizens to participate the RAPID program.

Although the law enforcement programs and procedures for detecting, testing, and apprehending DUI offenders are mostly in place, according to State officials and the KSP, emphasis placed on these programs has diminished over the years. The Safety Board believes that it is extremely important to renew and again focus public awareness and enforcement campaigns against drunk drivers.

Presentence Investigations and Rehabilitation.--The Safety Board's investigation indicates that the alcohol evaluation performed during the pickup driver's 1984 DUI arrest and conviction was not adequate and that a thorough evaluation might have indicated that he had an alcohol problem. The pickup driver was "allowed" to volunteer to go to the ADE class and thus avoided a license suspension. The pickup driver's MAST results have not been located and so it is not known whether they indicated that he had an alcohol problem which should have been treated at another level. There were no indications that the courts investigated the pickup driver's habits and background--for example, criminal arrest and circumstances--to discover if he had a more serious alcohol problem. The procedures in effect at the time of his 1984 DUI conviction that permitted him to avoid loss of his license and to not receive a more comprehensive alcohol assessment resulted in Kentucky missing the dual opportunity to apply a sanction that could have deterred his future drinking and driving and to provide appropriate treatment for his underlying alcohol abuse problem.

The need for proper presentence investigaton was underscored by the treatment panel at the Surgeon General's Workshop. In its report, the panel stated:

> Short-term, low-intensity, educational programs traditionally broadly applied have been of limited effectiveness, and more intensive longer-term treatment options may be more beneficial (albeit more costly) and perhaps applicable to a more selected population of offenders.

The Safety Board believes that Kentucky should develop a statewide uniform system to assess a DUI offender's alcohol and drug dependency level and to provide or require treatment commensurate with the level of problem. However, these programs have demonstrated very limited effectiveness in improving traffic safety. Therefore, alcohol and education programs should not be substituted for, but used in conjunction with, proven countermeasures, such as license revocation.

Improving and Implementing DUI Laws.--The Safety Board believes that the recommendations made by the committee formed by the governor of Kentucky to assess the current DUI laws are extremely valuable and urges the State legislature to enact them. Especially important are the license sanctions, the illegal per se, and the administrative revocation laws. The IIHS report, the recommendations presented at the Surgeon General's workshop, and other studies have pointed out that these types of laws were responsible for the decline in fatal crashes, and the IIHS report concluded that the

administrative revocation laws were the most effective and reduced fatal crashes by 9 percent.

The Safety Board also believes that it is the application of the DUI laws rather than the specifics of the laws that is weak in many States. The degree to which police agencies enforce the law, prosecutors prosecute on the original charge, and judges and licensing agencies render appropriate sanctions are key factors in the success of most laws. The Board urges all States to review their DUI laws and their implementation in light of the problems discussed in this report and make appropriate corrections to reduce the unacceptably high level of alcohol-related traffic crashes.

## Highway

General.--The surface of the highway, the shoulders, and the pavement markings on I-71 were in good condition. The signs posted to discourage wrong-way movements at the interchanges were in fair to excellent condition. The interchanges immediately adjacent to the accident site generally had the necessary signing specified in the MUTCD, including turn prohibition signs, "Do Not Enter" signs, and "Wrong-Way" signs. U-turn prohibition signs were installed at the crossovers near the accident site. However, the "One-Way" signs and pavement marking arrows specified in the MUTCD were not used near the interchanges.

Wrong-Way Interstate Accidents.--There was no previous history of wrong-way accidents on the accident segment of I-71. Further, it is highly unlikely that the placement of appropriate highway signs and pavement markings at the accident site would have substantially altered the outcome of this accident. However, approximately 272 fatalities per year do occur as a result of wrong-way driving accidents.

As a result of its investigation of a head-on collision near Baker, California on March 7, 1968, the Safety Board recommended that the FHWA:

H-68-24

Continue its support of State Highway Department research and application of remedial measures to avert or redirect wrong-way traffic movements at expressway, freeway, and multilane divided highway ingress and egress points. This research effort should be expanded and consideration given to the development and application of measures to avert or redirect wrong-way traffic movements which occur on a roadway at points other than those used for ingress and egress. Directional arrows applied at regular intervals, rumble strips, signs, and other signal systems might be considered. The Safety Board further recommends that the FHWA advise the National Joint Committee on Uniform Traffic Control Devices of the effective measures developed to redirect wrong-way traffic movements which occur on a roadway at points other than those used for ingress and egress; and, urges the National Joint

> Committee to implement these measures on a national basis in the most expedient manner at its command.

