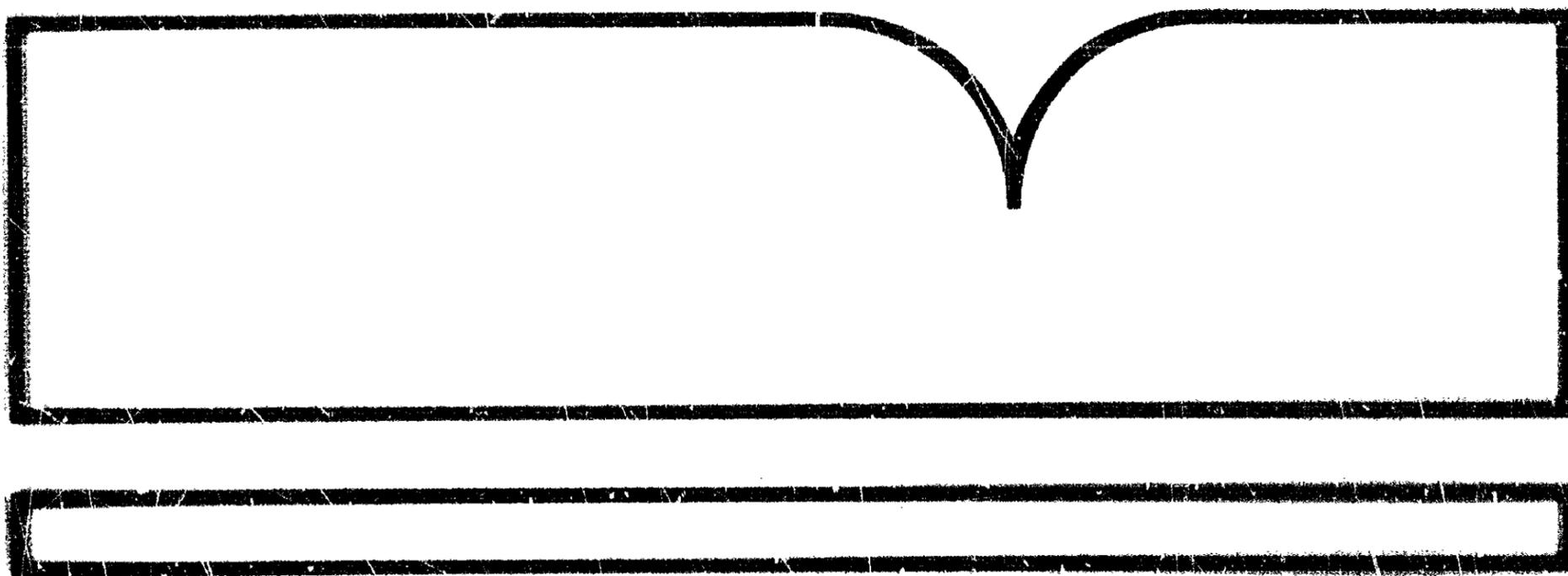


PB85-916207

Highway Accident Report - Collision of  
Tuba City School District Schoolbus and  
Bell Creek, Inc., Tractor-Semitrailer,  
US 160 near Tuba City, Arizona, April 29, 1985

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

10 Dec 85



U.S. Department of Commerce  
National Technical Information Service

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16. Abstract About 3:14 p.m. mountain standard time on April 29, 1985, a Bell Creek, Inc. tractor-semitrailer transporting 99 head of cattle and traveling about 59 mph struck the rear of a 1977 Tuba City Unified School District schoolbus on eastbound U.S. 160 about 16 miles north of Tuba City, Arizona. The schoolbus was stopped with its warning lights flashing in the eastbound lane of the two-lane highway to discharge passengers. The weather was clear, the pavement was dry, and there were no visibility obstructions for about 1.4 miles to the rear of the schoolbus. Of the 32 schoolbus passengers (ages 5 to 21 years), 2 were fatally injured, 4 sustained serious injuries, 4 received moderate injuries, 18 sustained minor injuries, and 4 were not injured. The truckdriver and the schoolbus driver received minor injuries.  The National Transportation Safety Board determines that the probable cause of this accident was the truckdriver's chronic fatigue, which adversely affected his ability to avoid a collision with the stationary schoolbus; his chronic fatigue developed from a loss of sleep due to a combination of excessive duty time and a prolonged irregular duty pattern. Contributing to the accident was the failure of Bell Creek, Inc. to properly monitor the truckdriver's activities to prevent excessive hours of service.			
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NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: December 10, 1985

COLLISION OF  
TUBA CITY UNIFIED SCHOOL DISTRICT SCHOOLBUS  
AND BELL CREEK, INC. TRACTOR-SEMITRAILER,  
U S 160 NEAR TUBA CITY, ARIZONA,  
APRIL 29, 1985

SYNOPSIS

About 3:14 p.m. mountain standard time on April 29, 1985, a Bell Creek, Inc. tractor-semitrailer transporting 99 head of cattle and traveling about 59 mph struck the rear of a 1977 Tuba City Unified School District schoolbus on eastbound U.S. 160 about 16 miles north of Tuba City, Arizona. The schoolbus was stopped with its warning lights flashing in the eastbound lane of the two-lane highway to discharge passengers. The weather was clear, the pavement was dry, and there were no visibility obstructions for about 1.4 miles to the rear of the schoolbus. Of the 32 schoolbus passengers (ages 5 to 21 years), 2 were fatally injured, 4 sustained serious injuries, 4 received moderate injuries, 18 sustained minor injuries, and 4 were not injured. The truckdriver and the schoolbus driver received minor injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the truckdriver's chronic fatigue, which adversely affected his ability to avoid a collision with the stationary schoolbus; his chronic fatigue developed from a loss of sleep due to a combination of excessive duty time and a prolonged irregular duty pattern. Contributing to the accident was the failure of Bell Creek, Inc. to properly monitor the truckdriver's activities to prevent excessive hours of service.

INVESTIGATION

The Accident

On April 29, 1985, a Bell Creek, Inc. tractor-semitrailer was traveling behind another Bell Creek, Inc. tractor-semitrailer on eastbound U.S. 160 about 16 miles north of Tuba City, Arizona. The weather was clear, the pavement was dry, and there were no reported visibility obstructions on the straight, two-lane, undivided highway for about 1.4 miles eastbound to the accident site. As both Bell Creek trucks approached a schoolbus, the first truckdriver notified the accident truckdriver on the CB radio that "we had a slow moving bus up here..." According to postaccident statements the former "didn't get any response" to that transmission from the following truckdriver. He further said that the schoolbus was traveling about 40 to 45 mph and that after he had passed the schoolbus he saw the accident truck in his rear-view mirror traveling about 1/4 mile behind the schoolbus. The first truckdriver did not become aware of the accident until he stopped about 50 miles from the accident site to wait for the second truck to catch up.

Three witnesses approaching the accident site in the westbound lane reported that they could see the red lights mounted on the front of the schoolbus flashing as they approached. One witness reported that the schoolbus appeared to be stopped, and the other two reported that the schoolbus was stopped before the collision.

At about 3:14 p.m. mountain standard time the second Bell Creek, Inc. tractor-semitrailer struck the rear of the schoolbus. All the witnesses reported that the rear of the schoolbus was lifted up by the force of the collision. After impact the schoolbus was moved forward about 136 feet as it rotated 155 degrees clockwise and left the roadway to the right. It then overturned onto its left side and slid about 18 feet to a stop. The tractor-semitrailer continued forward about 261 feet as it jackknifed to the right and slid to its final rest position with the tractor off the eastbound roadway and the semitrailer blocking the westbound lane of U.S. 160. There was no fire. (See figures 1 and 2.)

None of the truck or schoolbus occupants were ejected. Of the 32 schoolbus passengers, 2 were fatally injured, 4 sustained serious injuries, 4 sustained moderate injuries, 18 sustained minor injuries, and 4 were not injured. The truckdriver and the schoolbus driver sustained minor injuries.

#### Emergency Response

The schoolbus driver reported that after the schoolbus came to rest he kicked out the windshield of the bus, and that all the occupants either walked or were carried out of the schoolbus through this opening.

The Tuba City Assistant Fire Chief, who was one of the westbound witnesses and was driving his fire department vehicle, immediately radioed the Tuba City Police dispatcher and requested that all available fire-rescue units, ambulances, and the Tuba City Police Department respond to the scene. He then entered the schoolbus and began to assess the injuries of the occupants, supervised the removal of the injured, and administered first aid.

The hospital in Tuba City implemented its disaster plan and dispatched two ambulances which arrived at 3:35 p.m. and 3:42 p.m., respectively. All occupants of the schoolbus had been removed by the time the first ambulance arrived. All of the injured were removed from the scene within an hour after the accident, and the less seriously injured were transported to the hospital in police vehicles and another schoolbus. The last injured person was admitted to the hospital emergency room at 5:30 p.m.

At 3:40 p.m. the Tuba City Police Department notified the Arizona Department of Public Safety (ADPS) office in Flagstaff, Arizona, about the accident. Flagstaff is located about 95 miles south of the accident site. The ADPS dispatched three police cruisers from the Flagstaff area, one helicopter from Flagstaff, and one helicopter and one fixed-wing aircraft with litter capability from Phoenix, Arizona, about 241 miles south of the accident scene. The helicopter from Flagstaff departed Tuba City en route to Flagstaff at 4:15 p.m. with an attending physician and one survivor suspected of having serious injuries. This helicopter arrived in Flagstaff at 5:17 p.m. The helicopter and the fixed-wing aircraft dispatched from Phoenix were not used in the rescue operation.

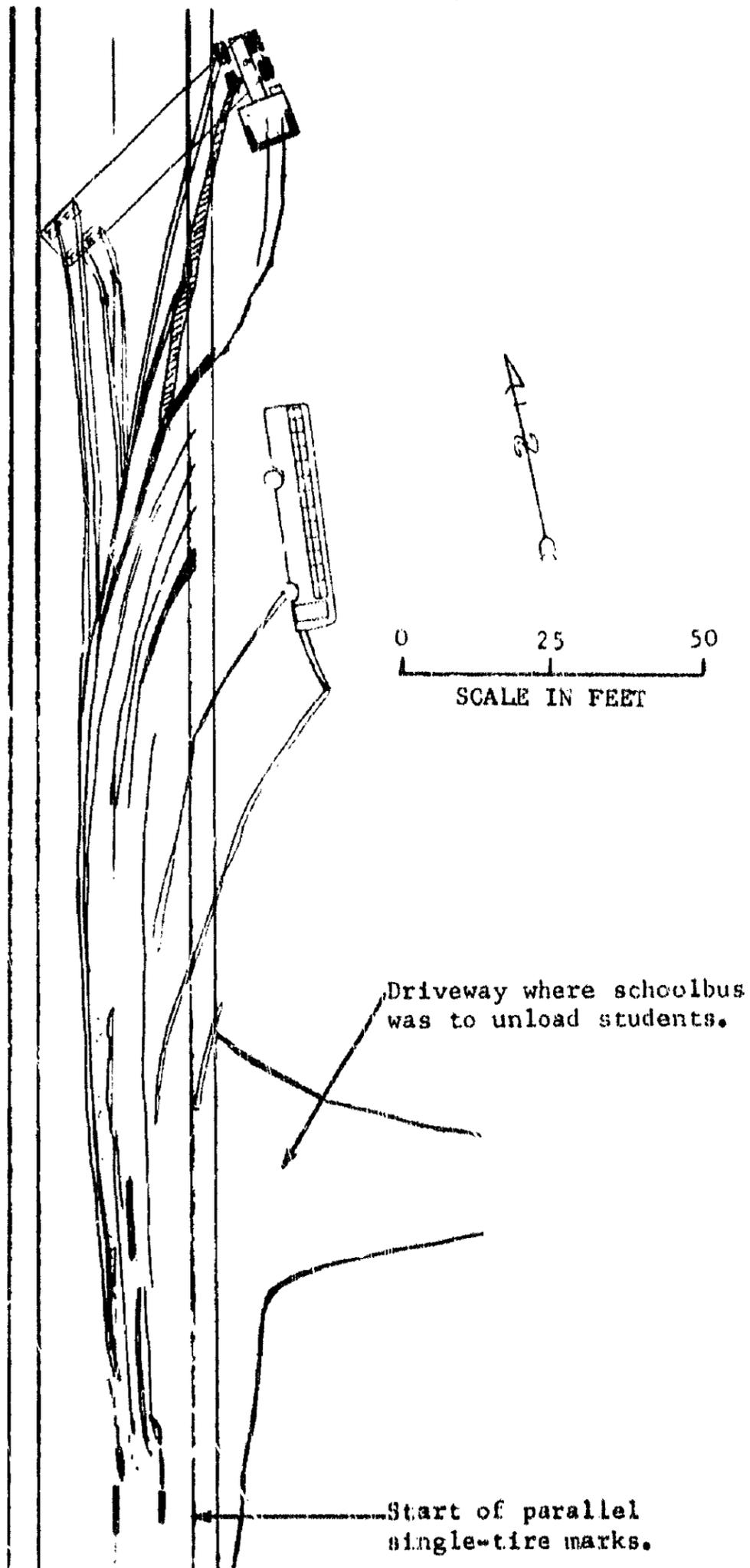


Figure 1.--Plan view of accident site.

