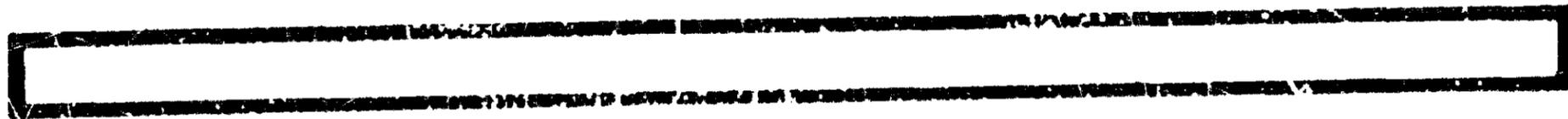
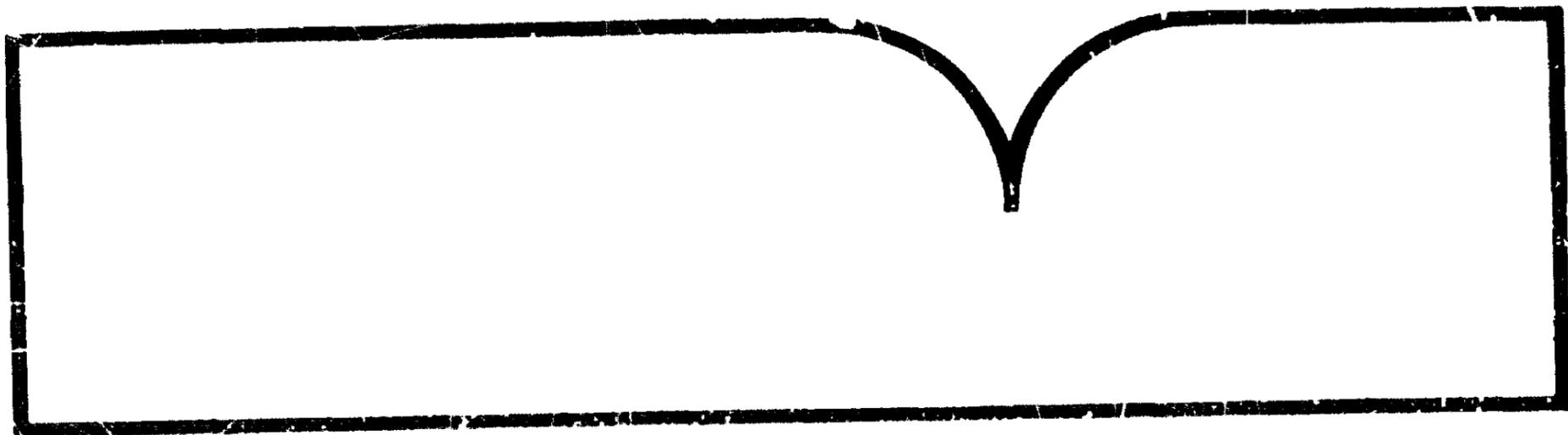


PB83-916205

Highway Accident Report - Collision of Humboldt
County Dump Truck and Klamath-Trinity Unified
District Schoolbus, State Route 96 near
Willow Creek, California, February 24, 1983

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

24 Feb 83



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<p>16. Abstract On February 24, 1983, an empty dump truck, traveling north on State Route 96, a two-lane rural highway near Willow Creek, California, suddenly veered left across the centerline and collided head-on with a southbound schoolbus loaded with 37 occupants. The truckdriver and one schoolbus passenger seated directly behind the schoolbus driver were killed; the schoolbus driver and 30 passengers were injured.</p> <p>The National Transportation Safety Board determines that the probable cause of the accident was the inattention of the truckdriver to the developing traffic situation ahead and the execution of a braking maneuver that resulted in the truck sliding out of the proper lane of travel.</p> <p>Contributing to the severity of some of the student injuries were the pre-Federal Motor Vehicle Safety Standard 222 schoolbus seats with exposed metal frames.</p>			
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: December 5, 1983

COLLISION OF
HUMBOLDT COUNTY DUMP TRUCK
AND KLAMATH-TRINITY UNIFIED DISTRICT SCHOOLBUS
STATE ROUTE 96
NEAR WILLOW CREEK, CALIFORNIA
FEBRUARY 24, 1983

SYNOPSIS

On February 24, 1983, an empty dump truck, traveling north on State Route 96, a two-lane rural highway near Willow Creek, California, suddenly veered left across the centerline and collided head-on with a southbound schoolbus loaded with 37 occupants. The truckdriver and one schoolbus passenger seated directly behind the schoolbus driver were killed; the schoolbus driver and 30 passengers were injured.

The National Transportation Safety Board determines that the probable cause of the accident was the inattention of the truckdriver to the developing traffic situation ahead and the execution of a braking maneuver that resulted in the truck sliding out of the proper lane of travel.

