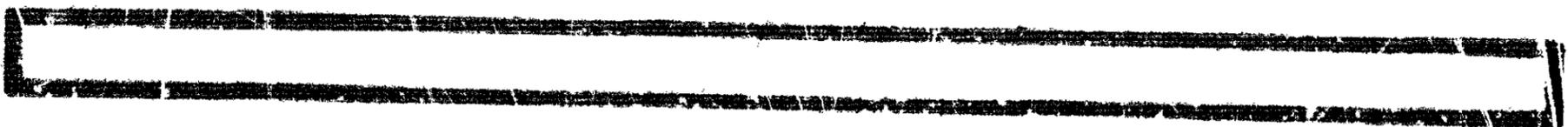
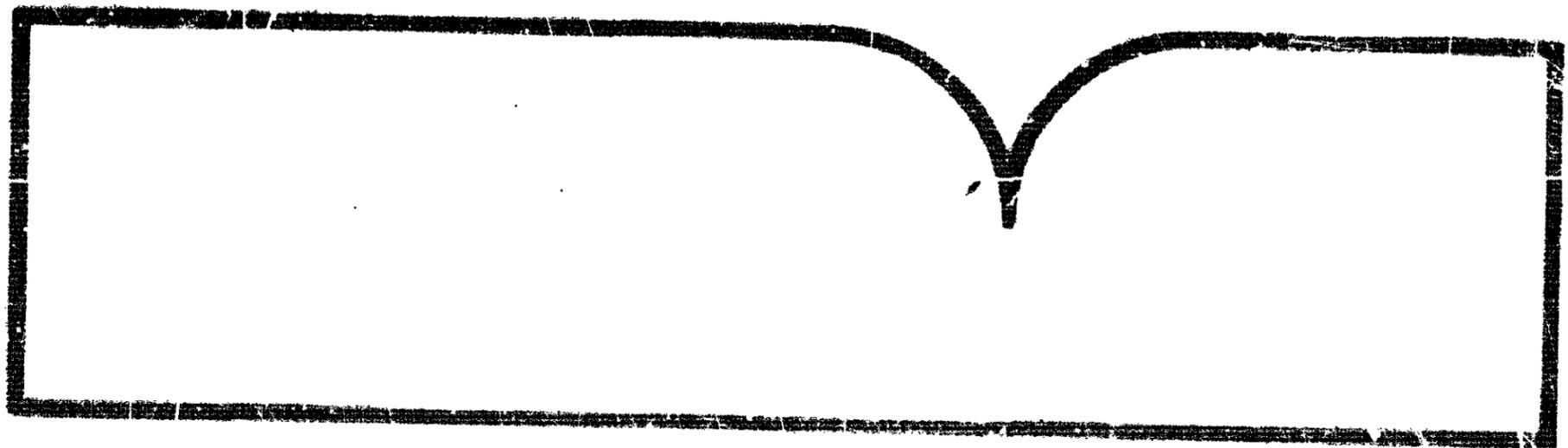


FB84-916206

Highway Accident Report - Activity
Bus, Tractor-Cargo Tank Semitrailer
Collision, State Route 61 Near Devers
Texas, December 23, 1983

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

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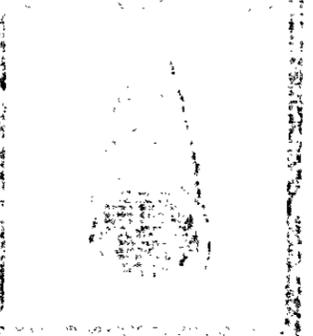
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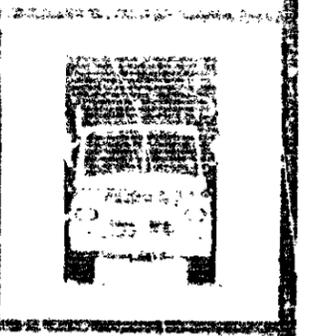
WASHINGTON, D.C. 20581



HIGHWAY ACCIDENT REPORT



ACTIVELY RUNNING ON-CARGO
TANK SEMITRAILER COLLISION,
STATE ROUTE 61
NEAR DEVEREUX, TEXAS
ON OCTOBER 22, 1981



NTSB-HAR-84-006

UNITED STATES GOVERNMENT

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/HAR-84/06		2. Government Accession No. PB84-016206		3. Recipient's Catalog No.	
4. Title and Subtitle Highway Accident Report—Activity Bus/Tractor-Cargo Tank Semitrailer Collision on State Route 61, Near Devers, Texas, December 23, 1983.				5. Report Date September 5, 1984	
7. Author(s)				6. Performing Organization Code	
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594				8. Performing Organization Report No.	
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594				10. Work Unit No. 4005	
				11. Contract or Grant No.	
				13. Type of Report and Period Covered Highway Accident Report December 23, 1983	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>About 7:40 p.m., central standard time, on December 23, 1983, a southbound activity bus (bus) suddenly veered leftward, crossed the centerline of State Route 61, a 2-lane, 2-way highway, and struck head on a northbound tractor cargo tank semitrailer near Devers, Texas. The tractor cargo tank semitrailer penetrated from 5.5 to 6.5 feet into the passenger compartment of the 1970 former schoolbus. The busdriver and all 21 passengers aboard were ejected through the front opening created in the collision. The truckdriver, the busdriver, and eight bus passengers were killed. Thirteen other bus passengers were injured.</p> <p>The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the activity bus following the deflation and subsequent blowout of the left front tire due to a nail puncture. Contributing to the severity of the injuries was the less rigid construction of the 1970 former schoolbus when compared to schoolbuses built after April 1977 which meet minimum Federal requirements for crashworthiness and occupant protection.</p>					
17. Key Words Activity bus accidents, steering axle tire blowout, loss of control, head-on collision, bus/truck collision.				18. Distribution Statement This document is available to the public through the National Technical Information Service Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED		20. Security Classification (of this page) UNCLASSIFIED		21. No. of Pages 32	22. Price

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted September 5, 1985

ACTIVITY BUS/TRACTOR CARGO TANK SEMITRAILER COLLISION
ON STATE ROUTE 61 NEAR DEVERS, TEXAS,
DECEMBER 23, 1983

SYNOPSIS

About 7:40 p.m., central standard time, on December 23, 1983, a southbound activity bus (bus) suddenly veered leftward, crossed the centerline of State Route 61, a 2-lane, 2-way highway, and struck head on a northbound tractor cargo tank semitrailer near Devers, Texas. The tractor cargo tank semitrailer penetrated from 5.5 to 6.5 feet into the passenger compartment of the 1970 former schoolbus. The busdriver and all 21 passengers aboard were ejected through the front opening created in the collision. The truckdriver, the busdriver, and eight bus passengers were killed. Thirteen other bus passengers were injured.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the activity bus following the deflation and subsequent blowout of the left front tire due to a nail puncture. Contributing to the severity of the injuries was the less rigid construction of the 1970 former schoolbus when compared to schoolbuses built after April 1977 which meet minimum Federal requirements for crashworthiness and occupant protection.

INVESTIGATION

The Accident

About 6:30 p.m., central standard time, ^{1/} on December 23, 1983, an activity bus (bus) carrying 22 persons departed Beaumont, Texas, for a 45-mile trip to a small church in Anahuac, Texas. About 7:40 p.m., the bus was traveling south on State Route 61 near Devers, Texas, when it suddenly veered leftward and struck head-on a northbound tractor-cargo tank semitrailer ^{2/} loaded with drilling mud and water. In this area, State Route 61 is a straight and level, 2-lane, 2-way roadway. It was dark, the weather was clear, and the road surface was dry. A motorist traveling about 2 miles behind the combination vehicle indicated that the combination vehicle's tail lights were illuminated and that no southbound traffic preceded the bus immediately before the impact. Passengers aboard the bus indicated that the bus was slowing down just prior to the collision.

At impact, the 19,175-pound bus ceased all forward motion and rotated to the left as it was pushed backward. The tractor of the 72,000-pound combination vehicle intruded into the passenger compartment. The frontal sheet metal structure of the bus was ripped open during the impact, and all of the 22 occupants were ejected through the large opening. (See figure 1.)

The combination vehicle continued forward after impact toward the right shoulder. The tractor separated from the combination vehicle, overturned, and came to rest with

^{1/} All times herein are central standard time.

^{2/} Hereafter referred to as the combination vehicle.