On January 17, 1969, FHWA responded that:

> The support of State research work to develop remedial measures to avert or redirect wrong way movements at points of ingress and egress on divided highways will be continued as a regular part of FHWA program... will explore expansion of the program as recommended. The National Joint Committee on Uniform Traffic Control Division will be kept informed as recommended.

On July 17, 1975, the Safety Board classified Safety Recommendation H-68-24 as "Closed-Acceptable Action." In the past, efforts have been made to reduce wrong-way driving at entrances and exits near interchanges. However, because the loss of life (about 272 deaths per year) from wrong-way accidents continues to be substantial, it is reasonable to conclude that wrong-way accidents on the main line between interchanges may now be a problem. A nationwide effort on the interstates should be initiated to post "Wrong-Way" and "One-Way" signs and place pavement arrows at each crossover or at periodic intervals (such as 1 mile). Although there are about 43,000 miles of interstate highway, the cost may not be great relative to the benefits of reducing these severe types of accidents. However, the Board recognizes that it may be necessary to establish, through a demonstration program, the feasibility of such a program. Because wrong-way accidents do not occur frequently on a particular interstate route within a State, the Board believes the FHWA should conduct a demonstration project to determine the feasibility of reducing wrong-way accidents on the main lines of interstates by the installation of additional signs and markings at all crossovers and at periodic intervals. Based on a preliminary assessment of the data presented in table 1, North Carolina, Georgia, and Indiana may be candidates for the demonstration projects.

## CONCLUSIONS

### Findings

1. The weather, the condition of the highway, and the mechanical factors of the three vehicles involved in the accident did not cause or contribute to the accident.

2. The pickup driver was operating his vehicle northbound in the left southbound lane of I-71 while under the influence of alcohol; toxicology tests indicated that his blood alcohol content was 0.26 percent about 1 1/2 hours after the accident.

3. Due to the curvature of the roadway, the busdriver could not determine that the pickup truck was on the wrong side of the highway until only 400 to 500 feet separated the two vehicles. The busdriver had 3 to 4 seconds or less to perceive the danger and take evasive action.

4. The busdriver steered the bus, which was traveling at a speed as high as 54 mph, to the left just before impact in an attempt to avoid the pickup truck, which was traveling at a speed between 52 to 61 mph.

5. The busdriver's performance was not a factor in this accident.

6. During impact, the right front leaf spring of the bus completely separated from the front axle and probably punctured the bus fuel tank, although this could not be determined, conclusively.

7. Sparks generated from damaged vehicle components scraping the asphalt roadway or the hot end of the leaf spring could have ignited the fuel vapors.

8. The fire entered the bus through the damaged right front floor and stepwell area and ignited the seating material, causing rapid development of smoke and fire inside the bus.

9. The fatally injured bus occupants died as a result of smoke injuries. None of the bus occupants suffered serious injuries as a result of collision forces with the pickup truck.

10. Although the bus seats complied with FMVSS 302, Flammability of Interior Materials, the materials used in the seats were sufficiently flammable to allow the fire to spread rapidly throughout the bus.

11. Although current fuel system integrity requirements for school buses provide adequate protection in most accidents, they do not adequately protect against fires in severe accidents.

12. The effective rear exit area in the accident bus was reduced significantly with an aisle width of only 12 inches leading to the rear exit door because both rear bench seats in the accident bus were full 39-inch-wide seats, rather than the shorter rear bench seats normally used in the last row of poststandard buses; this restriction prevented some of the occupants from exiting the bus.

13. Additional exits, such as pushout windows, in the church bus would have provided more egress area for passengers inside the bus.

14. While the 1984 DUI legislation improved Kentucky's existing laws for controlling drunk driving, the number of alcohol-related highway fatalities has begun to rise after initially falling.

15. The continuing high number of fatal alcohol-involved crashes in Kentucky and nationwide points to a need for greater action to address DUI drivers, not only in Kentucky, but throughout the nation.

16. Areas that require additional attention to improve the DUI prevention system nationwide include: implementation of administrative license revocation, elimination of plea bargaining to a nonalcohol-related offense and reduction of licensing penalties for enrolling in alcohol

education or treatment programs, improved evaluations of convicted DUI offenders, and enhanced public awareness and enforcement programs.

17. The adoption of administrative license revocation programs is one of the most effective steps that a State can take to reduce alcohol-related crashes.

18. The practice of allowing a person arrested for DUI to plea bargain to a nonalcohol-related offense is counterproductive and results in repeat offender drunk drivers being treated as first offenders.