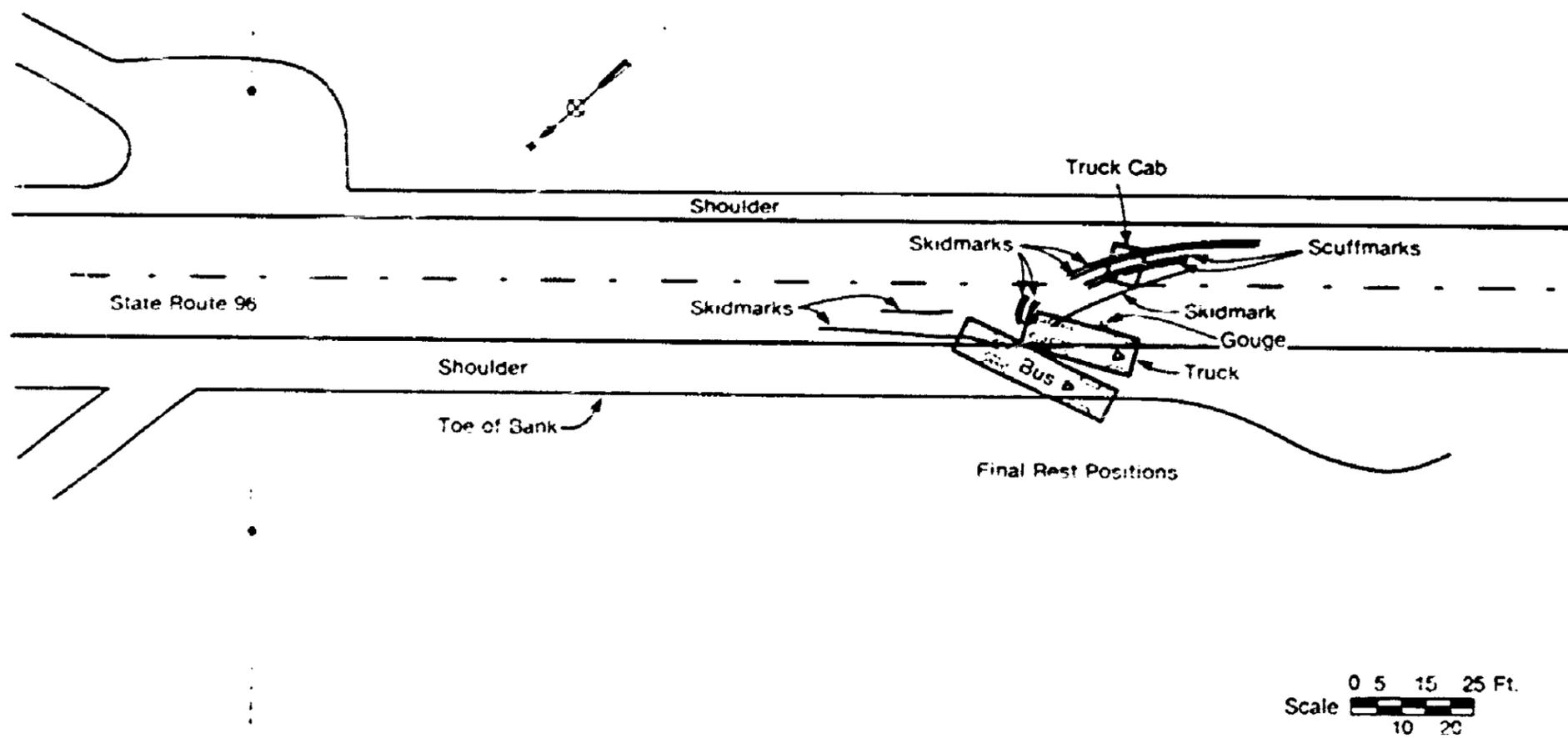
Contributing to the severity of some of the student injuries were the pre-Federal Motor Vehicle Safety Standard 222 schoolbus seats with exposed metal frames.

INVESTIGATION

The Accident

About 3:30 p.m., Pacific standard time, an empty three-axle dump truck was traveling northbound on State Route 96 following a small pickup truck at a distance of about 250 feet. State Route 96 is a two-lane, two-way mountainous road in northern California. Both vehicles had negotiated a right-hand curve and were entering a 526-foot-long straight section of the road. The pickup had begun to slow down to permit two southbound schoolbuses to pass by before the northbound pickup could turn left into a driveway. The pickup truckdriver briefly glanced into her rearview mirror while slowing her vehicle and observed the northbound dump truck following behind her swerving and skidding in the northbound lane. The first schoolbus had passed the dump truck and the second schoolbus was approaching the skidding dump truck. The skidding dump truck suddenly veered to the left across the highway centerline into the southbound lane and struck the second schoolbus head-on. (See figure 1.) Impact occurred between the right front of the dump truck and the left front of the schoolbus. Both vehicles came to rest within the southbound lane and the adjacent shoulder.

In addition to the pickup truckdriver, students in the first schoolbus and a truckdriver following the second schoolbus witnessed the accident. None of the witnesses recalled seeing brake lights illuminated on either the dump truck or the schoolbus before



-2-

Figure 1.—Accident site.

Impact. The passengers in the accident schoolbus stated that they were not cognizant of the schoolbus driver's activities or oncoming traffic immediately before the accident. However, after the accident, heavy skid marks from both vehicles were observed on the pavement surface heading up to the point of impact. (See figure 2.) The accident schoolbus driver stated that he was traveling between 45 and 50 mph just before the collision. He stated that he saw the dump truck coming around the curve, slide sideways within the northbound lanes as if the brakes were locked, and continue into the southbound lane of traffic.