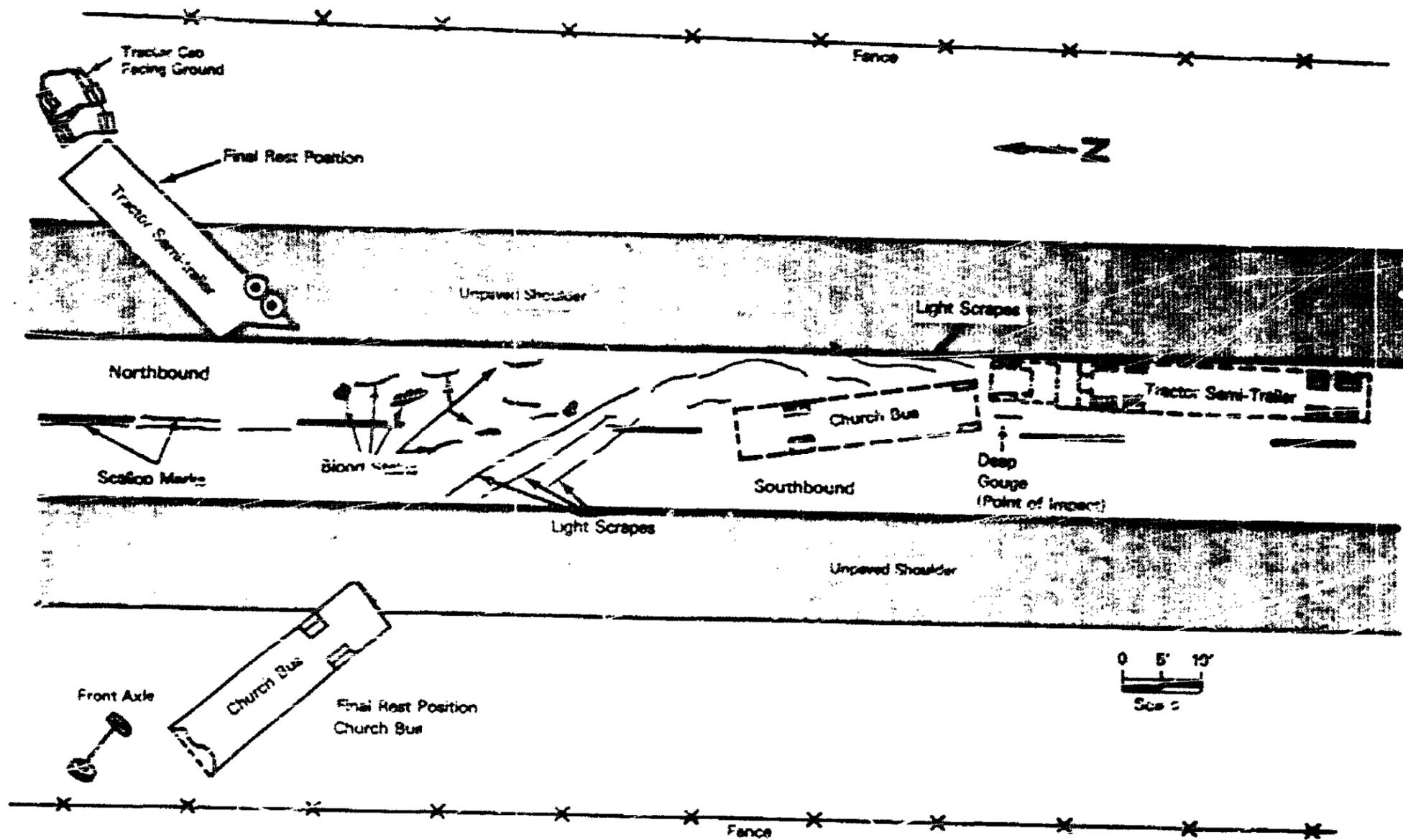


Figure 1.--Plan view of accident site (State Route 61).

the cab facing the ground. The cargo tank semitrailer overturned to the left and came to rest about 3 feet behind the tractor. The liquid cargo was not released during the impact sequence.

The truckdriver, the busdriver, and eight passengers on the bus were killed; 13 other bus passengers suffered minor to serious injuries.

Vehicle Information

Activity bus--The 1970 Ward conventional schoolbus body was mounted on a 2-axle 1970 International chassis. It was equipped with a governed 8-cylinder gasoline engine, power steering, air-mechanical service brakes, a 5-speed manual transmission, and a 2-speed rear axle. Although the bus was painted chrome yellow, all former schoolbus designations had been painted over. The bus also was equipped with 24 bench-type passenger seats, 12 on each side of the center aisle. The driver's seat was the only seat equipped with a seatbelt. The estimated weight of the bus at the time of the accident was 19,175 pounds.

The bus was owned, operated, and driven by the church pastor, who had purchased it from the Hardin, Texas, School District in October 1980. The bus had received its last annual State vehicle inspection in June 1983. Apparently the speedometer was not working. The vehicle mileage observed on the speedometer of the bus during the post-accident inspection was the same as the mileage written on the State inspection sticker (70,050). Maintenance was performed on the bus at the pastor's discretion. No maintenance records were kept.

During the collision, the engine compartment and the front section of the passenger compartment were destroyed completely. The engine, transmission, and front axle were separated from the chassis, and the bus body had shifted forward about 5 inches relative to the chassis. The front of the roof separated from the attaching side rails and window posts and was displaced upward about 4 feet above the windows on both sides. The front of the passenger compartment was skewed outboard of the chassis in both directions. Maximum penetration into the passenger compartment extended from the front of the bus to the third row of seats and was about 5.5 feet on the right side and 6.5 feet on the left side. The windshield and all side windows from the front to the third row of seats were missing. The interior of the bus was relatively undamaged from the fifth row of seats to the rear. (See figure 2.)

The metallic interior floor at the front of the bus was folded rearward into an accordion pattern. The driver's seat was separated from the floor. The seatbelt hardware for the driver remained attached to the floor, was slightly damaged, and did not appear to have been in use at the time of the accident. The frames of the four passenger seats in the first two rows were separated from their legs during impact. Although the 20 passenger seats in rows 3 to 12 remained in place, the seatbacks of six seats in rows 3 to 6 were bent forward, and the legs of another six seats were partially or completely detached from their floor anchorages. The remaining eight seats in the rear of the bus exhibited no impact damage. The metallic seatbacks and tubular steel seat frames in front of each passenger were hard and unyielding and were not covered with protective padding.

A postimpact inspection of the bus uncovered several discrepancies. The right side of the rear axle was secured to the chassis by a steel chain to prevent the left rear spring assembly from moving relative to the axle. The bus was equipped with two 9.00-20 bias ply tires on the front axle, and four 10.00-20 bias ply tires on the rear axle. A representative of International Harvester Company, Inc., inspected the front axle



Figure 2.--Side View of the Activity Bus.

assembly and indicated that the axle assembly was not the same assembly originally installed on this vehicle. The original PA-99 axle assembly had a different steering arm configuration and larger size tires (10.00-20 vs 9.00-20) than those observed on the accident bus. It is not known if this axle was installed on the bus at the time it was inspected. Two of the four tires mounted on the rear axle were worn smooth (no measurable tread depth). One of the remaining two tires did not meet the minimum tread depth requirements of 2/32 inch specified in the Texas vehicle inspection criteria. The outer sidewall of the left front tire was ruptured over 200° of its circumference and the inner tube was destroyed during impact. The cords along the ruptured area were broken and coated with melted rubber. The inner sidewall also displayed ply separations at several locations, but the separations were not continuous. A small sharp nail had penetrated through the tread section and could be felt from the inside. The circumference of the left front tire was measured to be about 9.68 feet. (See figures 3 and 4.)

Several preexisting brake discrepancies were observed. The right front brake actuator was partially inoperative. The push rod for the brake actuator was bent about 15° and exhibited moderate cyclic scoring. The slight elongation of the push rod clearance hole at the brake actuator housing was consistent with the wear caused by sliding contact with the bent push rod over an extended period of time. (See figure 5.)

The right rear brake actuator also was partially inoperative. The brake actuator push rod had fractured and separated from its backing plate. A metallurgical examination indicated that the fractured halves were heavily damaged, corroded, and had failed due to overload. This condition existed before the accident and would have reduced the braking force generated by the actuator when the brakes are applied. (See figure 6.)

The left rear brake actuator was not damaged. However, the actuator backing plate was mounted loosely to the left rear push rod. A loosely mounted push rod can reduce the braking force generated if the push rod is not perpendicular to the backing plate when air is applied to the brake actuator. The left front brake actuator was destroyed during impact.

Combination Vehicle.—The 1979 model LT-9000 Ford 3-axle conventional tractor was pulling a 1979 MD 3/ cargo tank semitrailer loaded with drilling mud and water. It was owned and operated by the B&J Vacuum Tank Service in Daisetta, Texas. The tractor was equipped with a diesel engine and a 5-speed manual transmission. Both tractor and semitrailer were equipped with air-mechanical service brakes. The combination vehicle weighed about 72,000 pounds at the time of the accident.