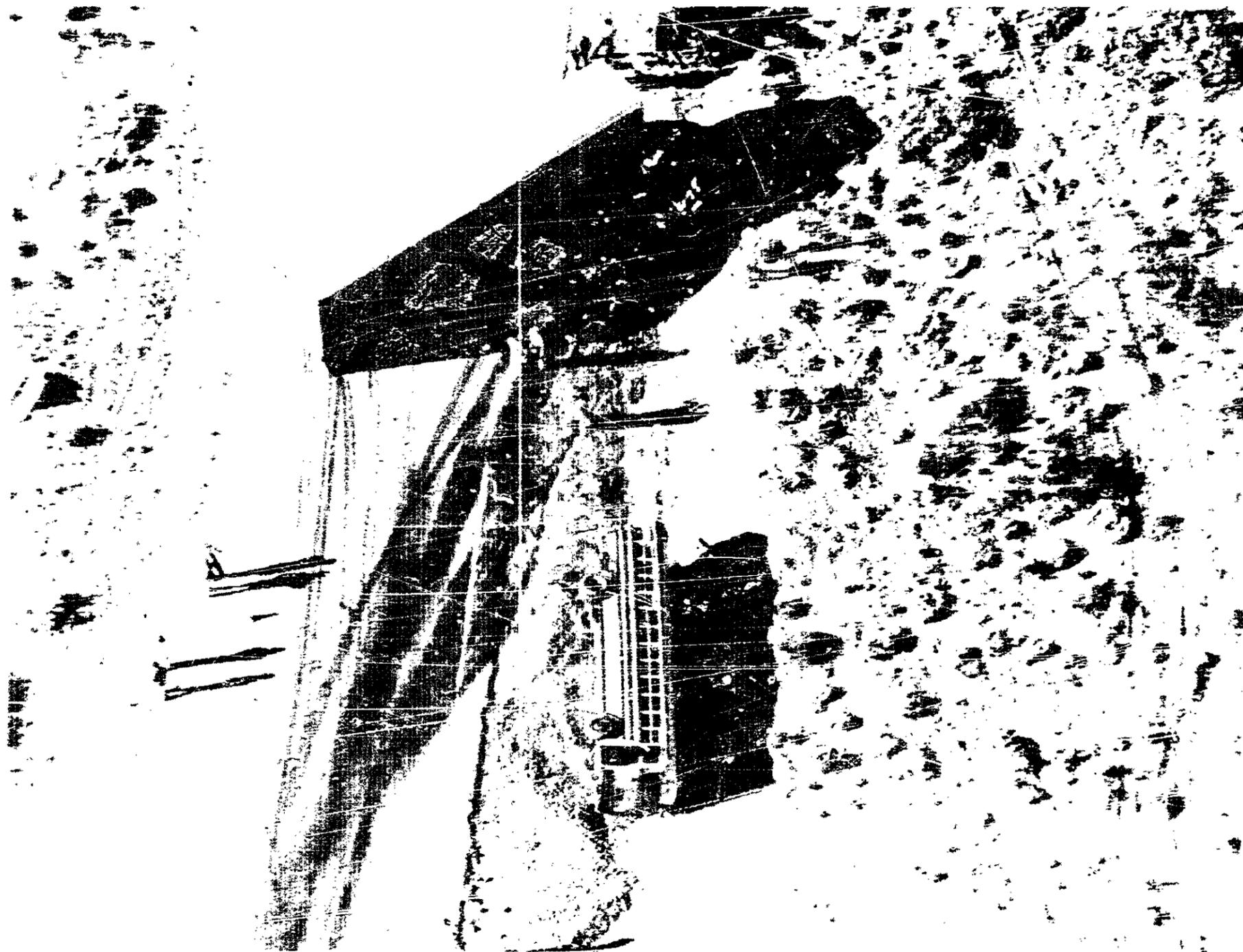


Figure 2.-- Aerial photograph of accident site. Photograph courtesy of the Arizona Daily Sun.

### Injuries to Persons

<u>Injuries</u>	<u>Drivers</u>	<u>Passengers</u>	<u>Total</u>
Fatal	0	2	2
Serious	0	4	4
Moderate	0	4	4
Minor	2	18	20
None	0	4	4
Total	2	32	34

### Driver Information

The 49-year-old schoolbus driver, who had been employed by the Tuba City Unified School District for 14 years, had been driving the accident route for about 1 year. He held a valid Class 4 Arizona chauffeur's license and an Arizona School Bus Driver Certificate that qualified him to operate schoolbuses without restrictions. His driving record was clear and showed no prior accidents.

The schoolbus driver reported that just before the collision he was completely stopped in the eastbound lane with his service brakes applied, that the schoolbus red warning lights were flashing, the "stop" arm was extended, and the right front door was opened. He further stated that the occupants of the rear row of seats in the schoolbus were standing up and stretching, and that some of the other passengers were standing up either to exit the schoolbus or change seats.

The 26-year-old truckdriver held a valid Nebraska chauffeur's license. On June 7, 1984, he was medically examined and found to be physically qualified to operate commercial vehicles in interstate commerce. He had been employed as a truckdriver since 1976 and had been employed by Bell Creek, Inc. since August 1984. During the previous five years while driving his personal vehicle, he had been convicted five times for speeding and once for exhibition driving (undue acceleration). He was involved in one accident in 1980 and another in February 1985, while driving his personal vehicle. He was not considered at fault in either of these accidents.

About 2 hours after the accident, the accident truckdriver stated to ADPS investigators that before the accident he was traveling between 50 and 55 mph. He remembered the truckdriver in front of him had told him over the CB radio about the slow-moving schoolbus ahead, and he stated that he saw the schoolbus ahead after the first truck had passed it. He also stated that the schoolbus was moving at the time he saw it, that he did not see any flashing lights or an extended "stop" arm on the schoolbus, and that the only thing he remembered about the accident was trying "to get that kid out of the back of the bus. I don't even know how I got out of the truck." He also stated that he had been scheduled to pick up the cattle near Tonopah, Arizona, on the morning of April 29, and that he had arrived in Tonopah on the morning of April 27, two days before the accident.

During the post-accident examination of the Bell Creek tractor, the ADPS recovered the truckdriver's records of duty status (daily logs) and other documents including mileage records, port of entry receipts, and a fuel receipt which contained conflicting information. There were two different duty status records for both April 25 and 26. The duty status record for April 27 and 28 showed that the truckdriver was off duty in Tonopah, Arizona, about 260 miles from the accident site. However, the fuel

receipt showed that the truckdriver bought fuel at a truckstop near Lupton, New Mexico, on the Arizona/New Mexico State border on April 28. A telephonic check with the Sanders, Arizona, Port of Entry located about 15 miles west of Lupton disclosed that the truckdriver had cleared that location in the early morning of April 28.

In a second interview with the ADPS on the day after the accident the truckdriver stated that he was traveling between 50 and 55 mph in 13th gear with his tachometer registering 1700 rpm just before the accident, and that he could not remember applying his brakes or taking any evasive action before the collision. He stated during this interview that he had arrived in Tonopah, Arizona, on April 28.

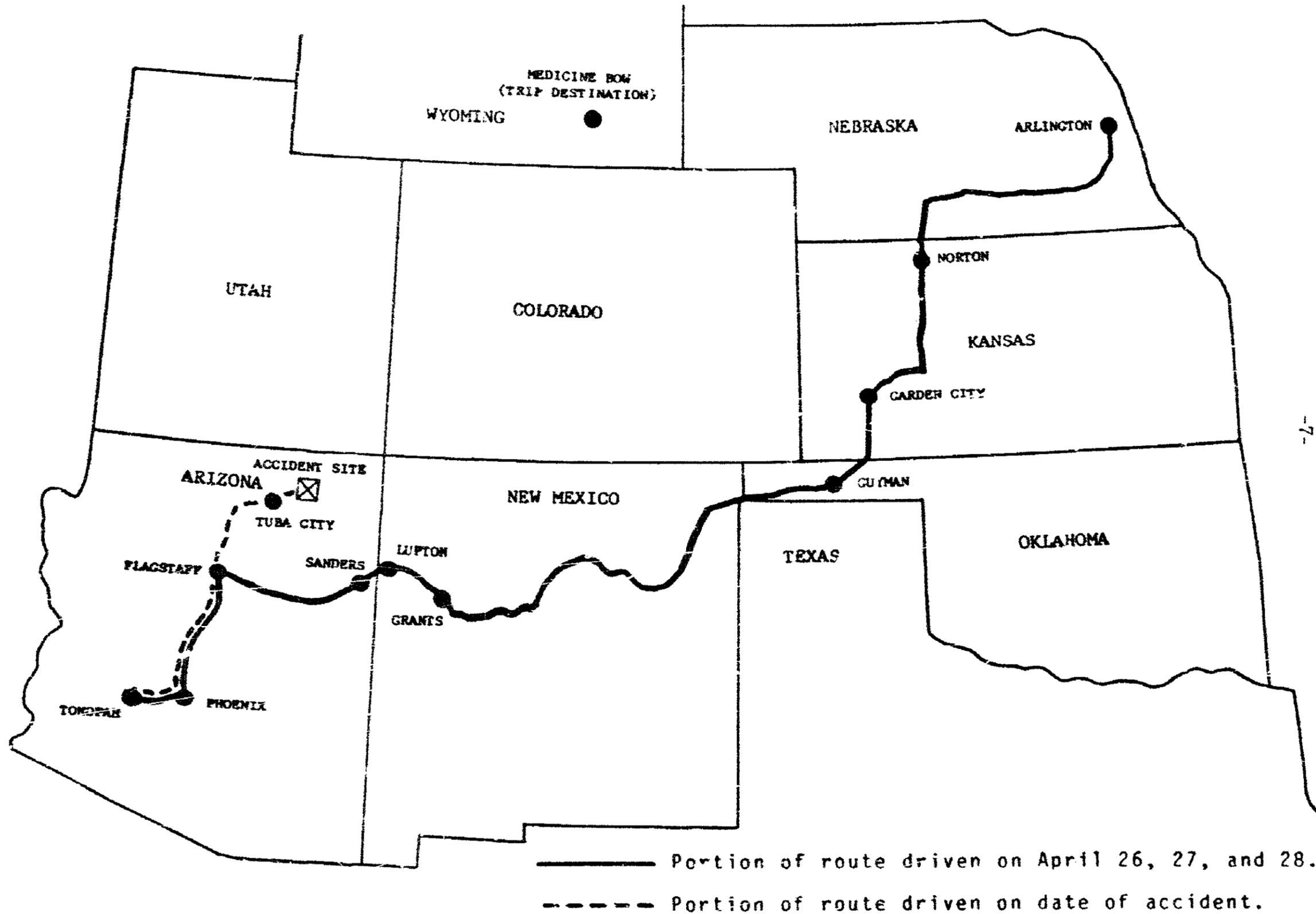
When asked whether he had been driving on April 27 and 28, as indicated by the mileage records and the fuel receipt found in the truck-tractor, rather than having been off duty in Tonopah, Arizona, as shown on the driver's record of duty status, the driver stated that "I don't really know..." and that "I probably am" driving in excess of the maximum hours permitted by federal regulation. The truckdriver again stated that the schoolbus was moving and that he did not see any flashing lights. The truckdriver also stated that he remembered throwing two cans of soft drinks wrapped in a shirt into the sleeper berth before the collision because they had started to slide off the engine cover in the tractor cab.

In an interview with Safety Board investigators on May 15, 1985, the truckdriver reported that he slept poorly the night of April 27 when he was in Grants, New Mexico, due to a cough which he said he got every spring. He said that on the morning of April 28 he took an over-the-counter medication which he said seemed to correct the problem. He said that he napped briefly in the morning on April 28, drove through Arizona during that day, and slept some more in the afternoon near Tonopah, Arizona. He then spent the evening in Tonopah with other truckdrivers, ate supper about 6:00 p.m., and drank three beers between 8:00 and 10:00 p.m. The truckdriver stated that he slept on the floor in a motel room he shared with other truckdrivers from around 10:00 p.m. on April 28 until 3:30 a.m. on April 29. He then got up, got his truck ready and drove to the ranch where the cattle were to be loaded. He loaded his trailer starting around 7:15 a.m. on April 29, had breakfast from about 8:00 a.m. to 8:45 a.m., and left Tonopah, Arizona, en route to Medicine Bow, Wyoming, around 9:00 a.m.

The truckdriver stopped for 15 minutes at a rest stop north of Phoenix, Arizona, at 10:30 a.m., and stopped for about 15 minutes at 1:15 p.m. in Flagstaff, Arizona, where he drank one can of a soft drink and ate an ice cream sandwich and two candy bars. The accident occurred about two hours later. (See figure 3.)

The truckdriver also stated during this interview that he may have been distracted immediately before the collision because two cans of soft drinks he had wrapped in a shirt were falling off the engine cover, and he had reached down and picked them up just before the collision. In response to a Safety Board request that he prepare an accurate record of his activities before the accident, the truckdriver prepared an hours-of-service record showing that he had been driving or had been on duty a total of 53 hours during the 8 consecutive days before the accident. Further investigation with officials for Bell Creek, Inc. indicated that the truckdriver had been on duty a total of 88 1/4 hours during the 8 consecutive days before the accident. (See Appendix B.)

Figure 3.--Truckdriver's route from Arlington, Nebraska, to the accident site.



### Vehicle Information and Damage

The 84-passenger schoolbus was manufactured by the Bluebird Body Company in May 1977 and was owned and operated by the Tuba City Unified School District. The odometer registered 087,131 miles. The 37.6-foot-long two-axle schoolbus was equipped with a diesel engine, a 4-speed automatic transmission, power steering, air-mechanical brakes, and 14 rows of bench-type seats on each side of the center aisle. The last semiannual inspection required by the State of Arizona was performed on April 11, 1985, and disclosed no mechanical defects. The 20,150-pound schoolbus and the 33 occupants weighed about 24,150 pounds at the time of the accident. The driver's seat was equipped with a lapbelt; the passenger seats were not equipped, nor were they required to be equipped, with lapbelts.

The right rear of the schoolbus was displaced forward and about 2.5 feet to the left, and the left rear was displaced forward about 9.7 feet. There were no exterior body panel separations between the roof and the rear body side panels. The extensive crush prevented inspection of all the side body panel joints at the left rear. However, of the joints that were visible, no exterior body panel separations were noted at this location. (See figure 4.) The rear 11 feet of both the longitudinal frame rails which formerly ran the entire length of the vehicle were bent 37 inches to the left. The emergency door at the rear was inoperable due to collision damage. (See figure 5.) The rear bumper, which was torn loose from its mounting to the longitudinal frame rails, had a rubber tire transfer 8 inches from its far right side.

The padded restraining barrier installed in front of the first passenger seat on the right side was displaced rearward 12 inches on the aisle side. The padded left front restraining barrier was not damaged or displaced from its pre-accident location. The remaining damage to the interior of the schoolbus was confined to the area containing the last four rows of seats. The floor was buckled upward in four places at these seats, and the seat legs on the last three rows of seats were torn from the floor. The seats of the last three rows were crushed forward with no space between the seat cushion and the seat back of the next row forward. The seat on the left side was displaced upward to within about 8 inches from the interior ceiling body panel. (See figure 6.)

No separation of the major interior body panels was noted at the rear of the schoolbus. The schoolbus had interior maintenance access panels installed along both sides above the windows. The maintenance access panels along the left side of the schoolbus contained a wiring harness which illuminated the interior dome lights, the sidemarker lamps, and the rear tail, stop, and flashing red stop lamps. The maintenance access panels on the right side contained a single wire which the ADPS reported illuminated the clearance and identification lamps on the rear of the schoolbus. These maintenance access panels were joined to their adjacent interior body parts by sheet metal screws located at each corner of the panel. Joint separations were noted at the connections joining the left and right maintenance access panels to the interior body sidewall panels at the rear. Above the 13th row of seats, where the separation of the maintenance access panel left the bottom edge of the body panel exposed, a quantity of blood, hair, and tissue was present on the edge of the body panel. (See figure 7.)