A resident of a trailer park adjacent to the accident site notified the California Highway Patrol (CHP) of the accident at 3:38 p.m. The CHP arrived on scene at 3:42 p.m. and asked for assistance from the appropriate emergency response units. Local residents, passing motorists, and schoolbus passengers assisted in evacuating the remaining surviving passengers through the schoolbus rear window emergency exit. Witnesses stated that because of the threat of fire from the diesel fuel spillage, the evacuation was hurried.

The schoolbus was carrying 36 high school students; 30 students sustained varying degrees of injury, and 1 was fatally injured. The schoolbus driver survived the collision with serious injuries. The truckdriver, who was ejected from the truck's cab, was killed on impact.

At 3:30 p.m., the reported temperature was 52° F. Although it had rained earlier that morning, witnesses stated that the weather was clear and the pavement was dry at the time of the accident.

Injuries to Persons

<u>Injuries</u>	<u>Drivers</u>		<u>Passengers</u>		<u>Total</u>
	<u>Dump truck</u>	<u>Schoolbus</u>	<u>Dump Truck</u>	<u>Schoolbus</u>	
Fatal	1	0	0	1	2
Serious	0	1	0	5	6
Minor	0	0	0	25	25
None	0	0	0	5	5
Totals	1	1	0	36	38

Vehicle Information and Damage

Schoolbus.--The 2-axle blunt nose 1972 transit schoolbus, manufactured by Gillig Corporation and owned and operated by the Klamath-Trinity Unified School District, was equipped with a diesel engine, air-mechanical service brakes, power steering, and a tachograph. The schoolbus was painted chrome yellow with black trim and was equipped with the necessary lights, mirrors, signal devices, identification labeling, and other safety devices required by Federal Highway Safety Program Standard (HSPS) 17: Pupil Transportation Safety. The schoolbus received its last annual inspection by the CHP in November 1982. The schoolbus was also equipped with two rows of 12 bench seats and a 5-seat bench for a seating capacity of 77.^{1/} The busdriver's adjustable seat was the only seat in the schoolbus that had and was required to have an occupant restraint. At the time of the accident, the probable weight of the loaded schoolbus was 26,550 pounds, and the tachograph did not have a chart installed.

^{1/} The seating capacity for this schoolbus is 77 assuming 3 passengers per seat for each of the 24 bench seats and one 5-passenger bench seat in the rear.



Figure 2.—Final rest positions of schoolbus and dump truck. According to witnesses, the truck cab had been pulled to the side of the roadway to allow emergency vehicles to get through.

Impact damage was confined primarily to the front, roof, and left side of the schoolbus. The front of the schoolbus was pushed inward and skewed rightward from the frame to the bumper. Maximum deformation near the front bumper was 49 inches on the right side and 27 inches on the left side. Impact damage along the left side extended from the front to the side emergency exit door. The exterior body was pushed inward 22 inches at the left front and 18 inches at the emergency exit door causing the sheet metal between these two impacted areas to buckle outward. Circumferential tire sidewall transfers were observed near the left front head lamp and underneath the emergency exit door. The side impact intrusion on the left side caused two rows of seats on both sides of the aisle to buckle inboard, thus blocking the center aisleway in the passenger

compartment. At least 10 rows of seats on both sides of the aisle were bent forward and several seat cushions separated from their seat frames. Two rows of seats were undamaged.

The impact damage in the front caused the steering wheel to be pushed rearward into the driver's seat. The right side entrance door was also forced rearward at impact, thus precluding the use of that exit by the injured occupants. The steering linkage was jammed due to frontal deformation. The engine driveshaft and rear axle components were not damaged during the impact sequence. There were no precrash deficiencies or abnormalities noted in the inspection of the schoolbus. (See figure 3.)

Dump Truck. --The 1968 International Harvester (IHC) 3-axle dump truck, owned and operated by the Humboldt County Road Division, was equipped with a diesel engine, air-mechanical service brakes, power steering, and a 10-cubic-yard dump body. The driver's seat was equipped with a seatbelt. An inspection of the seatbelt webbing and buckle after the accident did not reveal any evidence of seatbelt use during the accident. The probable vehicle weight at the time of the accident was 21,140 pounds.

Damage was confined primarily to the front of the truck. The force of collision separated the cab, engine, and front steering axle from the vehicle's chassis. Both right and left frame rails forward of the transmission were deformed leftward about 2.5 feet. The dump body, rear frame and axle assemblies, and all other components rearward of the transmission, were not significantly damaged. The roof was crushed inward. Both "A" pillars separated from the cab, and all cab windows were missing. Both doors were buckled outward. All electrical, air, and hydraulic connections on the engine were severed at impact. The steering column shaft also separated from the steering gear during impact.