The tractor of the combination vehicle was destroyed when it overturned onto its roof during the impact sequence; the cab separated from the frame, and the roof separated from the cab. The doors were pushed downward flush with the instrument panel. Virtually all survivable space near the driver's seating position was destroyed. The windshield and all windows were missing. The tractor frame was severed in three locations, and all attaching components (such as springs, suspension, wheels, fifth wheel, and axle assemblies) were disconnected during the impact. After impact, the cargo tank semitrailer separated from the tractor, overturned onto its left side, and sustained minor damage.

3/ MD Trailer Company, Fort Worth, Texas.



Figure 3.--An overall view of the tire.



Figure 4.--The tire with the nail head protruding from the tread area.

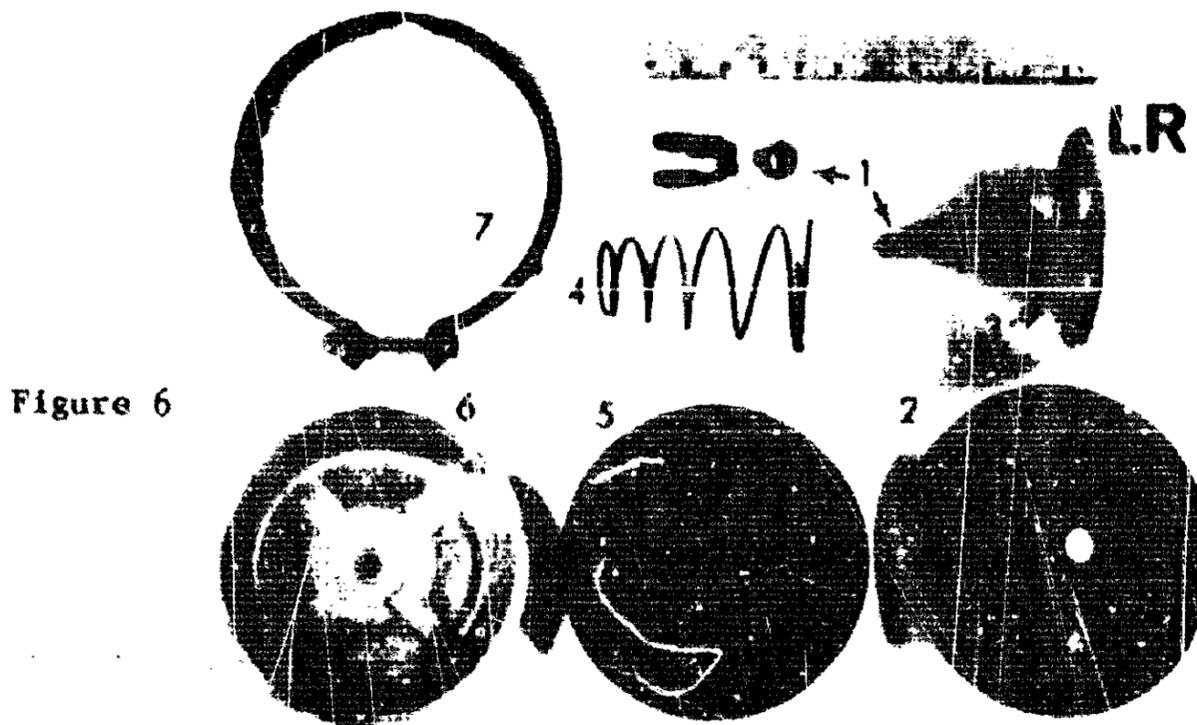
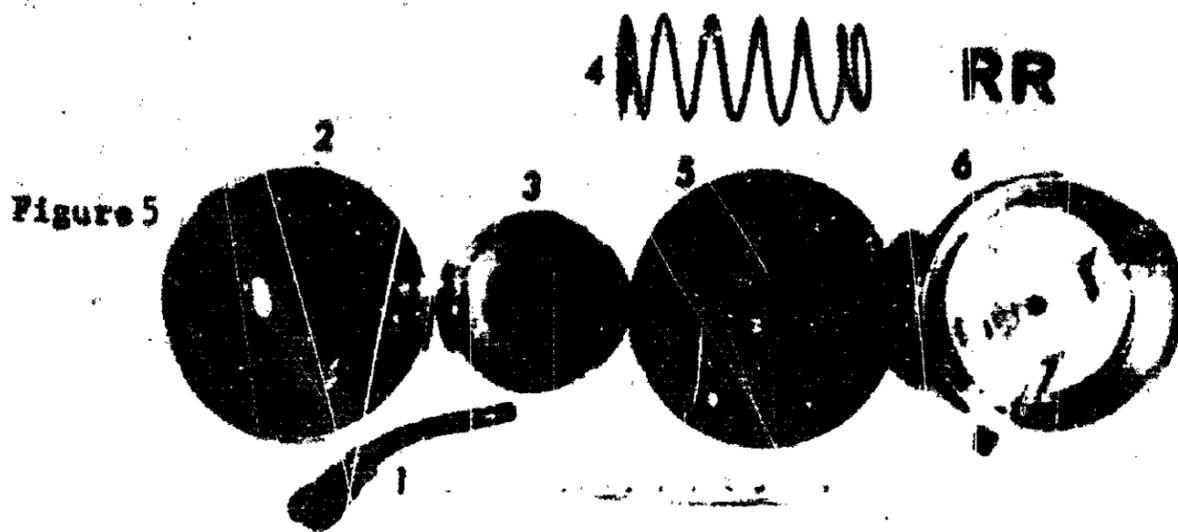


Figure 5 and 6.--Exploded views of the right rear (top) and left rear (bottom) brake actuators with components numbered (1) push rod assembly, (2) push rod housing, (3) backing plate, (4) springs, (5) flexible diaphragm, (6) pressure housing, and (7) assembly clamp.

Driver Information

The Busdriver.—The 56-year-old driver was a part-time pastor of a small church in Anahuac, Texas, and owner of a scrap metal business. He was familiar with driving and maintaining commercial vehicles; he had driven a 2-ton dump truck about 20,000 miles/year for his business in addition to operating and maintaining the activity bus. Using the bus, he routinely picked up church members on Tuesday, Friday, and Sunday so that they could attend church activities. A one-way trip normally took about 2.5 hours to complete because of the long distances between passengers' residences; the one-way trip covered about 80 miles of travel.

The busdriver held a valid Texas operator's license. At the time of the accident, no special license was required to operate a bus in Texas. In January 1984, the State of Texas enacted special licensing requirements for all bus operators. (See Appendix C.) The driving record of the busdriver indicated that he had received two traffic violations, one in 1982 for "failure to yield right of way" and one in 1983 for "no tail lamps." He had no reported accidents. His license was suspended on November 3, 1982, because he did not have liability insurance on the bus. His license was reinstated November 9, 1982, after he complied with the insurance requirement.

On the day of the accident, the busdriver woke about 8:30 a.m. and had breakfast. He visited his wife on her job in Beaumont, Texas, around noon, and later visited his daughter, who had just had a baby, at St. Elizabeth hospital in Beaumont. At 1:30 p.m., he left the hospital and returned to his residence in Nome, Texas. He rested until 5:00 p.m. and began picking up the children for the evening church revival. He made several stops in Sour Lake and Beaumont and departed Beaumont about 8:30 p.m. en route to the church in Anahuac, about 45 miles away.

The Truckdriver.—The 38-year-old truckdriver had been working for his present employer for about 2 weeks. However, he had been employed previously by his present employer, and his present employer considered him to be a good truckdriver. The truckdriver had a valid Texas commercial vehicle license, had received one speeding citation in 1979, and had reported no accidents. 4/

On the day of the accident, the truckdriver started work about 9:00 a.m. hauling excess fluids from a well being dug in Monroe City, Texas. During the day, he made several trips to dispose of the fluid near the drilling site. The driver spent much of his time waiting to be loaded between trips. The driver had loaded his vehicle for the last time and was returning to the employer's yard in Daisetta, Texas, about 10 miles away, to discharge his load when the accident occurred.

Highway Information

State Route 61, a 2-lane, 2-way undivided highway which runs between Devers and Anahuac, Texas, has a paved asphalt surface. The posted speed limit is 55 mph. The road is designated as a Federal-aid, secondary rural highway and has an average daily traffic volume of 1,950 vehicles. Near the accident site, State Route 61 is flat and has an unrestricted sight distance in both directions. The travel lanes are 10-feet wide and are separated by a broken yellow centerline with raised reflectorized pavement markings. There are 7-foot unimproved shoulders on each side of the road. The roadway pavement surface was in good to excellent condition, and the pavement markings were visible.

4/ Driving records in Texas do not contain information showing if the vehicle being operated was a commercial or a private vehicle. Thus, it could not be determined whether the ticket was issued while driving a commercial vehicle or a personal vehicle.