19. Enforcement and public awareness campaigns should be enhanced to make additional progress in the fight against drunk driving.

**Probable Cause**

The National Transportation Safety Board determines that the probable cause of the collision between the pickup truck and the church activity bus was the alcohol-impaired condition of the pickup truck driver who operated his vehicle opposite to the direction of traffic flow on an interstate highway. Contributing to the severity of the accident was the puncture of the bus fuel tank and ensuing fire in the bus, the partial blockage by the rear bench seats of the area leading to the rear emergency door which impeded rapid passengers egress, and the flammability of the material in the bus seat cushions.

## RECOMMENDATIONS

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

--to the 50 States and the District of Columbia:

> Propose legislation establishing a date by which school buses manufactured before April 1977 will be phased out of use for transportation of passengers. (Class II, Priority Action) (H-89-1)

--to 49 States, except Kentucky, and the District of Columbia:

> Convene or reconvene a committee or task force to review your State's driving-under-the-influence (DUI) legislation and its implementation, in light of the problems discussed in the accident report on the pickup truck/church activity bus head-on collision and fire near Carrollton, Kentucky, on May 14, 1988. Particular attention should be paid to implementation of administrative license revocation programs, elimination of plea bargaining to a nonalcohol-related offense, reduction of licensing penalties for enrolling in alcohol education or treatment programs, improved evaluations of convicted DUI offenders, and enhanced public awareness

and enforcement programs. Based on this review, take appropriate action to improve your State's DUI prevention program. (Class II, Priority Action) (H-89-2)

--to various church associations and other special activity groups:

Purchase only school bus-type vehicles which meet the Federal Motor Vehicle Safety Standards set for school buses in April 1977. (Class II, Priority Action) (H-89-3)

--to the National Highway Traffic Safety Administration:

Incorporate in Federal Motor Vehicle Safety Standard 302 the recommendations of the National Institute of Standards and Technology concerning the new material acceptance criteria to reduce the rate of fire spread in all buses. (Class II, Priority Action) (H-89-4)

Revise Federal Motor Vehicle Safety Standard 217 to require that school bus egress be based on vehicle occupant capacity and be no lower than those currently required for nonschool buses. (Class II, Priority Action) (H-89-5)

Revise Federal Motor Vehicle Safety Standard 301 to provide additfonal protection for school buses in severe crash situations based on an evaluation of the merits of relocating fuel tanks, providing additional structure to protect fuel system components, and using frangible valves in critical locations. (Class II, Priority Action) (H-89-6)

--to the Federal Highway Administration:

Conduct a demonstration project to determine the effectiveness of installing additional signs and markings at all crossovers and periodic intervals to reduce wrong-way accidents on interstates. (Class II, Priority Action) (H-89-7)

--to the State of Kentucky:

Enact the recommendations made by the Driving-Under-the-Influence (DUI) Committee formed by the governor to assess the current DUI laws. These recommendations cover administrative license revocation, illegal per se, implied consent and testing, chemical analysis, suspended licenses, and alcohol driver education. (Class II, Priority Action) (H-89-8)

Amend the current driving-under-the-influence laws to prohibit the reduction or elimination of a licensing penalty if a convicted offender enrolls in an education or treatment program. Participation in these programs should be required in addition to appropriate licensing or other penalties. (Class II, Priority Action) (H-89-9)

Review all aspects of the plea bargaining prohibitions of the 1984 driving-under-the-influence law to determine if persons charged with alcohol-related offenses are being allowed to plea bargain the charge to a nonalcohol-related offense, and if so, take administrative or legislative action to correct the situation. (Class II, Priority Action) (H-89-10)

Expand the use by the Kentucky State Police of preliminary breath test devices and the three-part field sobriety test recommended by the National Highway Traffic Safety Administration, including the horizontal gaze nystagmus test, and urge and assist all other traffic law enforcement agencies in Kentucky to do the same. (Class II, Priority Action) (H-89-11)

Expand the use of sobriety checkpoints by the Kentucky State Police, and encourage and assist local law enforcement agencies to do the same. (Class II, Priority Action) (H-89-12)

Renew State efforts to publicize and encourage citizens to participate in the "Report a Problem Intoxicated Driver" program. (Class II, Priority Action) (H-89-13)

Expand efforts to make the public aware of increased emphasis on deterring impaired driving. (Class II, Priority Action) (H-89-14)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Acting Chairman

/s/ Jim Burnett
Member

/s/ John K. Lauber
Member

/s/ Joseph T. Nall
Member

/s/ Lemoine V. Dickinson Jr.
Member

**Joseph T. Nall, Member,** filed the following concurring/dissenting statement:

I fully concur with the report as adopted by the majority of the Safety Board. However, with respect to Safety Recommendation H-89-2 to the governors of the 50 States and the mayor of the District of Columbia, I respectfully dissent.