The truck was equipped with ten 10.00 x 20 tires, all of which, except for the right front tire, were inflated and had a minimum tread depth of 5/32 inch. ^{2/} The brakes had recently been relined. The minimum lining thickness measured was 7/32 inch. ^{3/} A minor air leak was found in the right front drive axle service brake chamber. The slack adjustment for each service brake was measured by representatives of the CHP investigation team, who advised that the slack adjustments which could be measured were within the manufacturer's recommended limits. (See figure 4.)

The IHC dump truck was purchased new by the Humboldt County Road Division and placed into service in August 1968. The truck was subject to daily driver inspections and annual preventive maintenance inspections by the county. A review of the maintenance records indicated that there were at least 30 repairs performed on the front axle and steering components during the 140,000 service miles for the IHC dump truck. Based on the mileage recorded for the 1982 calendar year, this vehicle probably was out of service for an extended period of time. The daily inspection reports for the last 3 months preceding the accident were also reviewed. No problems were reported by the driver during this time period.

^{2/} Due to rim damage, the air in the right front tire was released by the CHP during its inspection for safety reasons. The California inspection criteria note that a tire mounted on the steering axle of a commercial truck must have at least 2/32-inch tread depth at all points in all major grooves. There are no minimum tread depth requirements for tires mounted on any other axle.

^{3/} The California inspection criteria note that brake linings that are worn to within 1/64 inch of the bolts, rivets, or fasteners are unacceptable.

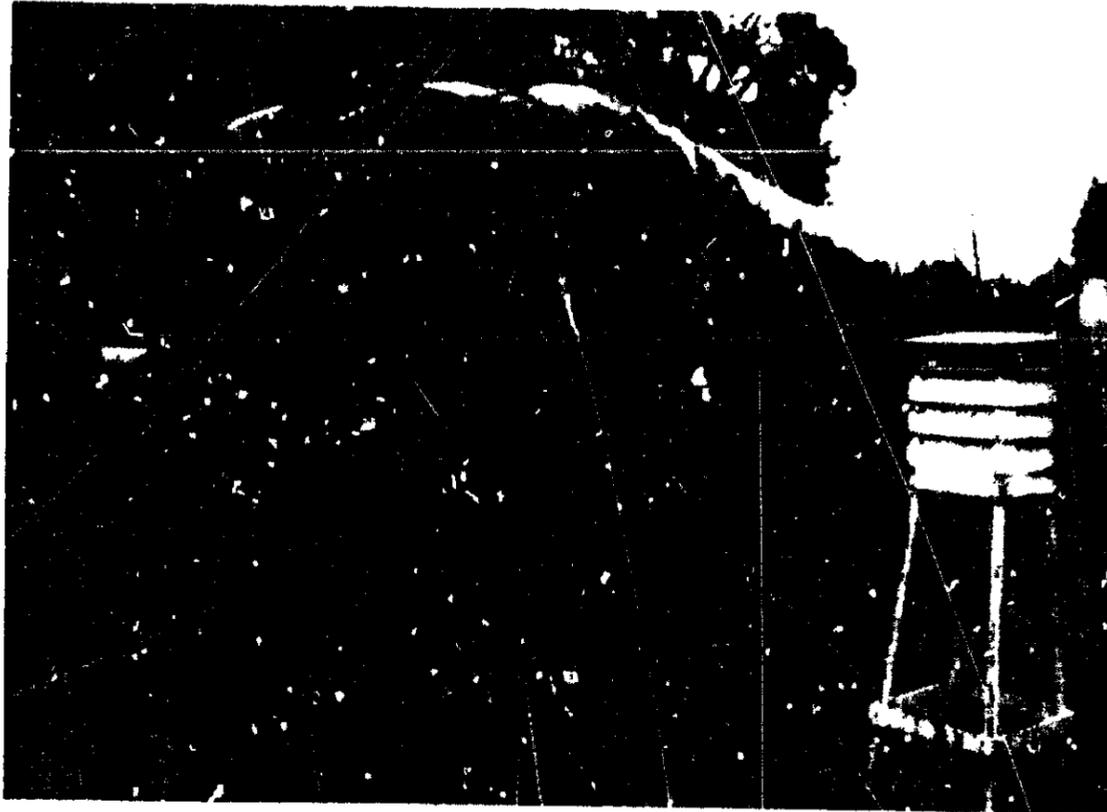


Figure 3.—Damage to schoolbus.



Figure 4.—Damage to dump truck.

The steering linkage on the IHC dump truck was closely inspected during the on-scene investigation. The drag link, which was attached between the steering gear pitman arm and the front axle steering lever arm, was found bent and separated from its ball-joint attachment at the steering lever end. (See figure 5.) The drag link and attaching ball-joint assemblies were removed from the vehicle by the CHF and taken to the California Department of Transportation (CALTRANS) for metallurgical evaluation. A Safety Board metallurgist also examined the drag link in detail. A bench binocular examination of the separated ball-joint stud, spherical bearing, and housing of the drag link revealed little wear on these components. The ball stud end drag link housing were intact; however, the spherical bearing was fractured. The components exhibited deformation, fracture characteristics, and wear patterns consistent with a single event separation. There was no evidence of a prior fracture in the spherical bearing or other components.