The first aid kit on the inside panel above the right side of the dashboard and the fire extinguisher on the sidewall behind the driver's seat were reported to have been removed during the evacuation of the schoolbus. A second fire extinguisher at the rear of the schoolbus was inaccessible because it was wedged in the collapsed portion of the rear of the schoolbus body. The steering wheel, dashboard, and instrument panel assemblies were intact. The right front boarding door and step well showed no damage. When tested, the door operated with difficulty due to misalignment of the door frame.

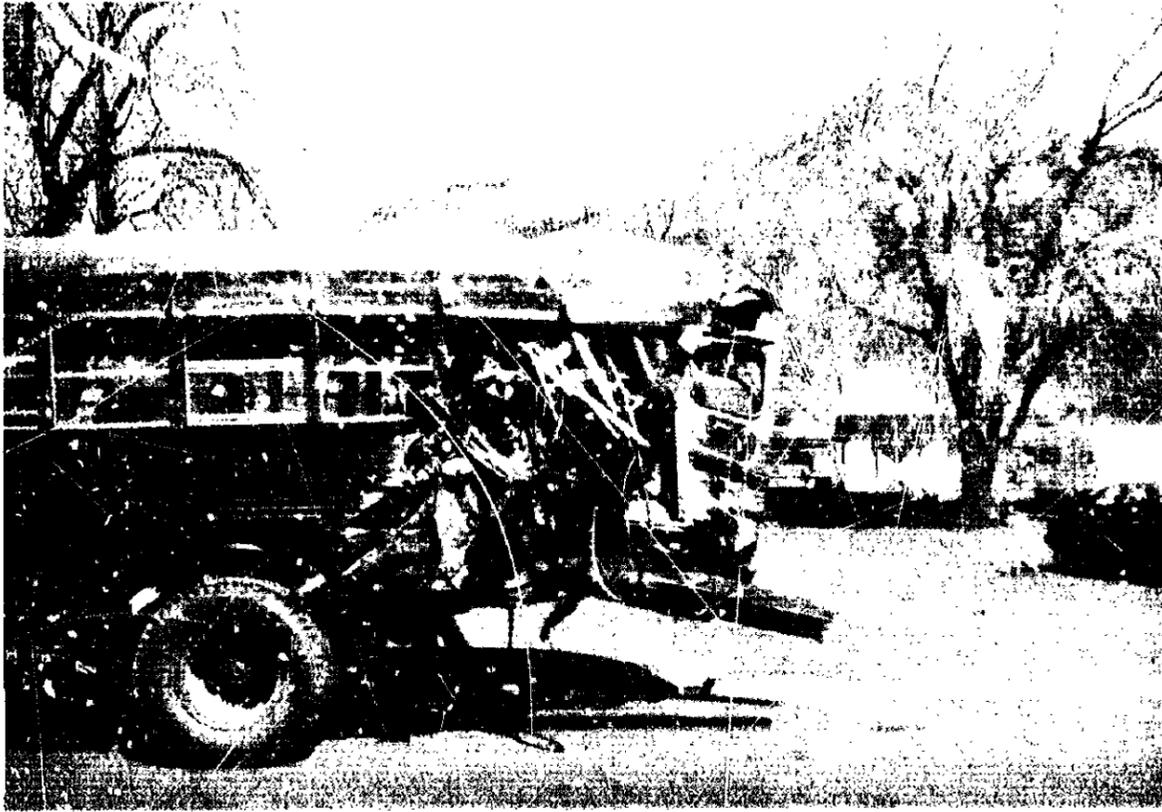


Figure 4.--Damage to left side of schoolbus.



Figure 5.--Damage to rear of schoolbus.

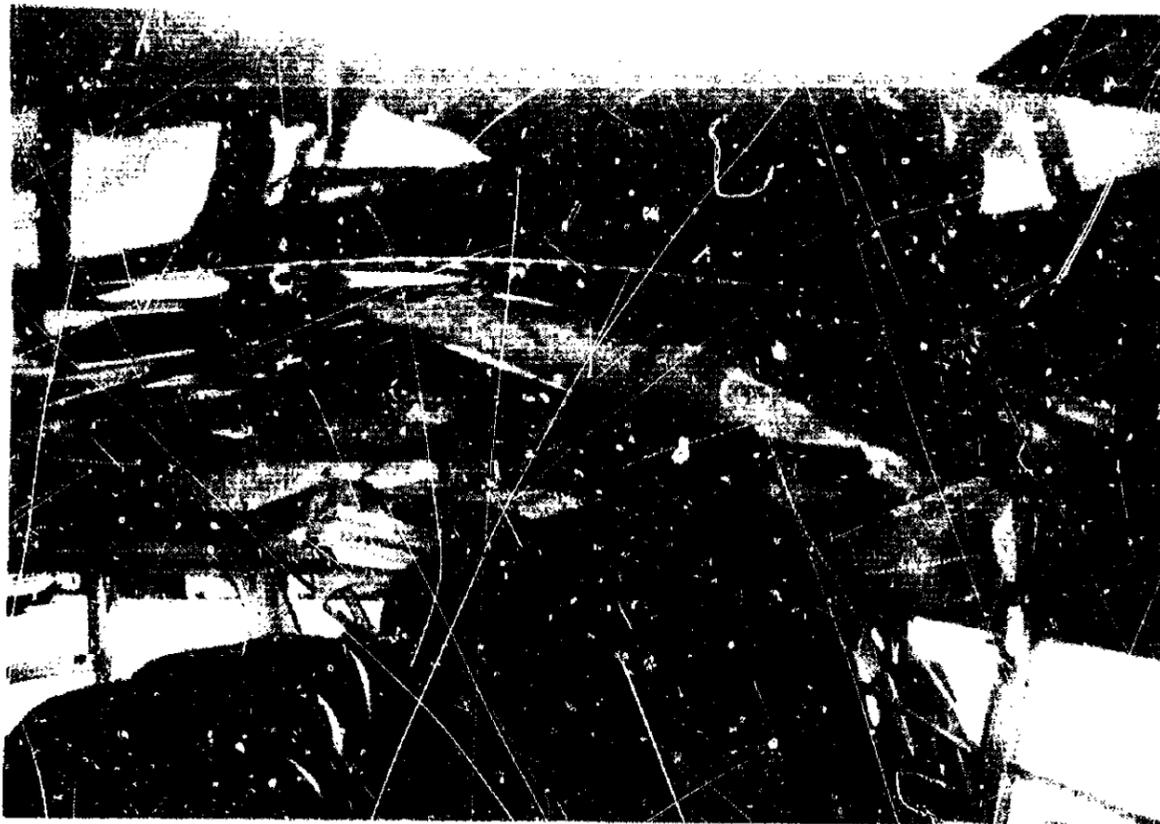


Figure 6.--Damage to interior of schoolbus.



Figure 7.--Separated maintenance access panel.

The schoolbus was equipped with 8-inch diameter lamps with red lenses on the front and rear in each upper corner of the schoolbus body and a stop arm on the left exterior sidewall near the driver's position. The schoolbus driver reported that when he checked the lights of the schoolbus on the morning of the accident they had all worked properly. According to a wiring diagram and information supplied by the schoolbus manufacturer, these lamps flash alternately and the stop arm swings forward to its extended position at a 90 degree angle to the left sidewall when a single switch is placed in the "on" position by the driver.

The hinged stop arm was found bent about 70 degrees forward of its fully closed position after the accident, and the side which faced rearward with the stop arm extended was abraded. The filament of the red lamp mounted at the upper right rear corner showed no distortion and was undamaged. The red lamp mounted at the upper left rear corner was extensively damaged. The bulb surrounding the filament was broken and the coiled portion of the filament was not recovered. The filament support posts and the small amount of straight sections of filament remaining attached to the posts were blackened.

The 3-axle 1983 cab-over-engine Freightliner truck tractor was operated in combination with a 2-axle 1984 Wilson double-deck livestock semitrailer. The empty weight of the tractor and semitrailer was 28,520 pounds. The estimated loaded gross weight at the time of the accident was 79,520 pounds. Both the tractor and the semitrailer were owned by Bell Creek, Inc.

According to the company safety director, the truck-tractor was governed to operate at a maximum speed of 62 mph. It was equipped with a diesel engine, 44.7-inch-diameter radial tires, a 13-speed manual transmission with a 3.73:1 ratio in 13th gear, and air-mechanical service brakes on all wheels. The ADPS reported that post-crash examination of the transmission indicated that it was in 12th gear at the time of the collision, which has a 1.16:1 gear ratio, and that a needle strike was found between the 2000 and 2150 rpm indicators on the face of the tachometer. The odometer on the tractor registered 149,445 miles.

The ADPS reported that the C-22 clamp-type brake chambers on the steering axle were inoperative before the accident, and that measurement of the pushrod stroke on the C-30 clamp-type brake chambers of the drive axles indicated that the brakes on these axles were properly adjusted. Inspection of the brake linings and drums on the front drive axle and the left rear drive wheel disclosed them to be in good working order with no contamination. The ADPS reported, however, that inspection of the right rear brake lining and drum disclosed oil contamination which probably existed before the accident. Inspection of the steering components disclosed no defects that may have existed before the accident.

Damage extended across the entire front of the truck tractor. The top of the cab was displaced about 4 feet rearward, and about 4 feet leftward. The right side of the cab and the right steering axle wheel were displaced 1 1/2 feet farther rearward than the same components on the left side of the vehicle. The top of the roof was crushed downward about two feet. (See figure 8.)

Measurement of the pushrod stroke of the C-30 clamp-type brake chambers on each wheel of the semitrailer indicated that they were properly adjusted and in good working order with no contamination of the linings or drums. Accident damage was confined to the front of the semitrailer. A large dent and a yellow paint transfer were noted at a point 11.6 feet high at the right front semitrailer corner. A dent also was noted at a point 9 feet high on the left front corner of the semitrailer. (See figure 9.)



Figure 8.-- Damage to truck-tractor.



Figure 9.-- Damage to semitrailer.

### Highway Information

The accident occurred on eastbound US 160 about 15.9 miles northeast of the intersection of U.S. 160 with State Route 264 in Tuba City, Arizona. At the accident site the highway is straight with two 12-foot-10-inch-wide asphalt driving lanes, a 3-foot-7-inch-wide eastbound asphalt shoulder, a 4-foot-1-inch-wide westbound asphalt shoulder, a 55 mph posted speed limit, and a slight downgrade in the eastbound direction.

Two parallel single-tire marks were found about 146 feet west of the final rest position of the front of the schoolbus. One tire mark was on the centerline and the other was about 8 feet to the right of the centerline. These tire marks were followed immediately by gouges and other tire marks leading to the final rest positions of the accident vehicles. (See figure 1.)

### Medical and Pathological Information

Although the Bell Creek truckdriver reported that the over-the-counter cough medicine he took the morning of April 28 seemed to correct the problem he had with coughing, ADPS investigators reported that the truckdriver was coughing during the interviews conducted on April 29 and 30. Tests performed on blood and urine samples collected from the truckdriver about 2 hours after the accident were negative for alcohol or other drugs, including those contained in the over-the-counter medicine the truckdriver stated he took the morning of April 28.

The two fatally injured students and three of the four seriously injured students were seated in the last four rows of seats. The fourth seriously injured student was seated in the second row window seat on the left before the collision. The fatally injured passengers sustained multiple fractures, massive internal injuries, and lacerations. One of the seriously injured passengers sustained a left renal contusion, and the others sustained multiple fractures, bruises, and abrasions. Four passengers sustained moderate injuries including humerus and clavicle fractures and an abdominal contusion. Minor injuries sustained by 18 students included sprains, contusions, bruises, and abrasions. (See figure 10.)

The schoolbus driver reported that he was wearing his seatbelt at the time of the collision. The truckdriver could not recall if he was wearing his seatbelt at the time of the collision.

### Motor Carrier Operations

Bell Creek, Inc. is a motor common carrier of livestock operating in the midwestern and western states from terminals in Arlington, Nebraska, and Garden City, Kansas. The accident truck was transporting 99 head of cattle from a ranch near Tonopah, Arizona, to Medicine Bow, Wyoming. The company pays its drivers by the mile, operates about 50 power units, employs 50 drivers, and experiences an annual driver turnover rate of 60%. Bell Creek assigns only one driver per power unit and does not conduct any "sleeper team" operations.

Bell Creek Inc. employs a full-time safety director, who is the only person in the organization assigned the responsibility for ensuring the company's compliance with Federal safety regulations. His duties include screening applications submitted by driver applicants, administering road tests to determine the applicants' familiarity with Bell Creek's equipment, maintaining driver qualifications files in accordance with Department of Transportation requirements, and conducting meetings with one or more drivers as

LEGEND

AIS+ SEVERITY CODE

- AIS-0 NO INJURY
- AIS-1 MINOR
- AIS-2 MODERATE
- AIS-3 SERIOUS
- AIS-4 SEVERE
- AIS-5 CRITICAL
- AIS-6 USUALLY FATAL

M-10; AIS-X

SEX AGE SEVERITY  
 \*AMERICAN ASSOCIATION FOR  
 AUTOMOTIVE MEDICINE:  
 ABBREVIATED INJURY SCALE.