A gouge (1.5 inches deep by 3 feet long) was observed in the pavement surface of the northbound lane. (See figure 1.) Light scrape marks in the northbound lane extended from the gouge and across the southbound lane. Blood transfers also were noted on the pavement surface extending north toward the rest positions of the accident vehicles. Light tire scallop marks were observed near the road centerline which began about 1,252 feet from impact and ended about 102 feet from impact. The marks started in the northbound lane and extended about 350 feet, crossed over into the southbound lane, and continued for another 800 feet. The light scallop marks made a cyclic pattern that was repeated approximately every 9.34 feet, and the marks were about 7 inches apart. (See figure 7.)

The combination vehicle came to rest about 120 feet north of the estimated point of impact on the northbound lane shoulder. The bus came to rest on the southbound lane shoulder about 95 feet north of the estimated point of impact.

Medical and Pathological Information

Injuries	Drivers		Passengers		Total
	Bus	Combination Vehicle	Bus	Combination Vehicle	
Fatal	1	1	8	0	10
AIS 3 (Serious) 5/	0	0	4	0	4
AIS 2 (Moderate)	0	0	2	0	2
AIS 1 (Minor)	0	0	7	0	7
None	0	0	0	0	0
Total	1	1	21	0	23

The driver and all 21 passengers were ejected from the bus. Their ages ranged from 5 years old to 56 years old. Figure 8 contains the reported seating position, age, sex, and injury severity of the bus occupants; appendix D describes the bus passenger injuries by abbreviated injury scale severity and seating location. The truckdriver was the only occupant in the combination vehicle, and he was killed in the collision.

The busdriver's death was attributed to a crushed chest, a crushed abdomen, and a broken back. No other preexisting medical problems were detected. The truckdriver died from a crushed head. He also sustained multiple rib fractures and a compound fracture of the left elbow. Toxicological tests for both drivers were negative for alcohol, opiates, and other drugs.

No autopsies were performed on the eight fatally injured bus passengers. However, the county coroner's report indicated that they had died from massive internal and multiple head injuries. Fatal injuries were attributed to impact trauma.

Seven of the 13 injured bus passengers sustained minor injuries consisting of abrasions, contusions, and lacerations of various parts of the body. The remaining six injured bus passengers sustained moderate to severe injuries that consisted of torn ligaments; fractures of the femurs, tibias, and fibulas; dislocated shoulders; and unspecified blunt head trauma.

5/ Abbreviated injury scale. (See appendix D.)

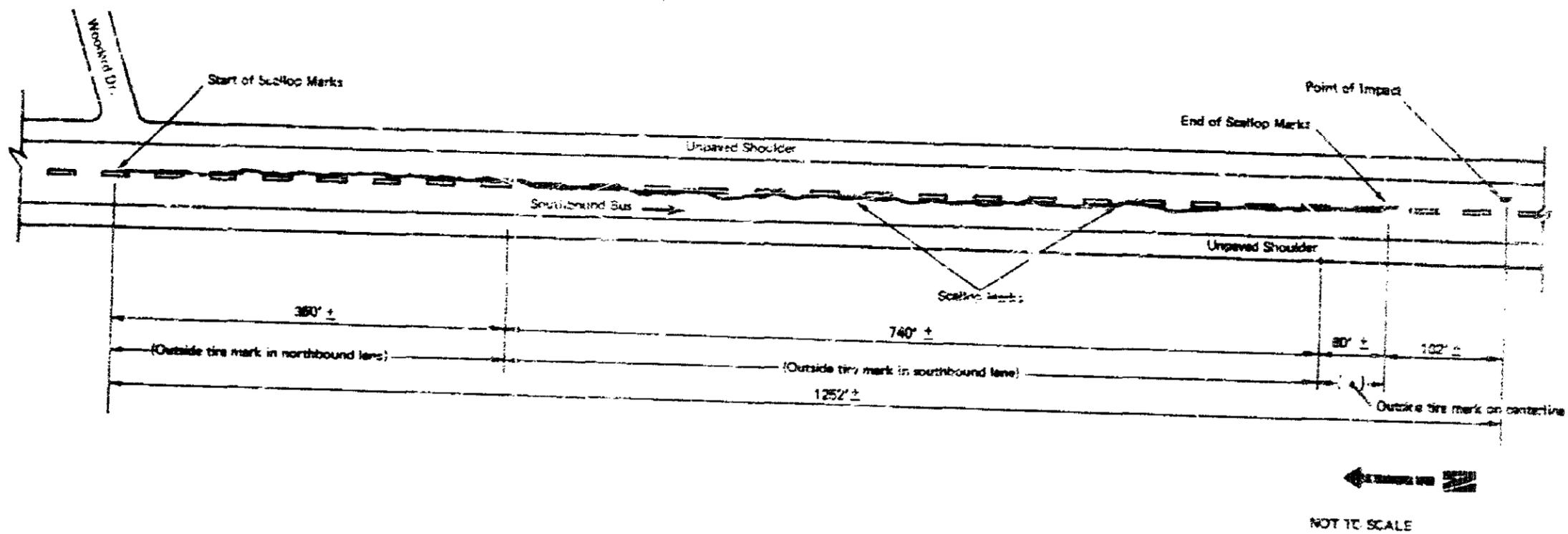
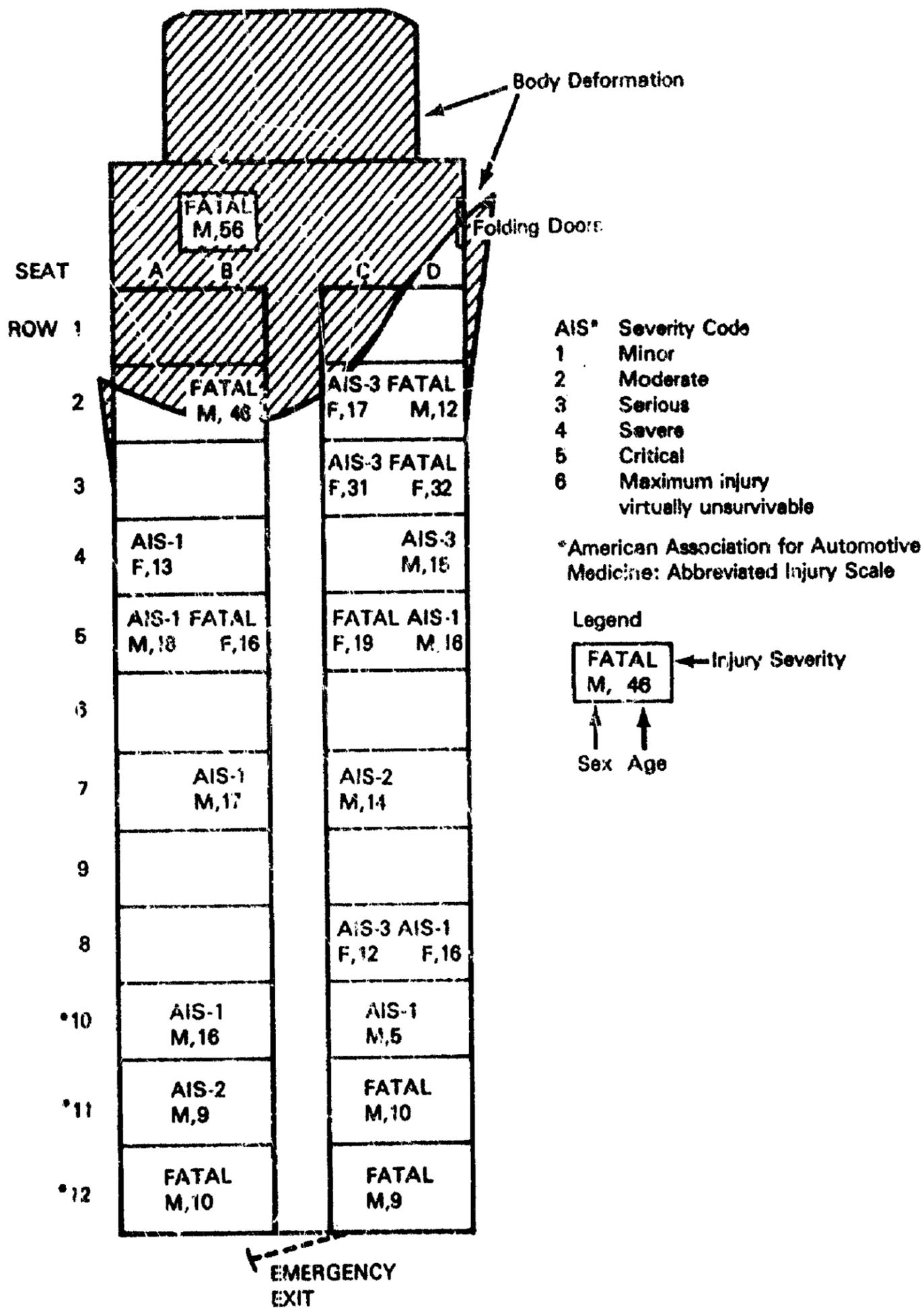


Figure 7.--Plan view of the tire scallop marks in the southbound lane.