Instead of a general rehash of closed recommendations, I would have preferred that the Safety Board commit its resources to a comparative study of both the successes and inadequacies of the States' driving-while-impaired laws. A Safety Board special study would provide the governors and mayor direction and a qualitative assessment about the relative merits and efficacy of the programs we suggest in the current recommendation. While I recognize that the Safety Board has limited resources under current budget constraints, I believe the safety benefit for the traveling public deserves a greater commitment to identify the problems currently before us. I am also concerned as to whether the States will be able to review their own laws objectively without the Safety Board's leadership.

/s/ Joseph T. Nall
Member

March 28, 1989

# APPENDIXES

## APPENDIX A

## INVESTIGATION AND HEARING

### 1. Investigation

The National Transportation Safety Board was notified of this accident via the news media on the morning of May 15, 1988. A team of investigators was dispatched from the Washington D.C., area and arrived at the accident site about 7 p.m. the same day. Participating in the investigation were representatives of the State of Kentucky, the Kentucky State Police, the First Assembly of God Church, the Ford Motor Company, the Sheller-Globe Corporation, and the National Highway Traffic Safety Administration.

### 2. Depositions and Hearing

A public hearing was held on August 2-4, 1988.

# APPENDIX B

## DRIVER'S LICENSE INFORMATION

**Cadillac Driver, Frazelle G. Eberhardt**

Mr. Frazelle G. Eberhardt, 34, held a valid Ohio driver's license with a restriction for corrective lenses.

**Busdriver, John R. Pearman**

Mr. John R. Pearman, 36, held a valid Kentucky driver's license with a restriction for corrective lenses. There were no violations or accidents listed on his driving record.

**Pickup Driver, Larry W. Mahoney**

Mr. Larry Mahoney, 35, had a valid Kentucky driver's license with no restrictions. His license also permitted him to drive motorcycles. His driving record listed an accident on October 6, 1984, and a conviction for driving under the influence of alcohol on March 24, 1984.

# APPENDIX C

## STATE OF KENTUCKY
## TASK FORCE RECOMMENDATIONS ON SCHOOL BUS

| Current Requirements | Recommended Change | Cost |
|---|---|---|
| 1. All public school buses must meet current State and school bus safety requirements and Federal requirements. All private buses meet only current State requirements. | All buses public and private constructed for a Kentucky owner after November 1, 1990 must meet Kentucky Department of Education, and Federal safety requirements. | |
| 2. No side emergency door exit required. | Left-side emergency door on all new school buses of 22 passenger size or greater constructed November 1, 1990 or later. | $172.00 List Price |
| 3. Cage around fuel tank now required by Federal government standards. | Requirement of bus chassis manufacturers to redesign the location of fuel tanks to a less exposed area of the bus for all buses manufactured for use or sold in Kentucky by November 1, 1990. In the event that this is not feasible, request the United States Department of Transportation to study the feasibility of using a polyurethane material or similar type covering to go around outside of fuel tanks to help prevent puncture and spillage. Material may act as a self sealent. | |
| 4. A problem exists with some gasoline powered engines catching on fire. | Formally request bus chassis manufacturers to recall gasoline powered buses with fuel systems that have and continue to cause fire hazards. This includes the problem identified as the hot fuel problem. | |
| 5. Push out windows required on bus size greater than 21 passengers constructed after July 13, 1988. | Any bus with seating capacity of 16 passenger or greater constructed before November 1, 1990 be retrofitted with push-out windows. | $43.00 list price per window plus installation. Approximately one hour required for installation per window. |
| | **Bus Size** / **Number of Push Out Windows**<br>16-21 passenger conventional bus design — 1 pushout window left side evenly spaced.<br>22-54 passenger — 2 pushout windows, 1 per side evenly spaced.<br>55 passenger and greater — 4 pushout windows, 2 per side evenly spaced. | |
| 6. Emergency exits and push-out windows required to be marked with words "Emergency Exit" on both inside and outside of bus. | Require additional marking around emergency exits and push-out windows on inside of each bus with fluorescent paint of contrasting color for ease in identifying exits in emergency situations. | Minimal; cost of paint plus labor |
| 7. Seating material standards have not been increased to reflect current updated technology. | Formally request the United States Department of Transportaion to increase the research into materials used in bus seats which would be less flammable, have a slower burn rate, and emit less toxic fumes than the current federal standards require. | |