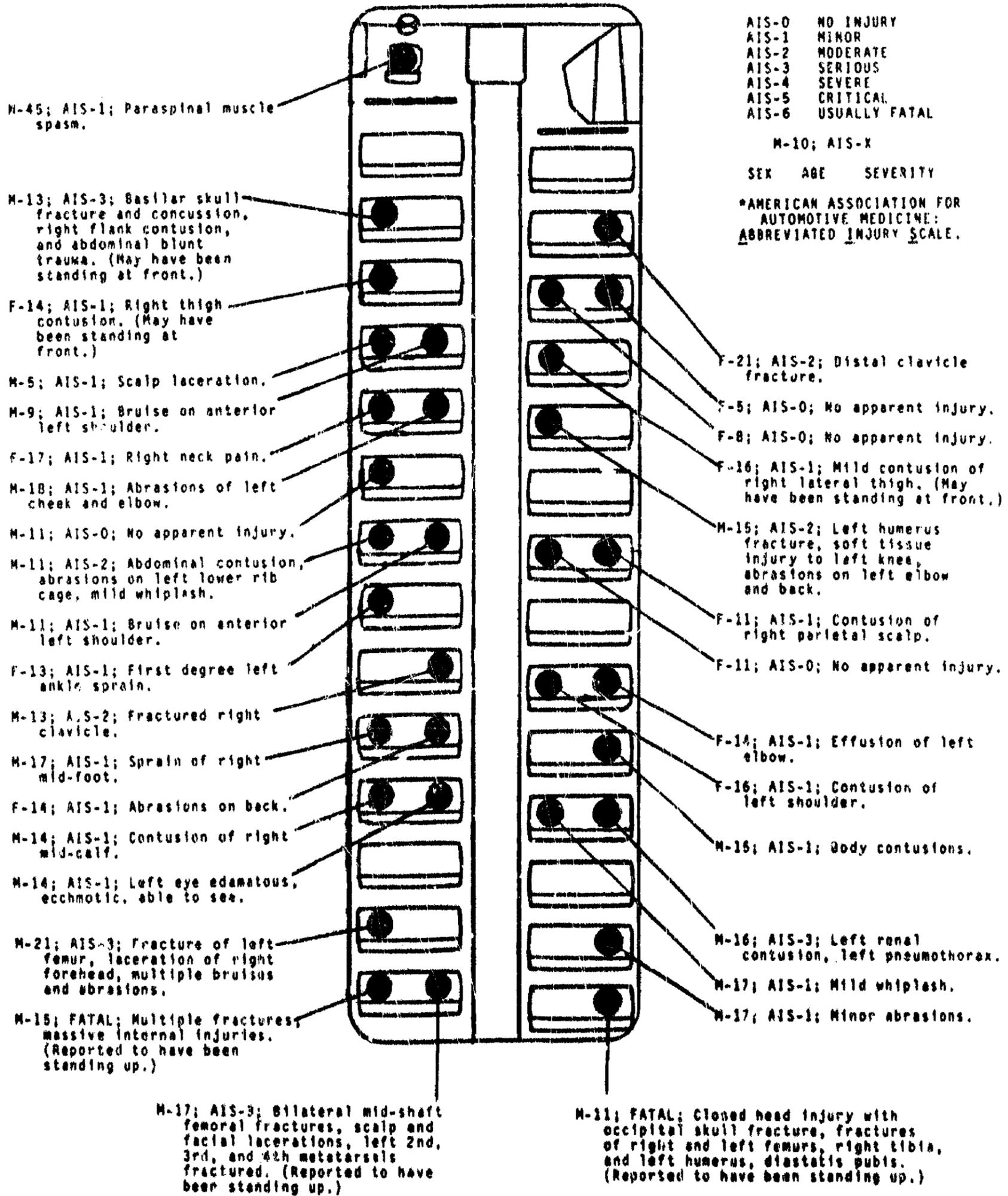


Figure 10.--Schoolbus occupant seating and injury chart.

needed. Large group safety meetings are held with the drivers about two or three times a year. However, both the accident truckdriver and the safety director stated that there had been no meetings held with one or more truckdrivers to discuss compliance with Federal hours of service regulations.

Drivers are hired as needed from a pool of experienced applicants who have submitted a preliminary application containing physical and personal information. When a vacancy arises, an applicant is called in and given a driving test to determine his familiarity with company vehicles. Drivers are paid 20 cents for each loaded mile driven and 12 cents for each empty mile driven. In addition, drivers are paid not more than 10 dollars each time they load livestock. New drivers generally are dispatched to travel in convoy with more experienced drivers to gain experience in loading and unloading livestock. During three of the four one-week pay periods ending April 7, 1985, the gross pay of the accident truckdriver exceeded the average gross pay earned by the other drivers assigned to the carrier's Arlington, Nebraska, terminal. <sup>1/</sup>

Since the market value of livestock is determined by weight, shipments of livestock need to be transported by the fastest practical means to minimize weight loss. The livestock need to be checked periodically en route to ensure that none are hurt or have fallen down, and should be unloaded and watered after a maximum of about 36 hours of travel.

Bell Creek, Inc. is subject to the requirements of the Federal Motor Carrier Safety Regulations (FMCSR) of the U.S. Department of Transportation contained in Title 49, Code of Federal Regulations, Parts 390 to 397. Section 395.3(b) of these regulations prohibits a driver from remaining on duty more than 70 hours in any 8 consecutive day period. Section 395.8(a) prohibits a driver from driving more than 10 hours since his last 8 consecutive hours off duty, and prohibits a driver from driving after having been on duty (which includes both driving and on duty - not driving) more than 15 hours since his last 8 consecutive hours off duty.

On October 28, 1976, the Nebraska Motor Carrier Safety Office of the Department of Transportation's Federal Highway Administration (FHWA) completed a safety management audit to determine Bell Creek's compliance with the requirements of the FMCSR. This safety audit disclosed that, in addition to record-keeping violations relating to the driver qualification files, Bell Creek, Inc. had on more than 80 occasions required or permitted its drivers to remain on duty more than 70 hours in 8 consecutive days during the 3 months prior to completion of the audit.

As a result of the 1976 audit the FHWA in 1977 sent a civil forfeiture claim letter to Bell Creek claiming \$5000 for the recordkeeping violations pertaining to the driver qualification files. At the time of the 1977 enforcement action the Federal statute which authorized the assessment of civil penalties for violations of the FMCSR [49 U.S.C. 320 h)] applied only to those violations pertaining to preparation, forwarding, and/or retention of required records, such as the required retention of Bell Creek's driver qualification files. The statute did not provide for the assessment of civil penalties for so-called "operational" violations, such as excessive drivers' hours of service. At that time, in order to have prosecuted violations of the hours of service regulations disclosed by the 1976 audit, the Department of Transportation would have had to forward evidence documenting the hours of service violations to the U.S. Department of Justice, which, in

<sup>1/</sup> In one of those pay periods his gross pay was one standard deviation above that of the average driver's pay. Standard deviation is a statistical measure that indicates the extent which a parameter varies around an average.

turn, would have had to institute criminal proceedings in the U.S. Courts. This procedure was not pursued, and Bell Creek, Inc. was not assessed any penalty for the hours of service violations disclosed by the 1976 audit.

The enactment of the Motor Carrier Safety Act of 1984 (Sec. 213(b), Public Law 98-554, 98 STAT. 2842, October 30, 1984) expanded the types of enforcement options available to the Department of Transportation for assessing penalties for violations of the FMCSR. The 1984 Act authorizes the collection of civil penalties for all types of violations of the regulations. [See revision to 49 U.S.C. 521(b).]

On September 2, 1977, the carrier executed a settlement agreement with the FHWA in which the carrier offered \$3000 in full compromise and settlement of the claim. This offer was accepted and the settlement agreement was signed by the FHWA on September 12, 1977. There was no follow-up audit performed to determine if Bell Creek had corrected the violations noted during the 1976 audit, and there were no other audits performed after 1976 to the date of the accident.

On June 13, 1985, a safety management audit of Bell Creek operations during the preceding 2 months by the Nebraska FHWA Motor Carrier Safety Office disclosed 1 instance of using a physically unqualified (colorblind) driver, 5 instances of failing to report an accident, 5 instances of requiring or permitting a driver to drive more than 10 hours, 5 instances of requiring or permitting a driver to remain on duty more than 70 hours in 8 consecutive days, and 51 instances of requiring or permitting a driver to make false entry on a record of duty status (daily log).

The FHWA motor carrier safety investigator who performed the audit reported that the falsifications were found, for the most part, by comparing duty status records with other documents, such as port of entry receipts, which were filed with the duty status records in the office of Bell Creek's safety director. In the investigator's opinion, the safety director either did not know of the discrepancies, or knew of them and took no action to correct them.

On September 3, 1985, the FHWA sent a civil forfeiture claim letter to Bell Creek, Inc., citing the carrier for 15 instances of requiring or permitting a driver to make false entry on a record of duty status, and claiming \$6000 for the violations. Bell Creek, Inc. paid the \$6000 on September 20, 1985.

#### Federal Motor Vehicle Safety Standards

The schoolbus involved in this accident was manufactured after April 1, 1977 and therefore was required to meet several Federal Motor Vehicle Safety Standards (FMVSS) including two relating to schoolbus body joint strength and schoolbus passenger seating and crash protection. FMVSS 221, Schoolbus Body Joint Strength, requires that an inside or outside body panel of a schoolbus be fastened so that it is capable of holding the body panel to the member to which it is joined when subjected to a force of 80 percent of the tensile strength of the weakest joined body panel. The purpose of this standard is to reduce deaths and injuries resulting from the structural collapse of schoolbus bodies during crashes. However, this standard does not apply to maintenance access panels. (See Appendix C.)

FMVSS 222, School Bus Passenger Seating and Crash Protection, establishes occupant protection requirements for seats and restraining barriers for schoolbuses. The purpose of this standard is to reduce the number of deaths and injuries resulting from the

impact of schoolbus occupants against structures within the vehicle during crashes and sudden driving maneuvers. FMVSS 222 provides for occupant crash protection through the use of strengthened, closely spaced, and padded seatbacks and padded restraining barriers installed in front of the first row of seats in large schoolbuses.

#### Tests and Research

Safety Board investigators performed tests at the accident site to determine the frictional coefficient of the roadway surface. By test-skidding a passenger car at 30 to 35 mph, investigators obtained a dry frictional coefficient of 0.88. This value was adjusted to between 0.62 and 0.63 for the schoolbus, and to about 0.48 for the truck.

Three days after the accident Safety Board investigators followed a substitute schoolbus in another vehicle as it drove over the accident route at the same time of day the accident occurred and in similar weather conditions. As the schoolbus approached the accident site, it was clearly visible to a following vehicle for a distance of up to 1.4 miles. The sun was to the left and rear of the driver, and the bus and its warning lights were not "masked" by objects in the background. (See figure 11.)

Safety Board investigators, using the information obtained from the documents found during the post-crash examination of the Bell Creek vehicle, the Bell Creek truckdriver's statements and hours of service record he prepared, and information supplied by Bell Creek, Inc., determined that the Bell Creek truckdriver drove a total of about 4,240 miles during the 8 consecutive days before the time of the accident. (See Appendix B.)

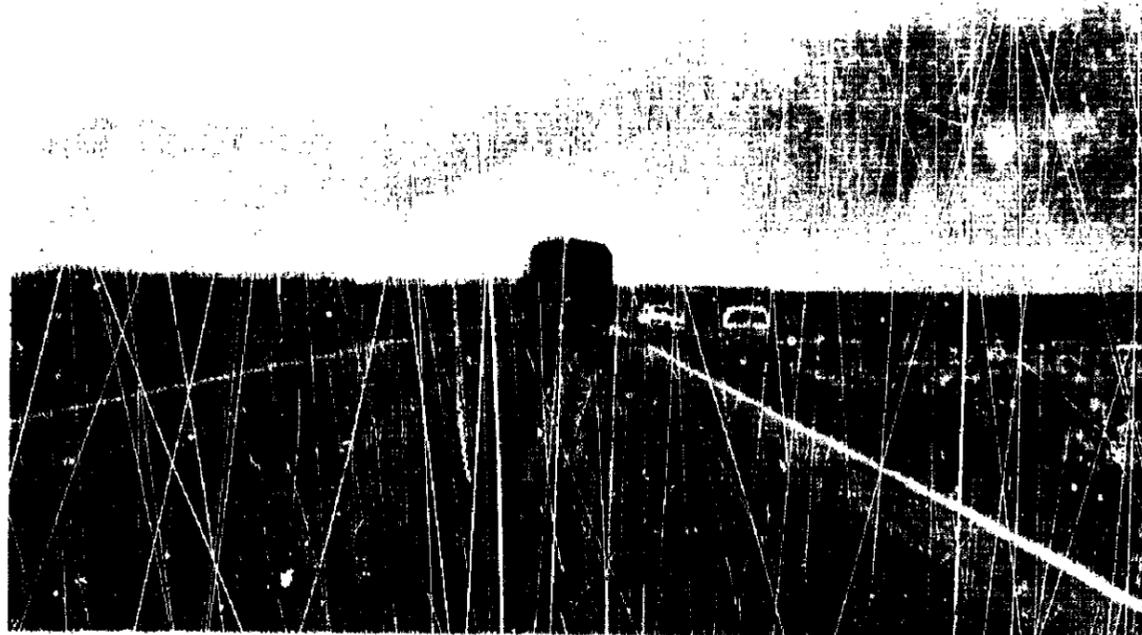


Figure 11.—View of rear of substitute schoolbus at accident site.

## ANALYSIS

### The Accident

The qualifications of the drivers, the weather, the highway, and the mechanical condition of the vehicles were not contributing factors in this accident. Both drivers were experienced in driving their vehicles and held valid licenses. The truckdriver had been medically examined and found to be physically qualified to operate commercial vehicles in interstate commerce in June 1984.

The weather was clear at the time of the accident. Tests indicated that the position of the sun was not a factor and that the schoolbus was clearly visible to a vehicle approaching from the rear for a distance of about 1.4 miles. Although the brakes on the Bell Creek tractor's steering axle probably were inoperative and the right rear brake probably was contaminated with oil before the collision and therefore would have been less effective in stopping the vehicle, there is no evidence to indicate that the truckdriver attempted to use his brakes to stop or slow his vehicle before the collision.

The Safety Board believes that the single-tire marks which were the first eastbound pavement marks attributed to this accident are overload marks made by the Bell Creek tractor's steering axle tires when the truck collided with the schoolbus.

The location of these overload marks indicates that at the point of the collision the left steering axle tire was on the centerline of the highway. The tire transfer on the rear bumper of the schoolbus about 8 inches from the far right was made by the right steering axle tire of the Bell Creek tractor and indicates that the centerline of the rear of the schoolbus was about 8 inches to the right of the centerline of the truck tractor, and that the rear of the schoolbus was slightly to the left of the center of the traffic lane at the point where the vehicles collided. The yellow paint transfer located on the right front of the semitrailer 1.9 feet higher than the pre-accident height of the schoolbus and the fact that the roof of the truck-tractor was forced down by the collision confirms the witnesses' statements that the rear of the schoolbus was lifted up by the collision. (See figure 12.)

Based upon the damage pattern to the vehicles, with the greatest deformation to the Bell Creek tractor on its right side, and the greatest deformation to the schoolbus on its left side, and the fact that the bus rotated clockwise 155 degrees after impact, the Safety Board believes that, at the time of impact, the Bell Creek vehicle struck the rear of the schoolbus at an angle to the left. The Safety Board believes that this angle is attributable to a left steering maneuver begun immediately before the collision.

Trucks often run the highway with their right tires on or near the edgeline. In a study <sup>2/</sup> on transverse displacements of trucks on rural freeways. It was found that the average distance from the edge of the travel lane to the outside of the wheel was 1.31 feet. Assuming the truck was on the edgeline on this rural road and that the driver steered hard left to avoid impact, it can be calculated that the angle at impact would have been about 4.6 degrees and the driver reacted about 124 feet or 1.5 seconds before impact. If the driver was 1.3 feet from the edgeline, the angle at impact would have changed to about 3.9 degrees and the driver would have reacted about 108 feet or 1.3 seconds before impact. The Safety Board believes that the truckdriver became aware of the schoolbus ahead in his traffic lane at about 1.3 to 1.5 seconds before the collision.