*Occupants of Rows 10-12 were in back of bus playing and moving around. Exact positions are unknown.

Figure 8.--Activity Bus Seating Chart Noting Occupant Age, Sex, and Injury Severity.

Six of the nine fatally injured bus occupants had been seated in the first five rows at the front of the bus where major seat damage was noted. The remaining three fatally injured bus occupants had been located in the last two rows of seats where no seat damage was observed. Seven of the 13 surviving passengers had been seated behind row 6, where minimum seat damage was noted. Four of the seven passengers sustained minor injuries, two sustained moderate injuries, and one sustained serious injuries.

Emergency Response

The Liberty County Sheriff's Department was notified of the accident at 7:53 p.m. A Texas Highway Patrol Trooper was dispatched and arrived on scene about 7:56 p.m. He observed the extent of injuries and fatalities and immediately requested medical assistance, wreckage service, and all available ambulances and rescue and emergency response personnel. The surrounding community's fire departments dispatched four vehicles, and the Texas Highway Patrol dispatched seven vehicles to the scene. Twelve ambulances, and 18 emergency medical technicians (EMT) and emergency care attendants (ECA) were dispatched to the scene. First aid was administered to surviving victims by the EMT's, ECA's, and police officers, but no triage was set up to establish injury treatment priorities.

Seven victims were pronounced dead at the scene. All others were transported by ambulance to four area hospitals for treatment. Two victims died while en route to the hospital and one other victim died 5 days after the accident. Although the Liberty County Fire Department had a written mass casualty plan, no formal mutual aid agreements existed between the fire department and other Liberty County emergency response units or between Liberty County and other surrounding jurisdictions. Informal local procedures were used to request assistance.

Texas Motor Vehicle Inspection

The bus was inspected and passed by the Texas inspection station of the Sour Lake Motor Company, Sour Lake, Texas on June 22, 1983, about 6 months before the accident. The inspector had recorded no awarded complaints or violations in the Texas Department of Public Safety record.

The Texas inspection system does not require a work sheet or checkoff of individual items inspected, and the inspector worked from a list of items posted above a work bench. The inspector said that he remembered what needed to be inspected and did not need to consult the list. The inspector recalled that he had looked at the tire treads, looking especially for cracks, and that there were no bald spots on the tires. He did not check the speedometer. He said that he did not ever use the tire tread depth gauge. If the tire "got down that close" he would tell the vehicle owner to "go someplace else."

The inspector did not remove the brake drums to make a brake inspection because it was not required. His usual practice when inspecting brakes was to make a full braking stop from 30 miles per hour on a nearby city street. The inspector said that he had inspected the brakes and tires of the bus and did not take exception to their condition. He had driven the accident bus only from the lot into the garage, and he did not make a road test.

ANALYSIS

The Accident

The weather and roadway surface were not factors in this accident. There was no evidence of physiological or psychological problems which could have influenced the performance of either the busdriver or the truckdriver during the accident sequence. The postaccident inspection revealed several preexisting mechanical discrepancies on the bus. Except for the condition of the left front tire, none of the mechanical discrepancies observed were causal to this accident. The deflation and subsequent blowout of the left front tire precipitated the accident sequence.

The left front tire failed when a small sharp nail penetrated through the tread section and inner tube of the bias ply tire. The ruptured inner tube slowly released pressurized air as the tire rotated under load. The tire eventually became underinflated, began to overheat due to excessive flexing of the plies along the shoulder area, and then ruptured almost completely around the circumference at the hottest areas. Rubber compounds used in tires begin to soften when tire temperatures exceed 240° F. The heavy coating of molten rubber in the ruptured area indicated that the outside wall cords were subjected to extremely high temperatures before they separated. The Safety Board could not determine when the nail entered the tire.

The deflated left front tire began marking the pavement with light scallop marks about 1,252 feet from impact. The scallop marks made a repeating cyclic pattern on the pavement about every 9.34 feet which was slightly less than the circumference (9.68 feet) of the failed left front tire. The scallop marks were about 7 inches wide and matched the tread width of the left front tire within 1/2 inch. The scallop marks in the southbound lane were almost parallel to the road centerline for 800 feet.

The driver may have been aware of the tire problem and may have attempted to slow the bus through engine braking to maintain steering control. It is not known why the busdriver did not steer the bus onto the right shoulder after perceiving the impending danger. He had sufficient distance to make the steering maneuver and was experienced with operating heavy trucks and buses. Had he promptly executed the steering maneuver toward the shoulder, he could have reduced the vehicle's speed in a shorter distance by traveling on the unimproved soft shoulder. The soft shoulder (medium hard soil) would have increased the tire rolling resistance and the vehicle's natural retardation force against forward motion. Thus, less time and distance would have been needed to stop the bus. If a tire failure had occurred after the bus had moved to the road shoulder, the driver would have had more time and lateral distance to make a second evasive maneuver, and possibly may have avoided the collision with the combination vehicle.

Shortly after the blowout, the left front tire and wheel assembly of the bus dropped 7 inches onto the road surface. The resulting drag on the left side of the bus caused the bus to veer immediately toward the left. The busdriver may have attempted to overcome the sudden directional change by steering rightward. However, the steering moment acting to redirect the bus leftward was beyond the physical capability of the busdriver and the mechanical advantage of the steering system. The physical evidence indicates that, after the blowout, the bus continued forward and leftward for 102 feet until it collided with the combination vehicle.

Based on the conservation of momentum, the Safety Board estimated that the speed of the bus was about 11 mph when it struck the combination vehicle, assuming that the combination vehicle was traveling at the posted speed limit of 55 mph before impact and

that the bus decelerated only from engine braking. Since the position of the bus remained relatively stable within the southbound lane before impact, the truckdriver would have been unable to perceive and react in less than 1 second to the impending danger after the bus crossed the highway centerline and entered his lane of travel.

Crash Dynamics

The former schoolbus was manufactured in 1970, before several Federal Motor Vehicle Safety Standards (FMVSS) were enacted to improve schoolbus crashworthiness and occupant protection. Schoolbuses manufactured after April 1, 1977, must meet the requirements of FMVSS 220-School/Bus Rollover Protection, FMVSS 221-School Bus Body Joint Strength, and FMVSS 222-School Bus Seating and Crash Protection. Under the requirements of FMVSS 222, schoolbuses weighing more than 10,000 pounds gross vehicle weight (GVW) must provide for occupant protection through the use of strengthened, energy-absorbing, properly spaced, and padded seats (or "restraining barriers" for front row seats). Schoolbuses weighing less than 10,000 pounds GVW must provide occupant restraints at each seating location in addition to the above mentioned requirements. Preliminary data indicate that FMVSS 222 appears to be effective in reducing many of the minor to moderate passenger injuries resulting in crash situations. 6/

In this accident, the bus displayed body joint failures that were typical of schoolbuses that were manufactured before FMVSS 221 became effective. The roof panels were separated from the attaching side rails and window posts in the front of the bus. The separations occurred on both sides above window level and probably resulted from the insufficient fastening of the roof panels to the side rails. The degree of roof-panel separation during the collision was directly related to the large opening created in the front of the bus and increased the probability of ejection of all the bus occupants. Post-1977 schoolbuses which comply with the requirements of FMVSS-220 and FMVSS-221 are more likely to retain their structural integrity and prevent the ejection of their occupants in severe collisions when the passenger compartment is intruded.

Additionally, the bus offered a very hostile passenger environment during the crash; far more hostile than a schoolbus manufactured today. Better seat padding, higher seatbacks, and energy absorbing seat surfaces in front of the passengers which are built into schoolbuses built after enactment of several Federal Motor Vehicle Standards could have been effective in reducing some of the contact injuries resulting from passengers' striking metallic seatbacks.

Even if the bus involved in the accident had been manufactured after April 1, 1977, it would not have been required to be equipped with seatbelts, because it weighed more than 10,000 pounds GVW. The design of the sheet metal floor and tubular steel seats within the former schoolbus would have required substantial upgrading to accommodate seatbelts. The stronger seats and more rigid floor structure needed for the installation of seatbelts would have changed the internal crush dynamics of the former schoolbus, affecting the outcome of this accident.