Approximately one-third of the spherical bearing volume was missing and apparently never recovered. The spherical bearing also contained a curved deformation on the outer surface and a case cracking network on the inner and outer spherical surfaces. The case cracking associated with this deformation appeared to have been produced by extreme pressure, as though the spherical bearing had been squeezed between the ball stud and the drag link housing.

The separation of the ball stud from the spherical bearing and drag link housing appeared to have resulted from an overstress condition. The load producing the overstress condition most likely was transmitted through the ball joint assemblies from the attaching steering gear pitman arm and steering lever arm during impact.

CALTRANS conducted an independent examination of the separated drag link and ball joint assembly. During its examination, the following conditions of the components were observed: a slight deformation in the hemispherical end of the ball stud which contained a minute area of material that was different in color from the rest of the steel gray ball stud (the material composition, however, was not established); several sets of marks and radial scratches on the shaft and socket plate of the drag link, respectively; a burnished groove approximately 0.002 inch deep in the ball stud stem; and a brinell mark on the outside of the spherical bearing opposite the fracture.

Based on its preliminary findings, CALTRANS released a report on June 23, 1983, ^{4/} which stated that the ball joint had separated from the drag link before the collision and that the ball joint had been reassembled using the bent drag link and broken spherical bearing which had been damaged in a previous accident.

The Safety Board, in conjunction with the steering gear manufacturer, disassembled and examined the power steering integral gear unit to determine if any visible signs of impact damage were present inside the unit. The steering gear inspection and subsequent tests did not reveal any indication of mechanical or hydraulic malfunction. No evidence of cracks, dents, marks, or other heavy impact loading was observed on either the rack or pinion gears. Normal signs of wear were observed on the gear assemblies. There was no indication of torsional bending on the pitman arm spline. No visible signs of leaks were found in the unit when it was pressurized to its design operating pressure of 1,300 psi. The hydraulic ram effect of the power steering fluid was capable of cushioning the impact load induced on the internal components of the unit.

^{4/} State of California Department of Transportation, Division of Construction, Office of Transportation Laboratory, letter/report to Mr. Lloyd Turner from Charles B. Kendrick, dated June 23, 1983.