<sup>2/</sup> Donald K. Emery, Jr., Georgia Department of Transportation, A Preliminary Report on the Transverse Lane Displacement for Design Trucks on Rural Freeways, (Presented to the A.S.C.E. Pavement Design Specialty Conference, Atlanta, Georgia, June 1-3, 1975).

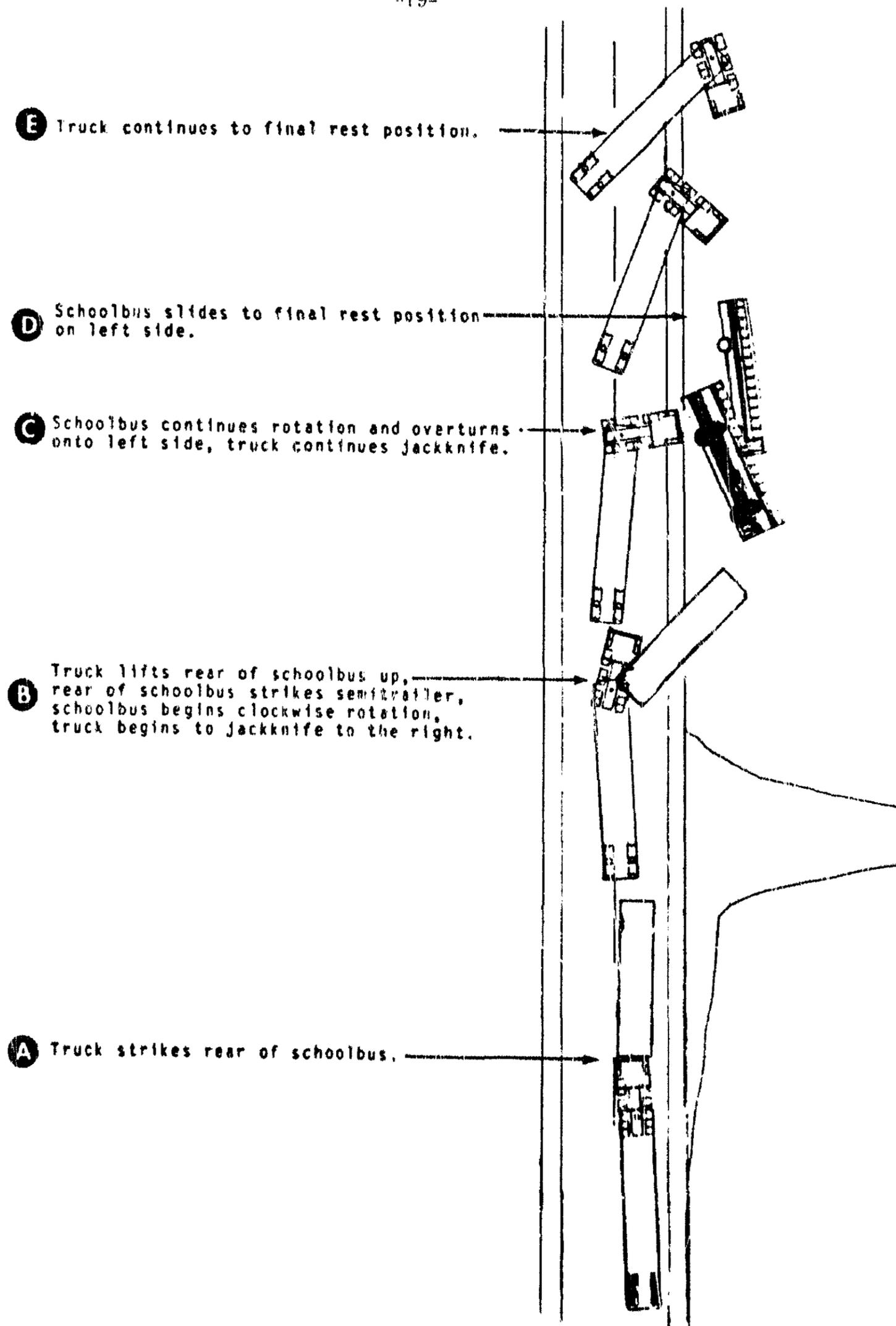


Figure 12.-- Accident sequence.

The location of the tire overload marks, given the overall length of the schoolbus, also shows that at the time of the collision the right front entrance door of the schoolbus was adjacent to the driveway where the schoolbus driver was to unload several of his passengers. The schoolbus therefore was positioned to unload passengers and probably was not moving. The rearward displacement of the left side of the right front restraining barrier is attributed to contact with this barrier by one or more of the passengers who were preparing to exit the schoolbus when the collision occurred. These occupants were apparently standing in or immediately adjacent to the entrance/exit stairwell and were thrown into the padded restraining barrier by the force of the collision. Based upon this evidence and the statements of the westbound witnesses and the schoolbus driver, the Safety Board believes that the schoolbus was stopped at the time of the collision.

Westbound witnesses who were approaching the accident site stated they could see flashing lamps on the front of the schoolbus before the collision. It was also determined that all of the lamps and the stop arm were controlled by operating a single switch. The schoolbus driver stated that all his lamps were working when he checked them the morning of the accident. The blackened condition of the filament support posts of the red lamp mounted at the upper left rear corner of the schoolbus body indicates that the tungsten filament in the bulb was exposed to oxygen while it was at an incandescent temperature, which indicates that the bulb was illuminated. The bending of the stop arm forward from its normal position and the abrasion of the side which normally faced rearward was caused by contact of this side of the stop arm with the ground after the schoolbus had rotated and turned over onto its left side, after which it slid 18 feet. If the stop arm had not been extended, it would not have been bent forward and the abraded side would have been folded back against the schoolbus body where it would have been protected against such abrasion. Based upon this evidence, the Safety Board believes that the warning lights on the schoolbus were flashing and the stop arm was extended at the time of the collision.

The truckdriver stated that before the collision his vehicle's speedometer was indicating a speed between 50 and 55 mph, and that he was in 13th gear with his engine turning at 1700 rpm. Data supplied by the tractor's manufacturer and calculations made by Safety Board investigators showed that when operating in the highest gear at 1700 rpm, given a 44.7-inch-diameter tire size and a 3.73:1 transmission gear ratio, the tractor would be traveling about 55 mph. The ADPS reported that the transmission was found to be in 12th gear after the accident, and that a needle strike was found on the face of the tachometer between the 2100 and 2150 rpm indicators. In 12th gear at 2100 rpm the vehicle's speed would have been 58.1 mph, and at 2150 rpm the vehicle's speed would have been 59.5 mph.

Tire and gouge marks at the scene indicated that the schoolbus traveled upright about 136 feet after impact, and slid an additional 18 feet on its side after it overturned. Evidence also indicated that the truck traveled 261 feet after the collision. Considering the placement of the vehicles in relation to each other at the time of the collision, this evidence also indicates that the rear of the schoolbus and the front of the truck-tractor remained together for a distance of between 44 and 130 feet. Using the friction coefficient of the roadway and the shoulder, the distance the schoolbus traveled after impact, and assuming that the schoolbus was stopped at the time of the collision, it was calculated that the schoolbus was accelerated to a maximum of 44 mph after it was struck by the truck. This maximum speed would have occurred immediately after the collision at the point of maximum engagement of the two vehicles, at which point both vehicles would have been traveling at the same speed.

Based upon these data, and by using the equation for the conservation of linear momentum, Safety Board investigators calculated that the truck was traveling about 57.4 mph at the time of the collision with a possible error of plus or minus 5.7 mph. The evidence indicates and the Safety Board believes that the truck was traveling about 59 mph at the time of the collision.

The evidence indicates that the truckdriver did not apply his brakes before the collision. At a speed of 59 mph, given the visibility at the accident scene, the truckdriver should have had ample opportunity to stop his vehicle before it struck the schoolbus if he had been alert and had perceived the stopped schoolbus in time to avoid the collision.

On May 15, the truckdriver told Safety Board investigators that he might have been distracted immediately before the collision when he reached down and picked up two cans of soft drink wrapped in a shirt, which he noticed were falling off the engine cover. This statement conflicts with his statement to ADPS investigators on April 30, in which the truckdriver said that he remembered throwing two cans of soft drink into the sleeper berth some time before the collision. Given the 1.4 mile sight distance and the fact the the first Bell Creek driver had radioed back advising the presence of the schoolbus, the Safety Board does not believe that an occurrence such as the truckdriver described would have been sufficient to distract him from observing the schoolbus.

#### Driver Alertness and Fatigue

Fatigue can be of two types, chronic or acute. Chronic fatigue results from extended periods of work over a span of several days or weeks, or from long periods of sleep deprivation. Acute fatigue occurs in a relatively short timeframe and can arise from any significant shortening in a person's usual sleep cycle, from physical exertion, stress, or long work hours.

The adverse effects of fatigue on human performance have been well documented. In 1978 the Bureau of Motor Carrier Safety (BMCS) published a study that examined the relationships among driver hours of service, irregularity of schedules, and driver performance. <sup>3/</sup> The study concluded that:

Fatigue effects are evident after about 8 hours of relay truck driving when the schedule is regular and considerably earlier than that when the schedule is irregular.

Participation in moderately heavy cargo loading to the extent engaged in by many relay truck drivers increases the severity of fatigue associated with irregular working schedules.

Cumulative fatigue effects are likely to be reflected in the driver's physiological state and in his performance after 5 consecutive days of operations even though the driver does not sense the progressive fatigue.

Significant increases in driver performance errors and decreases in psychophysiological arousal occur within current DOT limitations on driving time.

<sup>3/</sup> Mackie, R. R. and Miller, J. C. "Effects of Hours of Service, Regularity of Schedules, and Cargo Loading on Truck and Bus Driver Fatigue." (Technical Report 1765-F). Goleta, CA: Human Factors Research, Inc., 1978.

The truckdriver's type of irregular sleep and work patterns has been the object of medical and physiological research. Such research has demonstrated that many functions of the human body are maintained on daily cycles which are known as circadian rhythms. These include sleep-wake patterns, urinary excretion, and body temperature. One study <sup>4/</sup> demonstrated that the quantity and quality of sleep is degraded and performance is impaired as a result of working at night. These changes are primarily caused by the disharmony between the night worker's schedule and the underlying circadian rhythms of the body. The body is programmed to be awake and active by day and asleep and inactive by night, and it is extremely difficult to adjust this program to accommodate artificial phase shifts in the sleep-wake cycle. 4/

In relationship to the type of schedule that the truckdriver maintained, with its irregular pattern of driving by going off duty and then driving again at odd, irregular intervals, this research implies that the truckdriver, even when he attempted to sleep, faced difficulty because of this disharmony with his circadian rhythm. This resulted in additional sleep loss and even greater fatigue.

Driver inattention and fatigue have been identified as recurring factors in several commercial vehicle accidents investigated by the Safety Board and have resulted in numerous injuries and fatalities. In an accident in Livingston, Texas, on November 30, 1983, six persons were killed and six persons were injured when an intercity bus struck the rear of a tractor-semitrailer. As a result of the Livingston accident, the Safety Board issued Safety Recommendation II-84-60 to the FHWA on August 8, 1984, to:

Determine practical methods and means to prevent or minimize dozing at the wheel by drivers of carriers in interstate commerce, and advise the Safety Board of its findings. 5/

In its September 25, 1984, response to this recommendation, the FHWA agreed to undertake a research study on the problem of driver fatigue. The FHWA had not done so by the time the Safety Board had concluded its investigation of two additional accidents involving driver inattention and fatigue.

As a result of its investigation of an intercity bus rearend collision into a tractor-semitrailer on July 18, 1984, near Cheyenne, Wyoming, and a tractor-semitrailer rearend collision into a schoolbus on October 13, 1984, near Junction City, Arkansas, the Safety Board concluded that:

Fatigue had suppressed the vigilance of the drivers ... to a virtually ineffective level. In the few minutes preceding each collision, the drivers apparently were still capable of performing the minimal tracking tasks required to keep their vehicles on the road and in the proper lane. The truckdriver in the Junction City accident apparently was visually sensing his environment without being able to perceive a threat before the collision. The busdriver in the Cheyenne accident probably was

4/ Tilley, A. J., Wilkinson, R. T., Warren, P. S. G., Watson, B., and Drud, M. "The Sleep Performance of Shift Workers." Human Factors, 24:638, 1982.

5/ Highway Accident Report--"Trailways Lines, Inc., Bus/ E. A. Holder, Inc., Truck, Rear End Collision and Bus Run-Off-Bridge, U.S. Route 59, Near Livingston, Texas, November 30, 1983." (NTSB/HAR-84/04)

asleep when he collided with the rear of the truck ... In both accidents, the employing motor carriers failed to monitor their drivers sufficiently to prevent their operating a vehicle while fatigued. 6/

As a result of its investigation of the Cheyenne and Junction City accidents, the Safety Board on September 10, 1985, reiterated Recommendation H-84-69 to the FHWA, and submitted Recommendation H-85-19 to the American Bus Association (ABA) and the American Trucking Associations, Inc. (ATA):

Inform your membership of the circumstances of the accidents of July 18, 1984, near Cheyenne, Wyoming, and of October 19, 1984, near Junction City, Arkansas, and urge your members to review their internal policies and procedures for determining the hours of service for full-time and part-time drivers to ensure that drivers do not operate vehicles while fatigued.

Because of the recency of this recommendation, the ABA and the ATA have not yet responded.

The Bell Creek truckdriver, at the time of the accident, was in violation of the Federal 70-hour, 8-day rule in that he had been on duty 88 1/4 hours during the 8 consecutive day period prior to the accident. He also drove in violation of the 10- or 15-hour rules, or both, on April 23, 25, 26, 27, and 28. He also was suffering from a cough which he stated had disturbed his sleep and which therefore resulted in further rest deprivation. ADPS investigators reported that the truckdriver was still exhibiting this cough during post-accident interviews. Moreover, the driver's diet in the period before the accident may have exacerbated his fatigued state. His consuming three bottles of beer the night before the accident may have hampered the quality of the sleep he was able to acquire that night. His consumption of a large quantity of sweets several hours before the accident, with the resultant initial elevation of the body sugar level, may have in turn led to a rapid depletion of body sugar level, known as hypoglycemia, resulting in even further fatigue. Thus, the combination of driver activities as well as diet all contributed, to some extent, to his already fatigued state.

The Safety Board believes that the truckdriver was experiencing chronic fatigue at the time of the accident due to a combination of excessive on-duty time during the 8 days preceding the accident, and the disruption of circadian rhythm due to a prolonged irregular duty pattern (see Appendix B). These factors resulted in a reduced level of alertness and reaction time which, despite the fact that the truckdriver had been informed that the schoolbus was ahead, resulted in his failure to recognize that he was overtaking the schoolbus in time to take action to avoid the collision.