Had seatbelts been installed and used by the bus occupants, it is unlikely that they would have been ejected from the bus during the impact sequence. The extent to which passenger injury would have been reduced, however, is less clear. In this accident, the Safety Board was not able to determine at which point in the accident sequence the bus passengers sustained their injuries. For example, it could not be determined if the

6/ Statistical Evaluation of the Effectiveness of FMVSS-222: Schoolbus Seating and Crash Protection, Center for the Environment and Man, Inc., October 1980.

passengers were injured when they struck the inside of the bus during the initial impact, when they struck the inside of the bus during ejection, or when they struck fixed objects inside the bus after they were ejected. No clear injury/fatality pattern based on seating location emerged in this accident, adding to the difficulty of determining the injury mechanisms and potential effects of the use of restraints. If seatbelts had been used, restrained passengers at impact would have hit the unpadded seatbacks and sidewalls, and other sharp interior surfaces in the 12-year-old bus, causing injuries, in some cases even more severe than those actually sustained.

The Safety Board believes that it would be prudent for churches and similar activity groups to purchase used schoolbuses for transportation purposes which meet minimum Federal occupant protection and vehicle crashworthiness standards for schoolbuses manufactured after April 1977.

Neither the busdriver nor the truckdriver would have survived this accident even if they had been restrained by a seatbelt. The front section of the bus was destroyed from the front to the third row of passenger seats. The cab of the tractor also was destroyed during the collision sequence and its subsequent overturn. Both drivers were seated in areas where the impact forces were nonsurvivable. Thus, the use of seatbelts would not have altered the severity of their injuries.

Vehicle Inspection

The bus was in poor mechanical condition 6 months after the Texas vehicle inspection had been conducted. Three of six tires were well below the State minimum requirements for tread depth, two of four brake actuators were partially inoperative, and the rear axle was being held in place by a chain. Each of these items would have been grounds for rejection under current Texas inspection criteria.^{7/} Although the number of potentially hazardous mechanical problems on the bus was significant, the Safety Board could not establish if the accident bus was in the same mechanical condition at the time it was inspected 6 months earlier.

The Safety Board also could not determine when the left front tire was punctured. Research conducted by Dunlop Limited^{8/} indicates that punctures are invariably caused by nails or screws, that nails are easily the biggest cause of punctures, that the head of an ordinary nail can wear through in about 30 miles of moderately severe driving, and that many objects penetrate the tire and remain unobserved for 50 to 100 miles. Although inspection is not a solution to the tire puncture problem, it is one form of deterrent which should be encouraged. Because vehicles, such as heavy trucks, buses, and schoolbuses, are susceptible to loss of control if a steering axle tire fails, it is extremely important for operators to include in their pretrip inspections, a visual inspection for nails or other foreign objects in steering axle tires.

Activity Bus Accidents

The Safety Board has investigated at least 10 catastrophic accidents from 1974 to 1984 involving unregulated private activity buses not engaged in "for hire" operations. Seven of the 10 accidents involved church buses. These accidents included head-on collisions, rollovers and overturns, and railroad/highway grade crossing impacts; these collectively resulted in 56 fatalities and 199 injuries. In the 10 accidents, most of the

^{7/} Texas Department of Public Safety Rules and Regulation Manual for Official Vehicle Inspection Station and Certified Inspectors, October 1979.

^{8/} Tire Examination Methods for Police Accident Investigators; Dunlop Limited; London, England; Second Edition, November 1980.

buses were at least 9 years old, had a seating capacity of more than 16 passengers, were originally manufactured as schoolbuses, and had been purchased used. The data compiled from these accidents are not statistically significant, but do point out certain commonalities that exist in all of these accidents.

Poor mechanical condition of private activity buses has been a recurring factor in many of the accidents. Six of the 10 buses involved had serious mechanical problems detected during postaccident inspections. In 4 of the 10 accidents, the mechanical conditions were causal to the accident. (See appendix B.) Most activity bus owner/operators who purchase used schoolbuses do not adhere to the same preventive maintenance programs as the original bus owners (school districts and commercial operators). Older buses normally require more maintenance and should be subjected to more frequent periodic inspections if they are to remain in good operating condition. The Safety Board strongly urges all activity groups to implement adequate preventive maintenance/periodic inspection programs to insure that they are not operating mechanically unsafe vehicles.

The Safety Board reviewed accident data compiled in a 1979 study ^{9/} conducted by Indiana University for the National Highway Traffic Safety Administration. The study analyzed 13,500 police accident reports, 2,258 field accidents, and 420 in-depth accident investigations. The data indicated that mechanical defects or failures were involved in 13 percent of all highway accidents analyzed. Brake system and tires were the most common vehicle factors involved in the accidents.

The Safety Board encourages all activity groups to establish preventive maintenance programs for their privately owned vehicles to insure that the vehicles' brakes and tires are inspected properly and are maintained in good condition.

State Driver and Vehicle Inspection Requirements for Private Buses

In June 1984, the Safety Board conducted a survey of States to determine what requirements were applicable to private activity buses. (See appendix C.) The Safety Board was particularly interested in those States that are known to have a high population of private activity buses, and States where the Safety Board had investigated similar bus accidents. A total of 50 States and the District of Columbia were surveyed by telephone. Information was obtained from: State officials in the State Department of Transportation, Department of Public Safety, State Highway Patrol, or Motor Vehicle Administration. (See appendix C.)

The survey indicated that 29 of the 50 States and the District of Columbia had special licensing requirements applicable to private activity bus operators. The minimum age required to obtain appropriate licenses in all 50 States varied from 15 to 18. At least seven States required medical certification by a licensed physician for applicants applying for special bus licenses. Twenty-one States and the District of Columbia have no special licensing requirements for activity bus operators.

Two apparent irregularities were observed in the data for special licensing requirements. Twenty-one of the 28 States and the District of Columbia required applicants to take road tests to demonstrate their driving skills in the type of vehicle they intended to operate. Seven ^{10/} of the 28 States with special licensing requirements for

^{9/} Indiana University Institute for Research in Public Safety Study, "Tri-Level Study of the Causes of Traffic Accidents," May 1979, (DOT-H3-805-099).

^{10/} Nevada, Georgia, North Carolina, South Carolina, Minnesota, Kansas, and Washington.

ized either did not require or granted waivers for prospective operators to take a road test in an appropriate sized vehicle. Many activity buses engage in interstate travel, but are not subject to any Federal licensing or driver qualification requirements.

It is important that all activity busdrivers are familiar with the operation of their vehicles and have demonstrated their skills during the driver licensing process. Activity busdrivers are just as responsible for the safety of their passengers as commercial or schoolbus operators, and should be subject to the same State licensing requirements. All States impose licensing requirements on "for hire" commercial busdrivers, such as medical certifications, road tests, and a minimum age. States should either extend these requirements to include the "not for hire" busdrivers or require all prospective busdrivers to demonstrate their knowledge of these vehicles by taking an appropriate written examination and a road test in the size vehicle they are to be licensed to operate.

The survey also indicated that only 22 of the 50 States and the District of Columbia had vehicle inspection requirements applicable to private buses. The inspection procedures and performance criteria varied tremendously for those States requiring vehicle inspections. The frequency of inspection ranged from every 6 months up to every 13 months. One State even specified that buses had to be of certain size (32 passengers) before they were subject to vehicle inspections. In all the States surveyed, private activity buses were subject to random inspection by the highway patrol or State police if operated on public highways. (See appendix C for details.)

Seven of the 10 buses involved in the activity bus accidents investigated by the Safety Board were subject to annual State vehicle inspections. Three of the seven buses subject to annual State inspections had serious mechanical problems that were causal to the accident. However, the Safety Board could not determine if the adequacy of the periodic State inspections was a causal or contributing factor in any of the activity bus accidents investigated.

Emergency Response

The emergency response by Liberty County was effective for the accident conditions where 10 vehicle occupants were killed and 13 were injured. In a more serious accident involving a higher number of casualties, such as 30 to 50 injured bus passengers, a general call for emergency response without a prearranged plan of action may not be as effective. Liberty County should develop a disaster plan to include all fire, police, medical, and emergency support agencies within the County, as well as in adjacent counties. The plan should be coordinated with neighboring communities to provide clear guidelines on jurisdiction and logistical requirements, medical resource availability, and communication needs and capabilities. The plan should also provide details on establishing a triage system for injured persons and for determining the level of response to local disasters.

CONCLUSIONS

Findings

1. The weather and roadway conditions were not factors in this accident.
2. There was no evidence of physiological or psychological problems which could have influenced the performance of either the busdriver or the truckdriver.