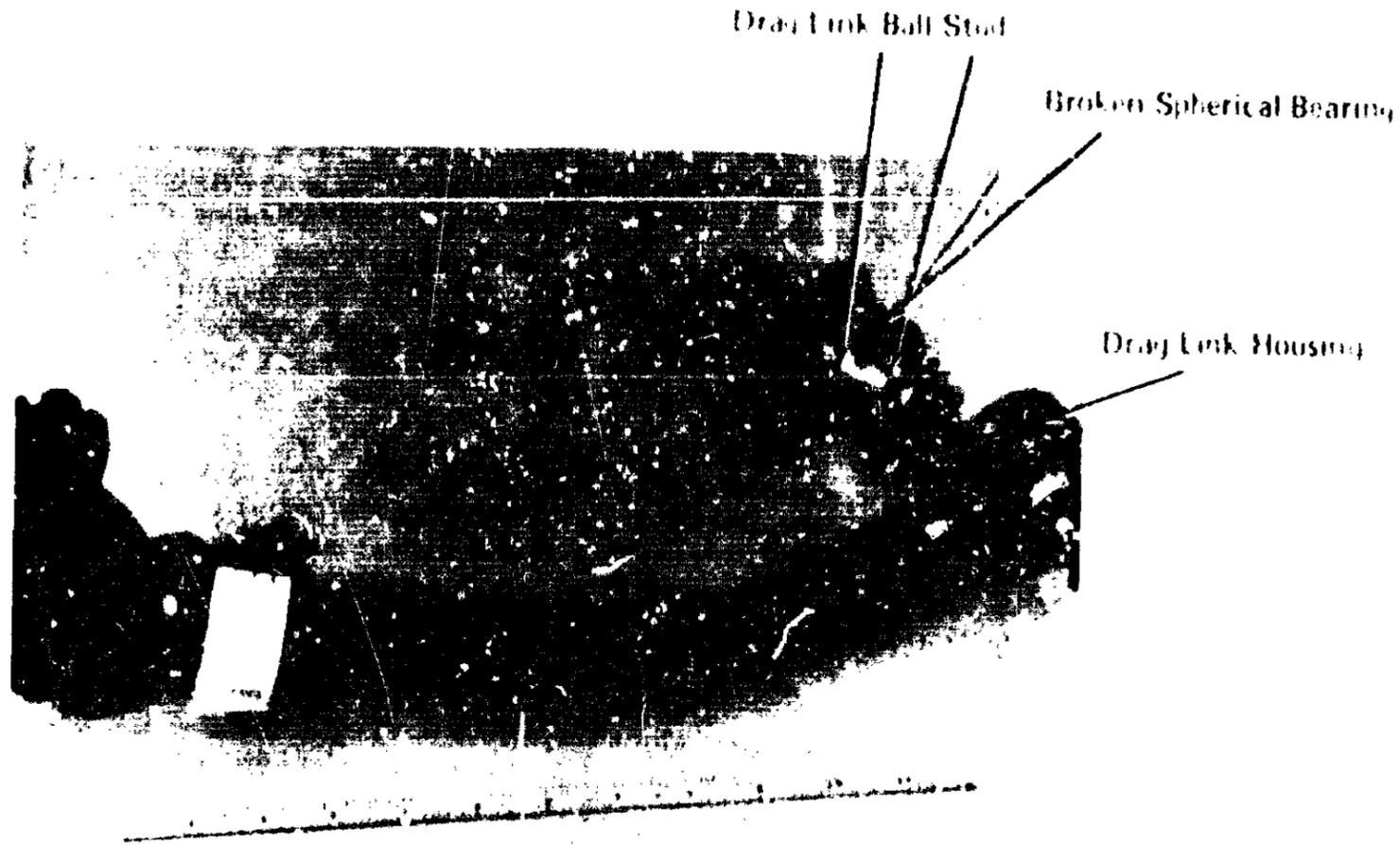


Figure 5.—Drag link and attaching components.

Driver Information

Schoolbus driver.--The schoolbus driver, age 28, resided in Willow Creek, California. He had been employed with the Klamath-Trinity Unified School District as a busdriver/maintenance man since November 1977. He had been driving the same schoolbus over the same routes throughout his employment with the school district. The schoolbus driver was highly regarded by his supervisors and students, and he received a letter of recognition from the school superintendent in August 1980.

As required by the State of California, the schoolbus driver received 40 hours of initial training ^{5/} and 10 hours of in-service training during each school year he operated a schoolbus. This driver training program complied with the recommended guidelines established in HSPS 17.

The schoolbus driver held a valid class 2 chauffeur's license for operating a schoolbus, and he completed the required medical certification examination in June 1981. His examination revealed that he was in good health, with no apparent medical problems. His vision was reported to be 20/400 in both eyes, and was corrected to at least 20/20 with glasses. The driver was wearing his glasses at the time of the accident. A review of his driving record did not disclose any previous accidents or traffic violations.

^{5/} Initial schoolbus driver training consists of 20 hours of classroom instruction and 20 hours of behind-the-wheel training.

The schoolbus driver was on his second schoolbus run for the afternoon when the accident occurred. He normally started his afternoon runs around 2:00 p.m. and finished around 4:15 p.m.

Dump truckdriver.--The 49-year-old truckdriver resided in Orleans, California, and had been employed with the Humboldt County Road Division since August 1980. He was assigned to the county road maintenance crew located in Hoopa, California. The truckdriver normally was assigned to the accident dump truck, but had driven this vehicle only about 9 times in the 2 1/2 months preceding the accident. During the same period, he was also driving a 5-cubic-yard truck on a regular basis. The truckdriver held a valid class 1 chauffeur's license, and he had completed the required medical examination in March 1981. 6/ A review of his driving record did not disclose any previous accidents or traffic violations.

According to his crew foreman, the truckdriver did not perform well as a dump truck operator. He had difficulty spreading loads and shifting gears on the 10-yard dump truck. He had driven the 10-yard dump truck off an embankment on one occasion, and had driven one wheel of the 5-yard truck over the edge of a dropoff on a different occasion. The foreman stated that the truckdriver drove extremely slow when traveling to and from worksites--slower than what was required for roadway conditions.

The truckdriver was frequently assigned to control the flow of traffic (flagging) at work sites. His foreman indicated that he was unreliable as a flagger. He would watch the equipment and men working rather than pay attention to oncoming traffic, and would permit traffic to endanger coworkers at the worksite. His foreman and all of his coworkers said that he was a "day dreamer" and that they had to call him more than once to get his attention, especially when he was flagging. His coworkers considered him to be careless and unsafe and did not want to work near him or ride with him when he was driving. He had performed satisfactorily during his probationary period on the job, but afterwards his performance began to decline. His first annual review indicated that he needed to improve considerably his truckdriving skills and to observe more closely the safety rules. He received an unsatisfactory rating during his last review. The review also indicated that he needed to improve further his driving skills. The reviewing official did not specify any formal remedial action to correct the truckdriver's performance.

In June 1982, the truckdriver had received a "Notice of Reduction in Force" advising him that he might be displaced from his position or laid off due to a consolidation in county services and personnel. Although he was not affected by the personnel consolidation, his coworkers indicated that the threat of another upcoming layoff and the unsatisfactory performance evaluation had "upset him a lot."

On the day before the accident, the truckdriver was allowed to drive the dump truck home in order to take it to the county maintenance yard in Hoopa for servicing the next morning. The truckdriver retired for bed about 9:00 p.m. that evening and slept soundly until 5:00 a.m. the next morning. On the day of the accident, the truckdriver departed his home about 5:30 a.m. and drove to the maintenance yard. He serviced the dump truck and proceeded to the Brannon Mountain worksite. He hauled one load of material to the worksite and spent the rest of the day flagging traffic at the site. He left the site around 3:15 p.m. in the dump truck and was returning to the county maintenance yard when the accident occurred.

6/ The medical certification examination was in compliance with 49 CFR 391.41-49.