#### Motor Carrier Operations

The fact that the truckdriver was found in possession of duty status records showing he was off duty on April 27 and 28 when in fact he had been on duty and driving leads the Safety Board to believe that this driver was falsifying his records of duty status to

6/ Highway Accident Report--"Fatigue-Related Commercial Vehicle Accidents: Cheyenne, Wyoming, July 18, 1984, and Junction City, Arkansas, October 19, 1984." (NTSB/HAR-85/04).

conceal hours of service in excess of those permitted by Federal regulations. The results of the June 1985 FHWA audit of the motor carrier's operations also disclosed that Bell Creek, Inc. was requiring or permitting drivers to falsify records of duty status. There is no evidence that the carrier conducted internal safety audits or analyses that included examination of drivers' duty status records for accuracy and compliance with applicable federal regulations relating to maximum driver's hours of service. The facts of this accident and the results of the June 1985 FHWA audit indicate, and the Safety Board believes, that Bell Creek was not properly monitoring its drivers' activities to prevent duty status record falsification to conceal excess hours of service by its drivers, and that the lack of such internal audits and controls on drivers' hours of service contributed to this accident.

The Safety Board believes that the method of driver compensation used by Bell Creek in fact encouraged the truckdriver, from an economic standpoint, to exceed the maximum hours of service permitted by Federal regulation. The driver received a salary that was directly related to the number of miles he had driven during the day period. The more miles the truckdriver drove, the more he was paid. The "per mile" method of compensation is widely used by the trucking industry, and the Safety Board is concerned that motor carriers who use this method of driver compensation may not adequately monitor their drivers' activities to ensure compliance with Federal regulations which limit their drivers' hours of service.

#### Federal Oversight of Motor Carrier Operations

Since the 1970s, various governmental investigative groups including the Safety Board have criticized the BMCS program for monitoring the safety of interstate motor carriers. <sup>7/</sup> Of all the problems confronting the BMCS, the greatest problem is sufficient manpower to ensure that the growing interstate motor carrier population complies with the FMCSR. A General Accounting Office report to a House Subcommittee of the Government Activities and Transportation Committee on Government Operations in July 1984 stated that the fiscal year 1984 Motor Carrier Safety field staff numbered 191, of which 94 were investigators who were responsible for performing safety audits of the over 200,000 interstate motor carriers. Accordingly, the ratio of investigators to carriers is 1 to 1,047; as to those investigators who conduct safety audits, the ratio is 1 to 2,128. Since an investigator can reasonably be expected to audit only about 50 to 60 motor carrier's per year, the BMCS has been urged repeatedly over the years to develop selection criteria for deciding which motor carriers to audit.

<sup>7/</sup> See U.S. General Accounting Office, "Need for Improved Inspection and Enforcement in Regulating Transportation of Hazardous Materials" (B-164497, May 1, 1973); "The Federal Motor Carrier Safety Program: Not Yet Achieving What the Congress Wanted" (CED-77-62, May 16, 1977); "Programs for Ensuring the Safe Transportation of Hazardous Materials Need Improving" (CED-81-5, November 4, 1980); U.S. Department of Transportation, Office of Inspector General, "Special Study of Bureau of Motor Carrier Safety, Federal Highway Administration" (September 28, 1979); National Highway Safety Advisory Committee, "Task Force Report on Commercial Vehicle Maintenance and Safety Inspection Programs" (June 15, 1979); Colin, S. Diver, "A Study of the Effectiveness and Fairness of DOT Hazardous Materials Enforcement Penalties" (June 1980); Congressional Research Service, Library of Congress, "Hazardous Materials Transportation: A Review and Analysis of the Department of Transportation's Regulatory Program" (April 1979).

The BMCS has made progress in developing criteria for selecting motor carriers for safety audits. The criteria developed by the BMCS have in the past several years included identifiers such as type of cargo transported, date of the most recent audit, a carrier's safety rating, vehicle inspection record, etc. These identifiers are assigned point values. A total point value for each carrier is then compiled and, by using the BMCS automated Management Informative System, lists which rank carriers in order by total point value are distributed to the Motor Carrier Safety field offices for their use in setting priorities for scheduling safety audits. 8/

There was no follow-up audit of Bell Creek's operations after the 1976 audit and the 1977 enforcement action by the FHWA Motor Carrier Safety field staff. It is therefore unknown whether the violations noted during the 1976 audit went uncorrected, or if they were corrected and then over time the carrier's compliance with Federal safety regulations again deteriorated. The audit selection criteria used by BMCS thus far in the past several fiscal years have not included a criterion requiring a follow-up audit of carriers who have been the subject of an enforcement action, and at the present time there is no nationwide policy requiring that motor carriers against whom an enforcement action has been taken be systematically re-audited after the conclusion of an enforcement action. The Safety Board believes that the BMCS should institute such a policy, and include this criterion as one of those to be used in selecting carriers for audit, in order to ensure the effectiveness of enforcement actions taken.

### Survival Factors

The two schoolbus passengers who sustained fatal injuries were occupying the left rear window seat and the right rear seat. The amount of crush damage in these areas did not provide survivable space. Three of the four schoolbus occupants who sustained serious injuries were also occupying the last four rows of the schoolbus where the crash forces were the greatest. The 21-year-old male occupant of the left window seat in the 13th row probably sustained his head laceration when he contacted the edge of the body panel joint which was exposed due to the joint separation of the adjacent maintenance access panel. The remaining passenger who sustained serious injuries was occupying the seat in the second row behind the schoolbus driver before the collision. This passenger was about to exit the schoolbus at the stop where the collision occurred and sustained his basilar skull fracture because he probably was standing up in the aisle and was thrown backward by the force of the collision, striking his head on some object inside the schoolbus when the collision occurred.

### Federal Motor Vehicle Safety Standard 221

On November 27, 1981, the National Highway Traffic Safety Administration (NHTSA) issued a notice of proposed rulemaking in the Federal Register which requested public comment on a proposal to amend FMVSS 221 to require that most maintenance access panels in large schoolbuses comply with the joint strength requirements of that standard. The notice stated that NHTSA had become concerned that schoolbus manufacturers were circumventing FMVSS 221 to a limited extent by the excessive use of maintenance access panels, and that most manufacturers had created maintenance access panels that were located above the window area and which extended the entire length of

8/ For additional information, see Highway Accident Report, "Collision of DeQueen, Arkansas, Police Department Patrol Car and Terrell Trucking, Inc. Tractor-Semitrailer, U.S. Route 71, Ashdown, Arkansas, July 15, 1984." (NTSB/HAR-84-07).

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

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

On July 2, 1984, NHTSA terminated the rulemaking action, but urged the schoolbus manufacturing industry to minimize the number of maintenance access panels.

No separations of the exterior or interior body panel joints which were subject to the joint strength requirement of FMVSS 221 were noted during the post-crash examination of the schoolbus. The Safety Board concludes that the schoolbus body demonstrated the crashworthiness required by FMVSS 221, Schoolbus Body Joint Strength.

The Safety Board believes, however, that the separations of the rear maintenance access panels from the adjacent interior body panels created a hazard to the occupants of the schoolbus at the rear because the edges of these maintenance access panels and the other body panels to which they had been joined were exposed. As occurred in this accident, contact of schoolbus occupants with exposed metal edges of body or maintenance access panels during collisions and overturns can result in severe disfiguring and sometimes life-threatening injuries.

On December 11, 1984, a 1979 International Harvester schoolbus lost control, ran off the roadway, and overturned two miles south of Durango, Colorado.<sup>9/</sup> On September 11, 1985, a 1985 Blue Bird schoolbus was struck broadside by a tractor semitrailer in Woodside, Delaware.<sup>10/</sup> In both these accidents, Safety Board investigators noted interior maintenance access panel separations. In these two cases, none of the injuries sustained by the schoolbus occupants were attributed to contact with the metal edges exposed due to the maintenance access panel joint separations. (See figure 13.)

Nevertheless, the Safety Board believes that these three investigations of accidents involving post-1977 schoolbuses, which disclosed maintenance access panel separations, indicate that FMVSS 221 pertaining to interior maintenance access panels of future schoolbuses should be revised. If the panels are located within defined occupant contactable zones, they should be subject to the same joint strength requirements as the other body panels.

#### Lapbelt Use and Federal Motor Vehicle Safety Standards

Since 1977, when new schoolbus safety standards relating to occupant protection were promulgated, NHTSA has required schoolbus manufacturers to use compartmentalization for occupant protection rather than the installation and use of lap

<sup>9/</sup> NTSB Docket No. DEN 85-H-SB08.

<sup>10/</sup> NTSB Docket No. HY-476-85.

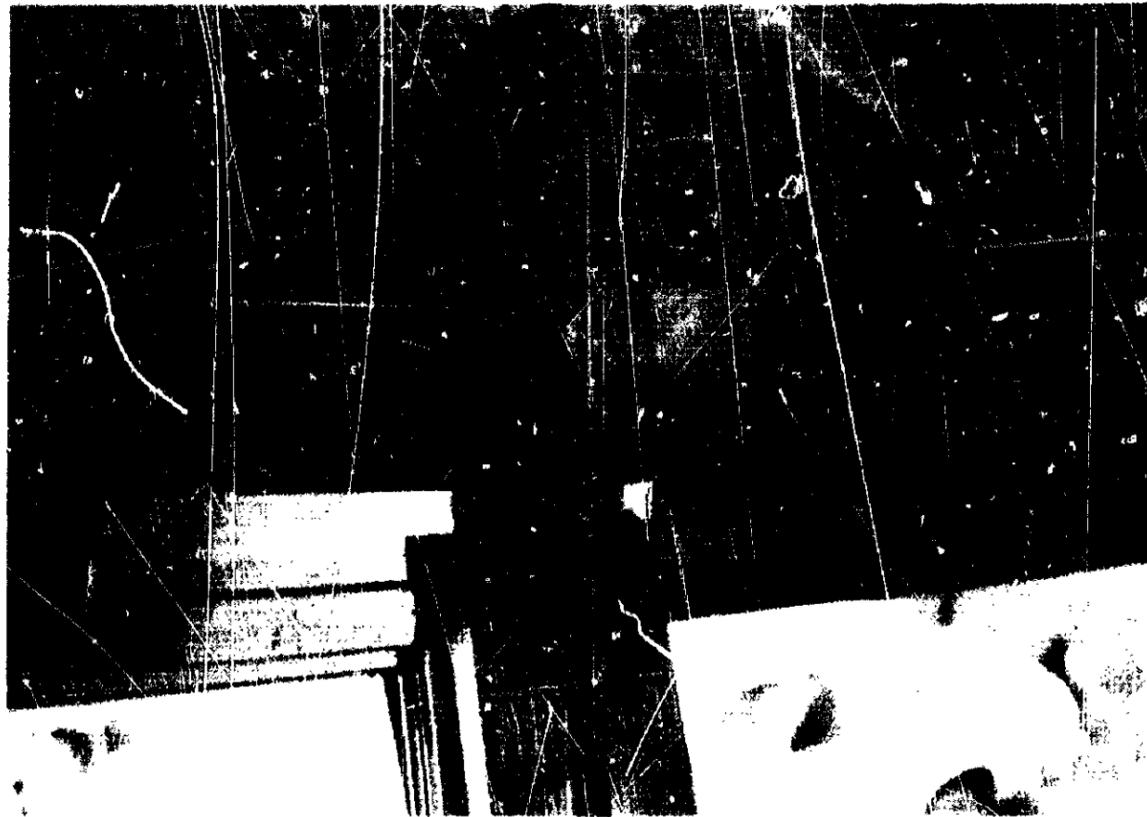


Figure 13.--Separated maintenance access panel. Accident on September 11, 1985, in Woodside, Delaware.

belts for passengers in large schoolbuses. Compartmentalization is essentially passive in that occupant contactable impact zones are defined and an occupant is protected against injury by interior padding of the seatbacks and restraining barriers and by controlled bending of the seat back or restraining barrier in front of the occupant.

The installation and use of lapbelts would not have prevented the fatalities or serious injuries sustained by the passengers in the last row of seats. The amount of crush in this area did not provide survivable space between the seat backs. The passenger in the aisle seat in the last row of seats on the left side probably was standing in the aisle at the time of the collision and therefore avoided being crushed between the seats.

The passenger in the window seat on the left side in the 13th row of seats sustained serious injuries. This seat was pushed up and to within about 8 inches of the ceiling of the schoolbus, and the use of a lapbelt would not have prevented his injuries.

The passenger in the window seat on the left side in the second row who was seriously injured probably was standing up to exit the schoolbus at the time of the collision. A lapbelt would not have been in use. The remaining passenger who was seriously injured was occupying the window seat on the right side in the 11th row. This person probably sustained his serious injury when he contacted the sidewall, the occupant next to him, or the ceiling of the schoolbus during the collision, the rotation of the schoolbus body, and/or the subsequent 90-degree overturn. The lack of available evidence concerning what object this person struck and what caused his injury prevents the Safety Board from determining whether this person's serious injury may have been prevented by the use of a lapbe.

The remaining passengers in the schoolbus sustained minor to moderate injuries. If lapbelts had been available and in use by all seated occupants, they would not have contacted the ceiling and would not have fallen or been ejected from their seats during the rotation and 90-degree overturn. However, the use of lapbelts would not have prevented the occupants from contacting the sidewalls, the windows, the seatbacks in front or behind them, or the persons sitting next to them. These passengers probably would have sustained similar types of injuries, such as abrasions and contusions, if lapbelts had been in use.

The Safety Board is currently conducting a safety study of accidents involving post-1977 schoolbuses to evaluate the adequacy of the occupant crash protection afforded by existing Federal standards.

## CONCLUSIONS

### Findings

1. The qualifications of the drivers, the weather, the highway, and the mechanical condition of the vehicles were not contributing factors to this accident.
2. The schoolbus was clearly visible to a vehicle approaching from the rear for a distance of about 1.4 miles.
3. The schoolbus was stopped in the eastbound lane of the highway at the time of the collision.
4. The schoolbus emergency warning lights were flashing and the stop arm was extended at the time of the collision.
5. The truck was traveling at about 59 mph at the time of the collision. The truckdriver did not apply his brakes before the collision.
6. At the time of the collision the truck had started an evasive left steering maneuver in an attempt to avoid the collision.
7. The truckdriver was falsifying his records of duty status to conceal excess driving and on-duty time.
8. The truckdriver had been on duty 88 1/4 hours during the 8 consecutive day period prior to the time of the collision.
9. The truckdriver was inattentive and was suffering from chronic fatigue due to a combination of excessive on-duty time, and a prolonged irregular duty pattern.
10. The per-mile method of driver compensation widely used in the trucking industry encouraged the truckdriver to exceed the maximum hours of service permitted by Federal regulation.
11. The failure of Bell Creek, Inc. to properly monitor the truckdriver's activities to prevent excessive hours of service contributed to the accident.