3. The deflation and subsequent blowout of the left front tire precipitated the accident.
4. The tire failure resulted from the penetration of a small sharp nail through the tread section and inner tube of the bias ply tire.
5. The deflated left front tire began marking the pavement with light scallop marks which closely matched the circumference and width of the failed tire.
6. It is not known why the busdriver did not steer his vehicle onto the right shoulder after perceiving the impending danger.
7. Both vehicle drivers were seated in areas where survival area was destroyed. The use of seatbelts would not have mitigated their injuries.
8. No clear injury/fatality pattern emerged for the bus passengers. Occupant injuries resulted from striking the inside bus structure or fixed objects outside the bus.
9. The former schoolbus was manufactured before several Federal Motor Vehicle Safety Standards were enacted to improve schoolbus crashworthiness and occupant protection.
10. Better seat padding, higher seatbacks, and energy absorbing seat surfaces in front of the passengers which are built into schoolbuses built after enactment of several Federal Motor Vehicle Safety Standards could have been effective in reducing some of the contact injuries resulting from passengers' striking metallic seatbacks.
11. Schoolbuses which comply with the Federal Motor Vehicle Safety Standard requirements for schoolbus rollover protection and body joint strength are more likely to retain their occupants in a severe head-on collision.
12. It would be prudent for churches and other activity groups to purchase buses which meet minimum Federal Motor Vehicle Safety Standards for crashworthiness and occupant protection for schoolbuses manufactured after April 1977.
13. Except for the condition of the left front tire, there was no evidence to suggest that the mechanical condition of the bus contributed to the accident, or that the bus was in the same mechanical condition at the time it was previously inspected, 6 months before the accident.
14. Activity groups establishing preventive maintenance programs for privately owned vehicles should insure that all vehicle brakes and tires are properly inspected and are maintained in good condition.
15. Many States do not require applicants for private bus licenses to take a road test with the same size vehicle they intend to operate.

16. Many activity buses engage in interstate travel but are not subject to any Federal driver qualification requirements.
17. Only 22 of 50 States and the District of Columbia surveyed had vehicle inspection requirements applicable to private buses.
18. Liberty County has no disaster plan.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the activity bus following the deflation and subsequent blowout of the left front tire due to a nail puncture. Contributing to the severity of the injuries was the less rigid construction of the 1970 former schoolbus when compared to schoolbuses built after April 1977 which meet minimum Federal requirements for crashworthiness and occupant protection.

RECOMMENDATIONS

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

--to the Governors of Nevada, Georgia, North Carolina, South Carolina, Kansas, Minnesota, and Washington:

Revise current State motor vehicle licensing procedures to require all applicants for commercial or noncommercial bus licenses to take an appropriate written examination and a road test in the size vehicle for which the license is to be issued. (Class II, Priority Action) (H-84-70)

--to the Governors of Arizona, Idaho, South Dakota, Kentucky, Wisconsin, Ohio, West Virginia, New Mexico, Florida, Mississippi, Tennessee, Iowa, Nebraska, Oklahoma, Arkansas, Missouri, Alabama, Alaska, Vermont, Utah, Oregon, and the Mayor of the District of Columbia:

Enact appropriate legislation to require all prospective operators of noncommercial buses to demonstrate their driving skills by taking an appropriate written examination and road test in the size vehicle for which the license is to be issued. (Class II, Priority Action) (H-84-72)

--to the Commissioner's Court of Liberty County Texas:

Develop a disaster plan to include all fire, police, medical, and emergency support agencies within the county as well as adjacent counties which provides clear guidelines on jurisdiction, logistical requirements, medical resource availability, communication needs, and the need for establishing a triage system in the event of a catastrophic accident. (Class II, Priority Action) (H-84-71)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ VERNON L. GROSE
Member

G.H. PATRICK BURSLEY, Member, did not participate.

September 5, 1984

APPENDICES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of this accident through the news media at 10:00 p.m., c.s.t. on December 23, 1983. Investigators were dispatched from the National Transportation Safety Board's Headquarters in Washington, D.C., the next morning. Investigators were assisted by representatives of the Texas Highway Patrol, International Harvester Corporation, General Tire and Rubber Company, and B&J Vacuum Tank Service.

Deposition

There were no depositions taken or public hearings held in conjunction with this investigation.

APPENDIX II

RECENT WTSB MAJOR ACCIDENTS INVOLVING UNREGULATED PRIVATE BUS OPERATIONS

LOCATION	DATE	TYPE OF OPERATION	MILES TRAVELED AND BUS CONFIGURATION	MECHANICAL CONDITION OF BUS	DRIVER LICENSING REQUIREMENTS	CAUSAL FACTORS OF ACCIDENT
Blythe, California	1/15/74	Private Farm Labor Bus	100 out of 110 Schoolbus Type Pre-Standard	-14-year-old bus -Annual State Inspection -Exhaust leaks, poor wiring, no emergency brakes	-Req'd chauffeur's lic. w/carm bus certificate -Req'd medical exam certif. -Had 5 years bus driving exp.	-Failed to reduce speed for conditions -Driver fatigue
Stratton, Nebraska	3/8/76	Private Church Bus	1 1/2 out of 2 Schoolbus Type Pre-Standard	-9-year-old bus -Bus recently inspected by State -No mechanical problems causal to accident	-No special requirements -Driver had valid schoolbus permit -Previous bus driving exp.	-Driver inattention failed to stop for train -Inadequate warning devices at crossing
Tifton, Georgia	4/11/78	Private Boys' Club Bus	885 out of 1100 Schoolbus Type Pre-Standard	-11-year-old bus -Brakes out of adjustment, RR Spring had 3 fractured leaves, low tire pressure in 5 tires, broken accelerator return spring -Bus not subject to Annual State Inspection (Not req'd)	-Req'd chauffeur's licence -Driver had no formal bus training -Had driven bus for 2 years	-Failure to reduce speed for road conditions -Failure of accelerator return spring -Improper maintenance
Luling, Texas	11/16/80	Private Church Bus	50 out of 180 Intercity Coach	-9-year-old bus -Annual inspection done 11 months before accident -Rear brakes (out of adjustment), marginal rear tires	-No special license req'ts -1-year driving exp. with bus -No prior bus driving exp.	-Poor lateral traction of marginal rear tires
Holmesville, New York	4/5/83	Handicapped Worker's Bus	15 out of 50 Schoolbus Type Post-Standard	-6-month-old bus -No mechanical defects -Annual State Inspection Required	-Class II license to operate bus. Must pass written exam every 2 years; and also medical exam every 2 years -5 years bus driving experience	-Improper towing by other driver -Bus operation or maintenance not related to cause

LOCATION	DATE	TYPE OF OPERATION	MILES TRAVELED AND BUS CONFIGURATION	MECHANICAL CONDITION OF BUS	DRIVER LICENSING REQUIREMENTS	CAUSAL FACTORS OF ACCIDENT
Devers, Texas	12/23/83	Private Church Bus	25 out of 65 Schoolbus Type Pre-Standard	-13-year-old bus -Several mechanical problems: poor brakes poor tires, suspension problems -Inspected by State 6 months before the accident	-No special req'ts for churchbus operators -3 years bus driving experience	-Loss of steering control due to failure of LF tire
Wofford Heights, California	7/7/84	Private Church Bus	150 out of 170 Schoolbus Type Pre-Standard	-11-year-old bus -No mechanical defects uncovered -Annual State Inspection required	-Class II license required -Medical certification required -Driver had 10 years bus driving experience	-Failed to reduce speed for road conditions -Improper route selection -Unfamiliarity with road
Carrollton Kentucky	7/4/83	Private Church Bus	250 out of 625 Intercity Coach	-13-year-old bus owned by church -No State inspection req'd -Brakes were inadequate emergency brake would not release and several tires were smooth	-Driver was operating vehicle on suspended license -Special license required for bus operation	-Driver lost vehicle due to inadequate vehicle braking
Queens County, New York	8/24/83	Private Church Bus	10 out of 25 Schoolbus Type Pre-Standard	-12-year-old bus -Very low air pressure in all tires -Annual State inspection required	-Class II license to operate bus -Must pass written exam every 2 years -Driver did not have NY permit and was not qualified to drive -Must pass medical exam every 2 years	-Speed too fast for road conditions -Poor vehicle handling due to under-inflated tires

LOCATION	DATE	TYPE OF OPERATION	HILLS TRAVELED AND BUS CONFIGURATION	MECHANICAL CONDITION OF BUS	DRIVER LICENSING REQUIREMENTS	CAUSAL FACTORS OF ACCIDENT
Florence, Alabama	4/18/83	Private Church Bus	25 out of 32 Schoolbus Type Pre-Standard	<ul style="list-style-type: none"> -15-year-old bus -No mechanical defects suspected -Bus recently inspected and serviced -No State inspection required -Bus in operation by church since March of 1983 	<ul style="list-style-type: none"> -No special requirements -Driver had been operating the bus about 1 year before the accident occurred -Had schoolbus license 1980-81 	<ul style="list-style-type: none"> -Both vehicles involved in accident were straddling the road on a blind hill