Available medical records indicate that the truckdriver had several medical problems. He was admitted to a hospital in 1965 after complaining of loss of memory and dizziness. The diagnosis was schizoid personality, convulsive disorder, and anxiety reaction. He was referred to a psychiatrist for treatment. From 1966 to 1972, he periodically suffered from the loss of vision. The diagnosis was renal glycosuria (an abnormally large amount of sugar in the urine), and he was advised to have frequent small meals which had high protein contents. He later reported to his doctor that eating five or six candy bars per day prevented passing out spells. Following an episode of loss of vision in 1978, the truckdriver was referred to the Humboldt County Mental Health Clinic in Eureka, California. Several electroencephalograms were performed as a result of his passing out spells, but the test results were normal.

In 1972, the truckdriver was treated for a lower abdominal muscle strain with an associated diagnosis of hypoglycemia (low blood sugar). Symptoms of hypoglycemia are characterized by sudden onset and include faintness, inability to concentrate, sweating, weakness, nervousness, hunger, sometimes mental confusion, and visual disturbances and unconsciousness. Medical records also showed that between 1972 and 1982 he had a left exploratory tympanotomy and stapes mobilization, suffered from hypoglycemia, had an appendectomy and was treated for hemorrhoids, proctitis, bursitis, and a cyst. He had a hemorrhoidectomy in 1982.

There is no record of the truckdriver having reported any of the above medical problems either on his employment application, dated July 1980, or during his medical examination performed for his truckdriver's license renewal in March 1981. However, he did advise his immediate supervisor of his hypoglycemia problem. Under the "Health and History" section on the medical examination form, the truckdriver checked "no" for the following items: seizures, fits, convulsions or fainting, nervous stomach, suffering from any other disease, psychiatric disorder, and any other nervous disorder. Although the medical examination was performed by a licensed medical doctor, none of his previous medical conditions was noted on the medical examination form.

Highway Information

The accident occurred on State Route 96, about 3.5 miles north of Willow Creek. State Route 96 is a two-lane, two-way paved asphalt road which generally runs north-south. Near the accident site, the road is straight and almost level. The asphalt road is about 25.8 feet wide with 12.35-foot-wide lanes. It was last resurfaced in September 1982. The roadway is divided by a dashed, single yellow centerline with raised yellow pavement markers spaced between the centerline dashes. The lanes are bordered by a solid white edgeline on each side. The average daily traffic was reported to be 1,800 vehicles for the 1981 calendar year. State Route 96 has maximum grades of about 5 percent and curves with radii as short as 200 feet.

Because of numerous curves on the approaches to the accident site and because of topography, roadway visibility in both directions was limited. (See figure 6.) Vegetation along the last curves in both the north and southbound directions leading up to the accident site reduced visibility to about 400 feet. No potholes were observed in the road surface, and the shoulder dropoff varied, with a maximum dropoff of 1.5 inches. Several tight radius curves were located about 0.4 mile from the point of impact. The tightest radius curve had a critical speed $\frac{7}{7}$ of 46 mph. Several advisory speed signs were posted

$\frac{7}{7}$ Critical speed is defined as "A velocity above which a particular highway curve could not be negotiated by a motor vehicle without yaw." The critical speed estimate is based on estimated lateral coefficient of friction (0.48) for truck tires and curve radii of 300 feet. J. S. Baker, Traffic Accident Investigation Manual, January 1975, p. 315.