12. The schoolbus demonstrated the crashworthiness required by Federal Motor Vehicle Safety Standard 221.
13. Joint separations of interior maintenance access panels with the resultant exposure of metal edges pose a hazard to schoolbus occupants during crashes.
14. The installation and use of lapbelts by the schoolbus passengers seated in the last row of seats and by the passenger in the window seat in the 13th row on the left side would not have prevented these passengers' fatal or serious injuries.
15. The passenger in the second row who was seriously injured probably was standing up to exit the schoolbus at the time of the collision. A lapbelt would therefore not have been in use.
16. The evidence available is insufficient to determine if the installation and use of a lapbelt would have prevented the serious injury sustained by the passenger in the window seat of the 11th row on the right side.
17. The remaining passengers who sustained minor or moderate injuries probably would have sustained similar injuries if lapbelts had been installed and in use.

#### Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the truckdriver's chronic fatigue, which adversely affected his ability to avoid a collision with the stationary schoolbus; his chronic fatigue developed from a loss of sleep due to a combination of excessive duty time and a prolonged irregular duty pattern. Contributing to the accident was the failure of Bell Creek, Inc. to properly monitor the truckdriver's activities to prevent excessive hours of service.

#### **RECOMMENDATIONS**

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

-to the National Highway Traffic Safety Administration:

Revise Federal Motor Vehicle Safety Standard 221, School Bus Body Joint Strength, to require that the joints of interior body maintenance access panels within a defined occupant contactable zone meet the joint strength performance requirement of other body panel joints. (Class II, Priority Action) (H-85-51)

-to the Federal Highway Administration:

Institute a nationwide policy which requires a re-audit of a motor carrier or hazardous materials shipper within 1 year after the completion of an enforcement action. (Class II, Priority Action) (H-85-52)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JIM BURNETT  
Chairman

/s/ PATRICIA A. GOLDMAN  
Vice Chairman

/s/ JOHN K. LAUBER  
Member

December 10, 1985

**APPENDIXES**  
**APPENDIX A**  
**INVESTIGATION**

Investigation

The National Transportation Safety Board was notified of this accident at 6:30 p.m. on April 29, 1985. Highway accident investigators were dispatched from the Safety Board's Headquarters in Washington, D. C., and arrived on-scene at 1:00 p.m. on April 30, 1985. Participating in the investigation were representatives of the Arizona Department of Public Safety (Highway Patrol); the Tuba City, Arizona, Police Department; Lell Creek Inc.; the Nebraska Motor Carrier Safety Office of the Federal Highway Administration; the Blue Bird Body Company; and Freightliner Corporation.

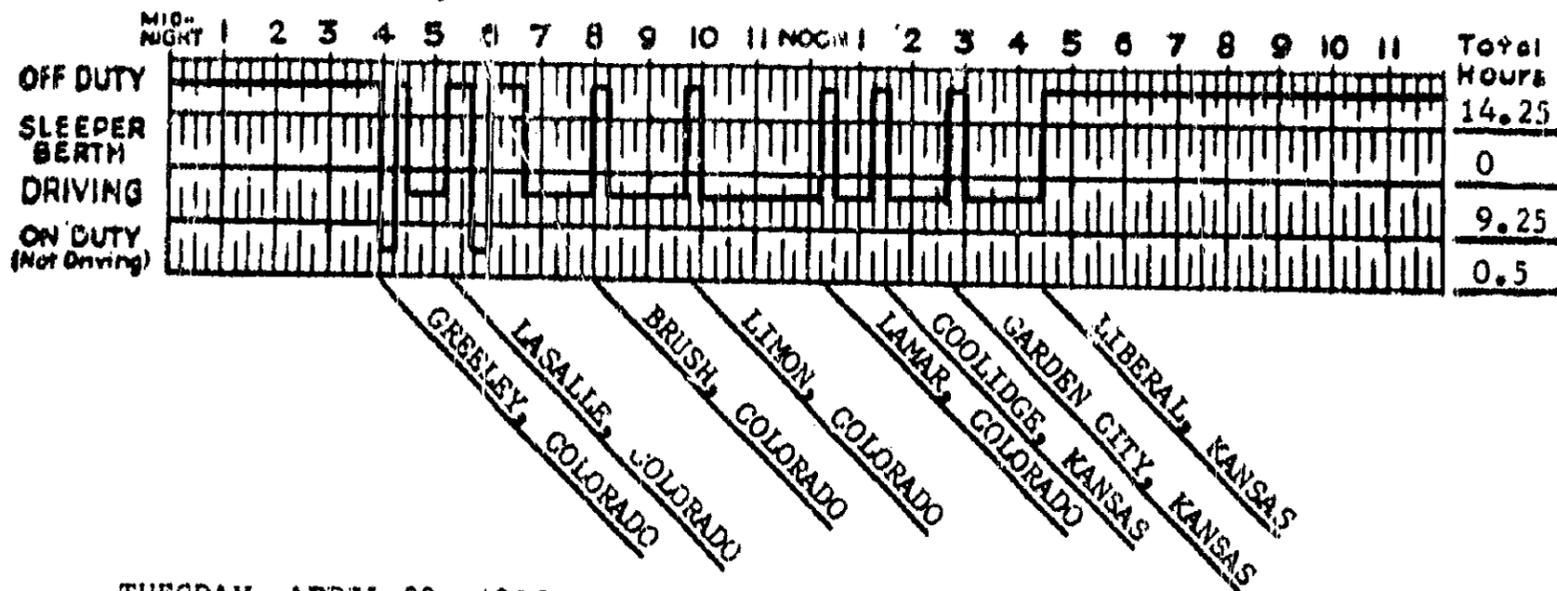
Depositions and Hearings

There was no deposition taken and no public hearing held in conjunction with the investigation of this accident.

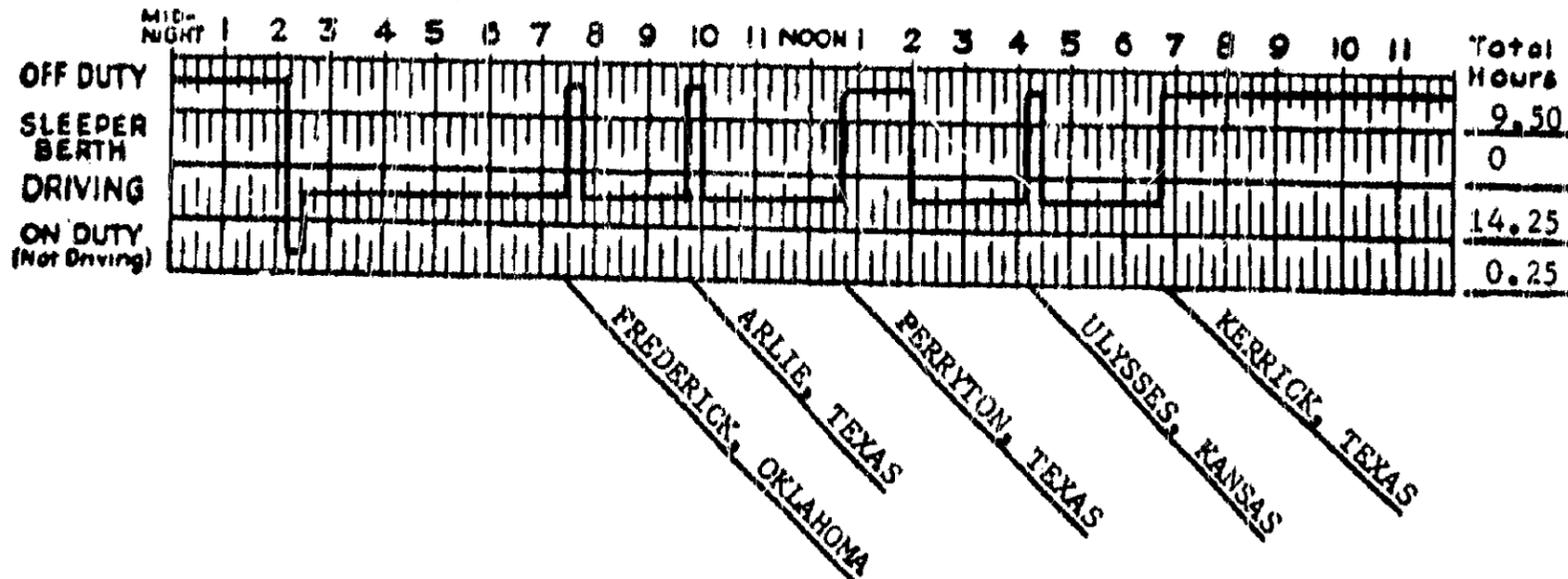
APPENDIX B

TRUCKDRIVER ACTIVITIES FROM APRIL 22 TO TIME OF ACCIDENT  
(TIMES SHOWN ARE MOUNTAIN STANDARD TIME)