| Current Requirements | Recommended Change | Cost |
|---|---|---|
| 8. Bus drivers conformity to Federal Regulations are not required at present. | Recommend the 1990 General Assembly require bus drivers to meet the minimum medical requirements set forth in the Federal Motor Carrier Safety Requirements. In the mean time, consider early adoption of the section of the Federal Mandate of the 1986 Commercial Motor Vehicle Safety Act which requires bus drivers to obtain a commercial drivers license. | |
| 9. Nine hours of training required in Transportation and regulations, driving fundamentals, care and maintenance, critical situations, accidents and emergency procedures, pupil management, first aid, and vehicle operations. | By November 1, 1990 require a minimum of an additional nine hours of Hands on School Bus Driver Training which would center around defensive driving for all new school bus drivers and school bus drivers with less than one year experience. | |
| 10. Requirement of at least semiannual practice of emergency evacuation of each school bus, once during each half of the school year. No evacuation drills required on private buses. | Requirement of four evacuation drills on each school bus each year, two in the spring and two in the fall which should be supplemented by additional educational films or evacuation and safety demonstrations. Requirement of one evacuation drill on each privately owned bus each year according to procedure approved by the State Fire Marshal. | |
| 11. All buses required to meet seating standards established by National Safety Administration when they were manufactured. | Requirement of all buses in current use to meet school bus seating capacity standards established by National Highway Traffic Administration. Last row, rear seats will be required to be removed, or replaced with a smaller two person seat in order to allow easier and faster access to the rear emergency door exit. No seats may be removed to allow a bus to become a passenger carrying and cargo carrying vehicle, except those buses designed for transporting special educational children. It is the bus driver's responsibility to enchance enforcement of current seating capacity requirements of all buses which is determined by the weight and size of the passengers. Violators are subject to penalties allowable by law. | |
| 12. No underfloor storage now required on any bus. | Recommend the installation of underfloor outside access storage compartments on Kentucky school buses constructed after July 1, 1989. Each school district shall purchase an adequate number of buses with storage compartments based on their districts extra-curricular activity use. | $550.00 list price. |

| Current Requirements | Recommended Change | Cost |
|---|---|---|
| 13. Federal requirements do not address the carrying of anything on bus except passengers. The Department of Education's policy is that the transportation of luggage shall be limited to one piece of luggage per seat with one empty seat separation between cargo area and passenger occupancy area. Luggage can not exceed 120 lbs. and must be strapped in school bus seat by web type straps. Luggage shall not exceed 30" in length nor 48" in girth and shall not be transported in a position that exceeds height of seat back. | Requirement of the Department of Education to adopt their requirement as a regulation on all school buses. Requirement of the Transportation Cabinet to adopt this requirement as a regulation on all private buses. | |
| 14. All buses with gross vehicle weight of less than 10,000 pounds are required to be equipped with seat belts at present. | Formally request National Highway Transportation Safety Administration and the Kentucky Department of Education to restudy the use of seat belts or any other state-of-the art passive restraint system on all buses with gross vehicle weight of 10,000 pounds and over. They are to study annually any improvements made concerning passive restraint systems and report their recommendation and requirement of use to the Bus Safety Task Force. | |
| 15. No standard invitation to bid on surplus buses now exists. | Adopt a standard invitation to bid on surplus school buses which specify the conditions of sale. See Attachment A. | |
| 16. No policy on disposal of surplus school buses now exists. | Adopt a state-wide policy on the disposal of surplus school buses. Recommend Transportation Cabinet be directed to develop regulations that would prohibit buses from being registered that have not passed the annual inspection program. See Attachment B. | |
| 17. Currently the Department of Education has authority over specifications of school buses. Transportation has authority over other buses and school buses once they are sold by the school districts to private individuals or groups. | It is necessary to ensure that the bus safety problem is totally and throughly studied and all possible recommendations are brought to the Governor's attention in accordance with the Executive Order establishing the Task Force on School Bus Safety, therefore, it is requested that the Governor modify the existing Executive Order to continue the existance of the Task Force indefinitely. That the Bus Safety Task Force provide a member to the school bus specifications be provided to the full Bus Safety Task Force prior to submission to the State Board of Education, and that the Bus Safety Task Force provide written comments to the State Board of Education concerning matters in which they concur or disagree with the school bus specifications, and that the State Board of Education must consider these written comments. | |

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