APPENDIX C

SUMMARY OF STATE SURVEY ON REGULATIONS APPLICABLE
TO UNREGULATED PRIVATE ACTIVITY BUSES
CONDUCTED JUNE, 1984

<u>States Surveyed</u>	<u>Driver License Requirements</u>	<u>Vehicle Inspection Requirements</u>
Arizona	No special licensing requirements.	No vehicle inspection required.
Nevada	<ul style="list-style-type: none">o Class III - to transport 15 passenger.o Class III - w/medical certificate to transport 15 or more passengers.o Class III - to operate vehicle w/3 axles.	No vehicle inspection required.
Colorado	<ul style="list-style-type: none">o Must have class "5" licenseo No medical examination requiredo Must take written/road tests on vehicle to be operated.	No vehicle inspection required.
North Dakota	<ul style="list-style-type: none">o Class II - license required.o Must take written/road test on the vehicle to be operated.o medical certification required.	No vehicle inspection required.
Wyoming	<ul style="list-style-type: none">o Must have class "B" license.o No medical certification.o Must take written/road tests or vehicle to be operated required.	No vehicle inspection required.
Montana	<ul style="list-style-type: none">o Activity buses are exempt from all motor carriers requirements if they are operated within a 200-mile radius or are less than 26,000 lbs GVWR. Otherwise vehicle and driver must make all applicable FMCSR requirements for driver qualifications and vehicle equipment.	
Idaho	<ul style="list-style-type: none">o No special licensing requirements.	No vehicle inspection requirements.
South Dakota	<ul style="list-style-type: none">o No special licensing requirements.	Annual inspection by State Patrol if vehicle- transports 10 passenger or more.
Kentucky	<ul style="list-style-type: none">o No special licensing requirements.	No vehicle inspection required.

<u>States Surveyed</u>	<u>Driver License Requirements</u>	<u>Vehicle Inspection Requirements</u>
Indiana	<ul style="list-style-type: none">o No special licensing requirements unless vehicle transports 16 or more passengers. Then a chauffuer's license is required.	No vehicle inspection required.
Wisconsin	<ul style="list-style-type: none">o No special licensing requirements.	No vehicle inspection required.
Ohio	No special requirements.	No vehicle inspection required.
Illinois	<ul style="list-style-type: none">o Class C license required to operate a bus.o Must take written/road tests on the vehicle to be operated.	Vehicle inspection required every six months.
Michigan	<ul style="list-style-type: none">o Class III operator license if operating "not for hire" bus.o Must take written/road test on vehicle to be operated	Periodic vehicle inspections required for activity and schoolbuses.
West Virginia	<ul style="list-style-type: none">o No special licensing requirements.	Annual vehicle inspection required.
Texas	<ul style="list-style-type: none">o Class "B" license required to transport unlimited passengers.o Class "C" license required to transport up to 29 passengers.o Must take written/road tests on vehicle to be operated.	Annual vehicle inspections required for activity buses.
Louisiana	<ul style="list-style-type: none">o Class "B" required to transport up to 14 persons.o Class "C" required to transport 15 or more persons.o Must take written/road tests on vehicle to be operated.	Annual vehicle inspection required for activity buses.
New Mexico	<ul style="list-style-type: none">o No special licensing requirements.	No vehicle inspection required.
California	<ul style="list-style-type: none">o Class II license required with a medical examination Written exam/road test required.	Vehicle inspection is required every 13 mos.
Hawaii	<ul style="list-style-type: none">o Operator - Type 4 license required with a medical examination.	Annual vehicle inspection required for activity buses.

<u>States Surveyed</u>	<u>Driver License Requirements</u>	<u>Vehicle Inspection Requirements</u>
Florida	No special licensing requirements.	No vehicle inspection required.
Georgia	Class 3 license required to operate bus.	No vehicle inspection required.
Mississippi	No special licensing requirements.	No vehicle inspection required.
North Carolina	Class B license required to operate vehicle with seating capacity of 12 or more.	State inspection is required.
South Carolina	Class 1 or 2 license is required based on size of vehicle operated.	State inspection is required.
Tennessee	No special licensing requirements.	No vehicle inspection required.
Virginia	No special license required to operate bus with a seating capacity of less than 32. Otherwise, Class "B" license is required.	Annual State inspection required.
Minnesota	Class "B" license required to operate vehicle with seating capacity of 10 or more.	No vehicle inspection required.
Kansas	Class "B" license to operate bus.	No vehicle inspection required.
Iowa	No special licensing requirements.	No vehicle inspection required.
Nebraska	No special licensing requirements.	No vehicle inspection required.
Oklahoma	No special licensing requirements.	No vehicle inspection required.
Arkansas	No special licensing requirements.	No vehicle inspection required.
Missouri	No special licensing requirements.	No vehicle inspection required.
New York	Class II license required with medical examination to operate any bus. Written exam/road test required.	Annual State inspection required.
Alabama	No special licensing requirements.	No vehicle inspection required.
Alaska	No special licensing requirements.	No vehicle inspection required.
Washington	Intermediate license required. Must take written exam., road test test can be waived.	No vehicle inspection required.

<u>States Surveyed</u>	<u>Driver License Requirements</u>	<u>Vehicle Inspection Requirements</u>
Pennsylvania	<ul style="list-style-type: none">o Class II license requiredo Must take written/road tests on vehicle to be operated.	Annual vehicle inspection required.
Rhode Island	<ul style="list-style-type: none">o Class I license requiredo Must take written road test on vehicle to be operated.	Annual vehicle inspection required.
Vermont	<ul style="list-style-type: none">o No special licensing requirements.	Annual vehicle inspection required.
New Hampshire	<ul style="list-style-type: none">o Commercial light vehicle license required if bus is 18,000 lbs. GVWR or heavier.o Must take written/road tests on the vehicle to be operated.	Semi-annual vehicle inspection required.
Maine	<ul style="list-style-type: none">o Class II License requiredo Must take written/road tests on the vehicle to be operated.	Annual vehicle inspection required.
Massachusetts	<ul style="list-style-type: none">o Class II license requiredo Must take written/road tests on the vehicle to be operated.	Annual vehicle inspection required.
Connecticut	<ul style="list-style-type: none">o Public service license required.o Medical certification requiredo Must take written/road tests on the vehicle to be operated.	No vehicle inspection required.
Maryland	<ul style="list-style-type: none">o Class C license required for vehicles with a seating capacity over 10 persons.o Must take written/road tests on the vehicle to be operated.	No vehicle inspection required.
Delaware	<ul style="list-style-type: none">o License according to vehicle weight classification.	Annual vehicle inspection required.

<u>States Surveyed</u>	<u>Driver License Requirements</u>	<u>Vehicle Inspection Requirements</u>
	<ul style="list-style-type: none">o Must take written/road tests on the vehicle to be operated.	
New Jersey	<ul style="list-style-type: none">o Type 1 license required for vehicles with a seating capacity 16 or more.o Must take written/road tests on the vehicle to be operated.o Medical certification required.	Annual vehicle inspection required.
Utah	<ul style="list-style-type: none">o No special licensing required.	No vehicle inspection required.
Oregon	<ul style="list-style-type: none">o No special licensing required.	No vehicle inspection required.
District of Columbia	<ul style="list-style-type: none">o No special licensing required.	Semi-annual vehicle inspection required.

APPENDIX D

ACTIVITY BUS PASSENGER
SEATING LOCATIONS AND INJURIES (NON-FATAL)

Abbreviated Injury Scale (AIS) 1 Injuries (Minor)

Row 4, left side, window: female, age 13.
Multiple contusions.

Row 5, left side, window: male, age 18.
Multiple contusions, multiple abrasions.

Row 5, right side, window: male, age 16.
Scalp laceration, laceration above left eye.

Row 7, left side, aisle: male, age 17.
Scalp laceration (2 inches).

Row 9, right side, window: female, age 16.
Multiple lacerations.

Row 10-12, seat unknown: male, age 16.
Multiple scalp lacerations, contusions.

Row 10-12, seat unknown: male, age 5.
Bruised ribs right side, bruised forehead.

AIS 2 Injuries (Moderate)

Row 7, right side, aisle: male, age 14.
Ligament tear-right knee, multiple contusions, unspecified blunt head trauma.

Row 10-12, seat unknown: male, age 9.
Fractured 5th left metacarpal, laceration (3 cm) right forehead to upper eyelid, broken upper incisor.

AIS 3 Injuries (Serious)

Row 2, right side, aisle: female, age 17.
Open fracture left tibia and fibula, unspecified multiple trauma.

Row 3, right side, aisle: female, age 31.
Open fracture right tibia and fibula, fractured left ulna, multiple lacerations lower legs, laceration below lip across chin, abrasion left forehead, abrasion left arm.

Row 4, right side, window: male, age 15.
Dislocated right shoulder, contusion left ankle.

Row 9, right side, aisle: female, age 12.
Fractured right femur.