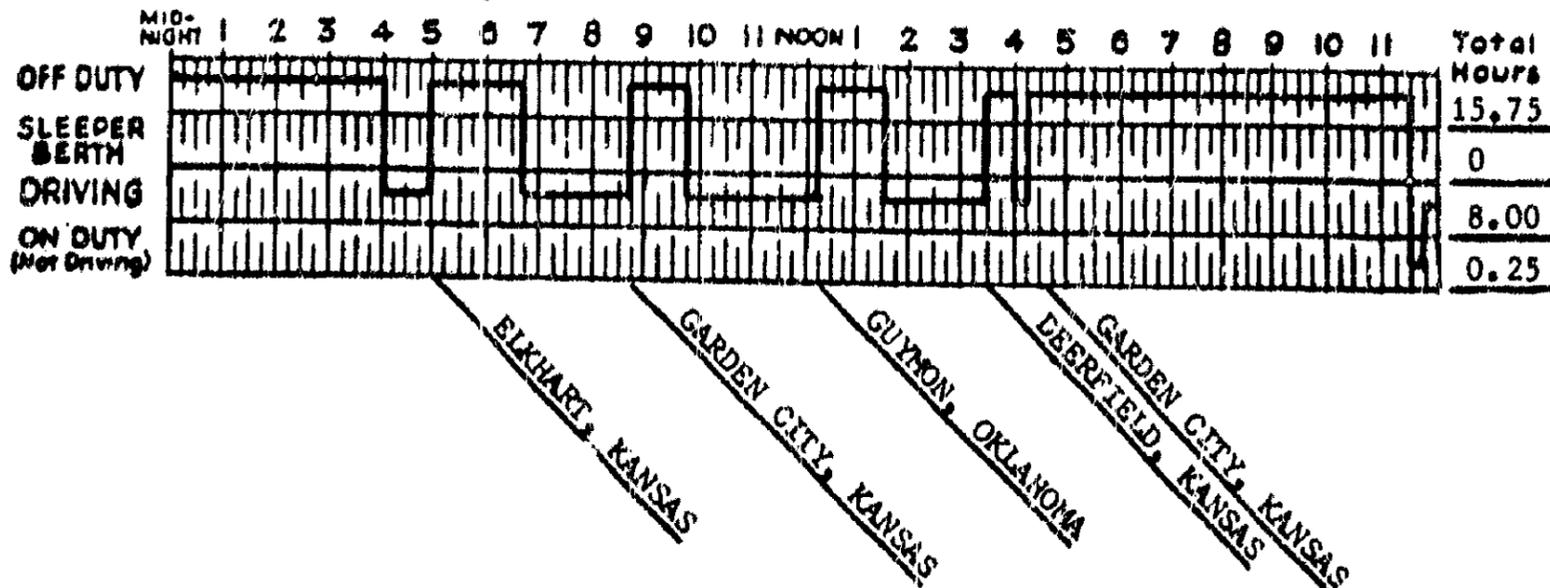
MONDAY, APRIL 22, 1985



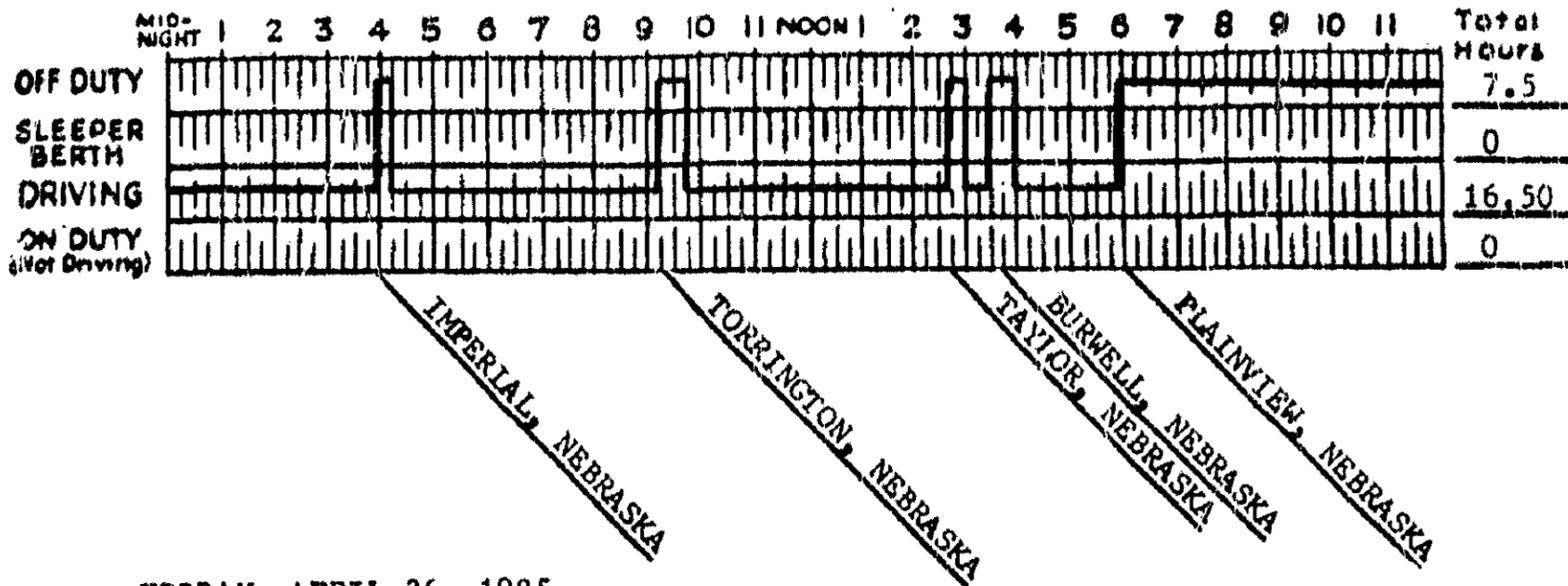
TUESDAY, APRIL 23, 1985



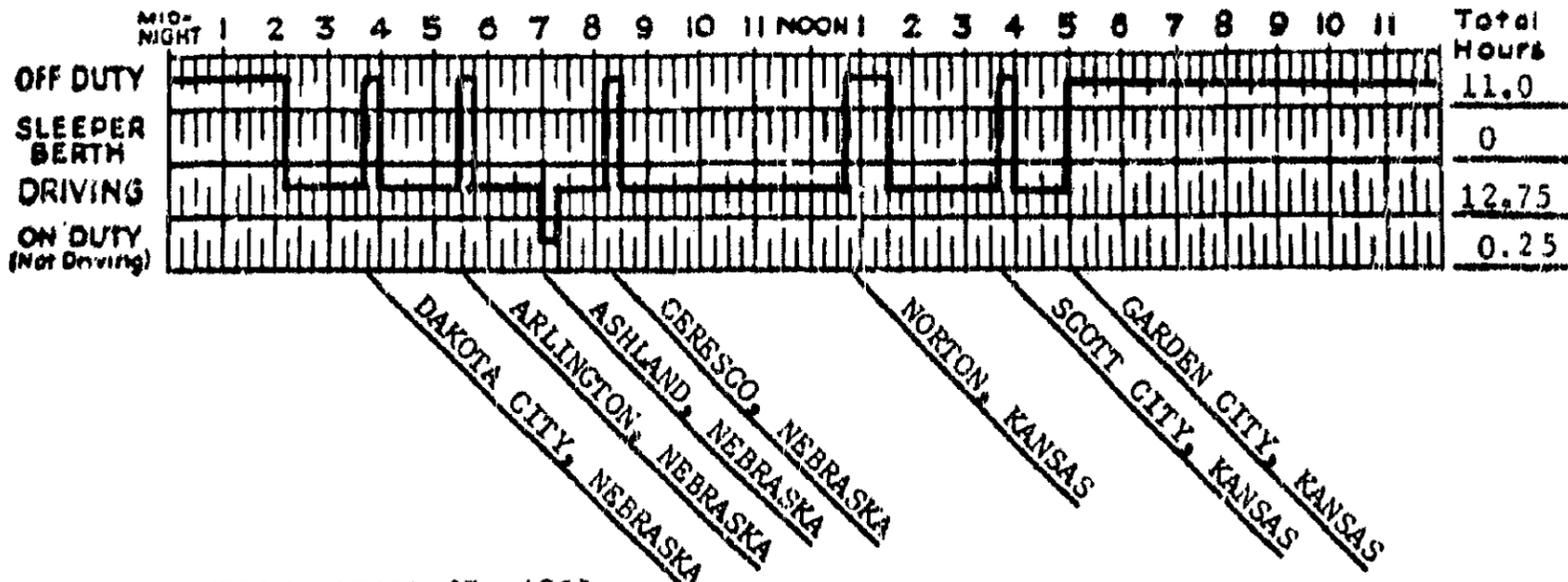
WEDNESDAY, APRIL 24, 1985



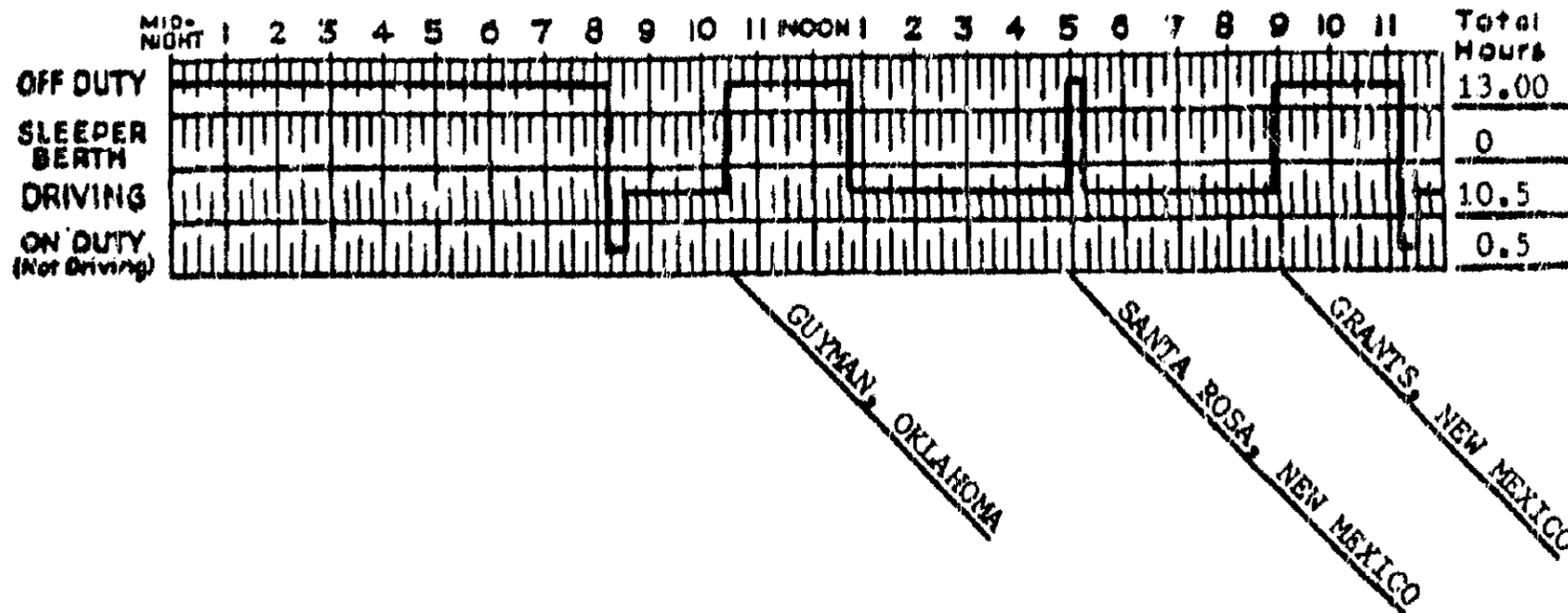
THURSDAY, APRIL 25, 1985



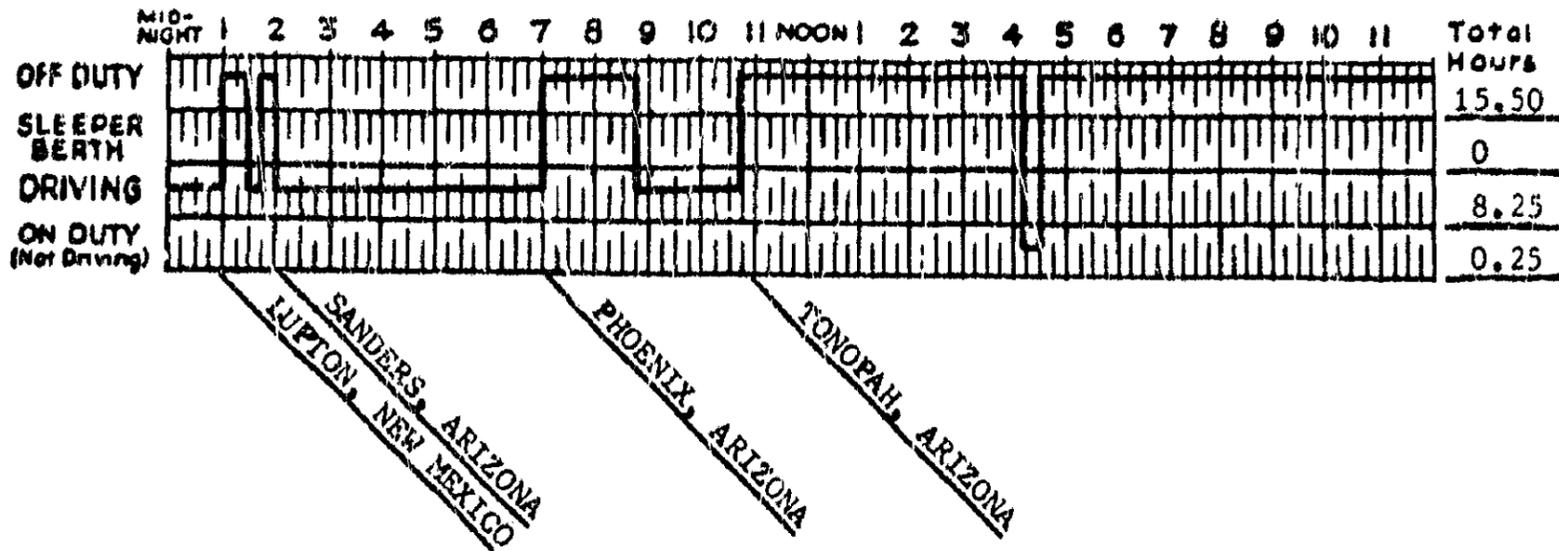
FRIDAY, APRIL 26, 1985



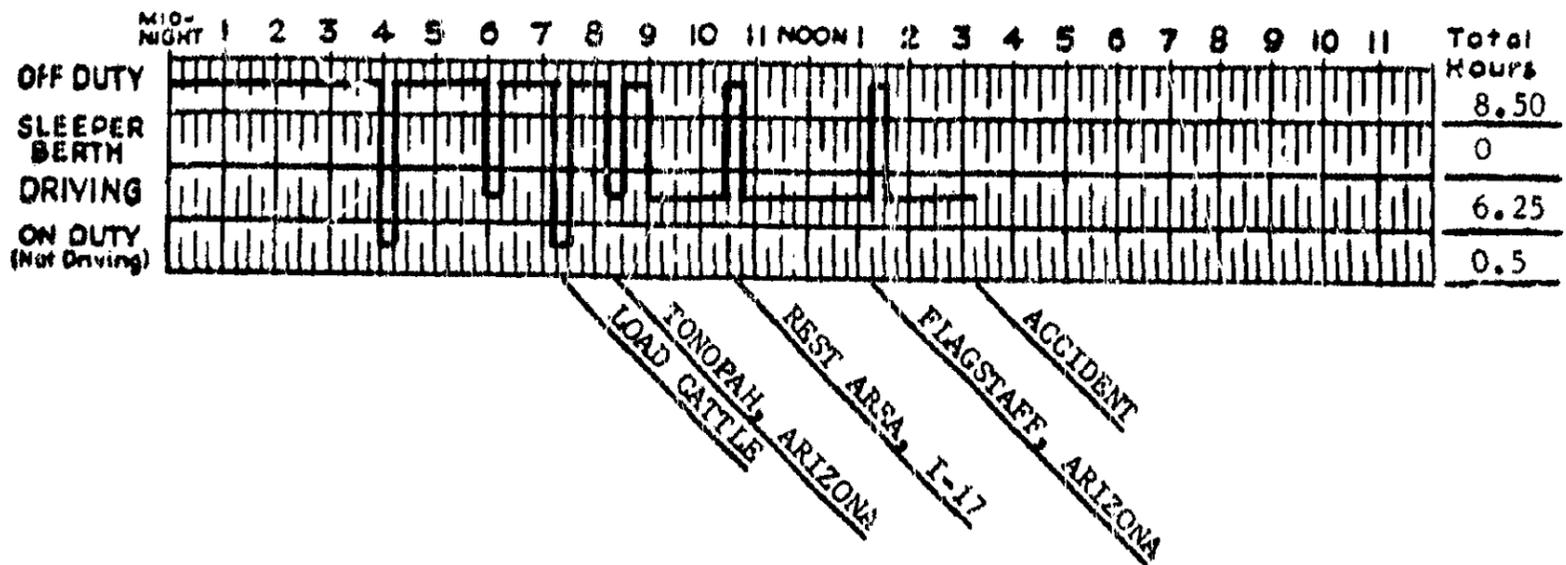
SATURDAY, APRIL 27, 1985



SUNDAY, APRIL 28, 1985



MONDAY, APRIL 29, 1985



ACTIVITY SUMMARY

DATE	DRIVING TIME IN HOURS	ON-DUTY TIME IN HOURS	TOTAL MILES DRIVEN
April 22, 1985	9.25	0.5	456
23	14.25	0.25	722
24	8.00	0.25	373
25	16.50	0	819
26	12.75	0.25	625
27	10.50	0.5	540
28	8.25	0.25	407
29	6.25	0.5	298
<b>TOTALS</b>	<b>85.75</b>	<b>2.50</b>	<b>4,240</b>

APPENDIX C

FEDERAL MOTOR VEHICLE SAFETY STANDARD NUMBER 221:  
SCHOOL BUS BODY JOINT STRENGTH  
(49 C.F.R. 571.221)

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

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

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

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

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

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

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

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

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

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

S6. *Procedure.*

S6.1 *Preparation of the test specimen.*

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

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

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

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

strengths of the joined body components as follows:

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

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

S6.3 *Strength test.*

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

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

S6.3.3 Apply a tensile force to the specimen by separating the heads of the testing machine at any uniform rate not less than 1/4 inch and not more than 3/4-inch per minute until the specimen separates.

(41 FR 3672, Jan. 27, 1976, as amended at 41 FR 36027, Aug. 26, 1976)

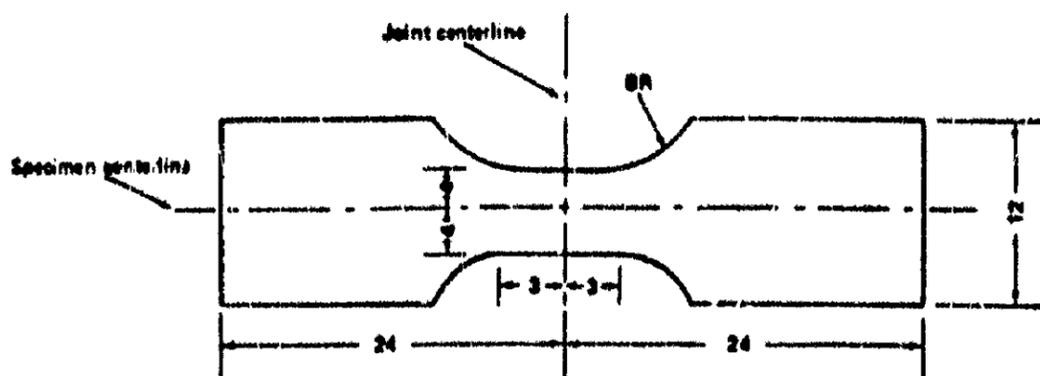


FIGURE 1