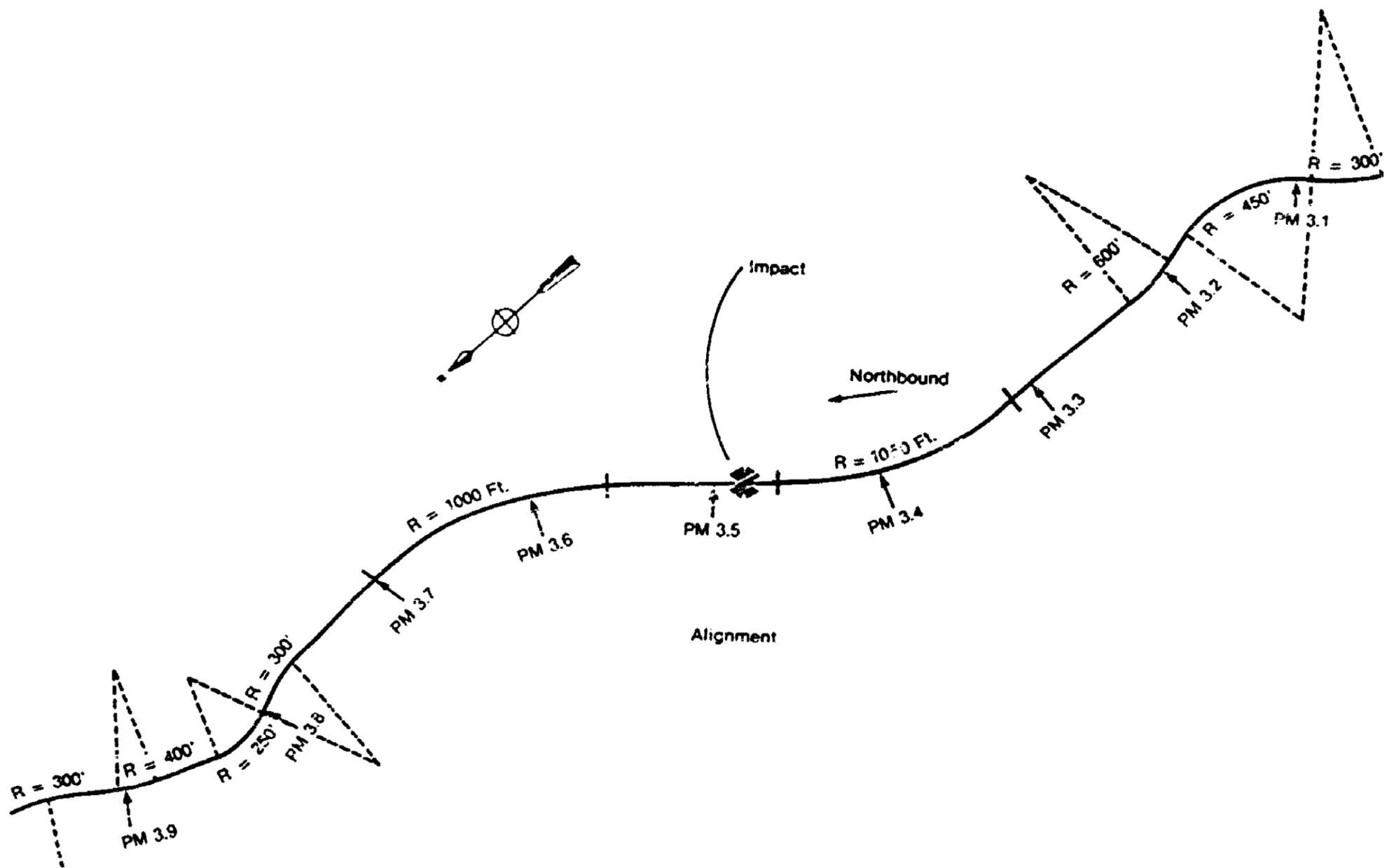


Figure 6.—Plan view of State Route 96.

at the tight radius curves in the southbound direction. There was no advisory speed signs posted in the northbound direction within 3 miles of the accident site. The unposted speed limit at the accident site was 55 mph in both directions.

No accidents had been reported within 0.33 mile of the accident site. However, from 1980 to 1982, 10 accidents had been reported within a 0.5-mile segment on each side of the accident site. Most of these accidents occurred in areas where sharp curves were present (between 0.33 and 0.5 mile from the accident site), and most involved only one vehicle running off the road and striking a fixed object.

Representatives of the CHP measured the dry road surface near the point of impact for the coefficient of friction with a drag sled.^{8/} The coefficient of friction was determined to be 0.92 and 0.90 for the southbound and northbound lanes, respectively. Coefficients of friction between 0.80 and 1.00 are typical for clear, dry, rough-textured pavement under optimum conditions. These test results indicate that the road surface had good friction qualities.

The dump truck had traveled about 3.2 miles northbound on State Route 96 when the accident occurred. The schoolbus had traveled south about 7.6 miles from the high school in Hoopa before reaching the accident site.

Although heavy rain after the accident and the sand and water used during the rescue effort might have erased some of the physical evidence, four sets of dual tire marks and a single tire mark were visible at the accident site. Four sets of dual marks (see figure 3), two sets in the southbound lane and the other two sets initiating from the northbound lane, continued up to the point of impact. The single tire mark was visible in the northbound lane and also continued up to the point of impact. Evidence of braking was apparent. Seven of the nine visible tire marks were continuous rubber skidmarks from tires sliding on the pavement surface. The remaining two tire marks (a dual tandem) appeared to be lateral scuffmarks. The skidmarks in the northbound lane were measured to be about 40 feet long.

The schoolbus came to rest with its right front embedded in the westside embankment, and its left rear dual wheel straddling the west edgeline of the road. The dump truck came to rest with the right side of the dump truck body against the left center section of the schoolbus. The truck's cab, which separated from the truck during impact, came to rest about 20 feet south of the truck's final rest position.

Medical and Pathological Information

Autopsies were performed on the truckdriver and the fatally injured student. The post mortem examination of the truckdriver attributed the cause of death to a ruptured aorta and a basal skull fracture. The truckdriver also sustained a fractured arm, several fractured ribs, and multiple abrasions and lacerations of the head and the body extremities. A toxicological sample was also analyzed, and the results were negative for alcohol and drugs.

The post mortem examination of the student attributed the cause of death to extensive basal skull fractures, subarachnoid hemorrhages, and petechial hemorrhages in the brain. The student also sustained several abrasions to the head and other extremities.

^{8/} A device fabricated from a cut section of tire filled with a dense material which is pulled through its center of gravity with a spring scale to measure the coefficient of sliding friction on a paved surface.

Survival Aspects

Except for the driver, none of the schoolbus occupants was restrained. The dump truck struck the schoolbus on the left front side and penetrated rearward into the driver's seat area and the passenger compartment on the left side. One of the passengers seated on the right side was ejected; another passenger seated on the right side was partially ejected.

Although some partial separations were noted, none of the passenger seats separated completely from either its floor or sidewall anchorages. Several seatbacks were pushed forward and inboard during the impact sequence. Blood transfers were observed on the exposed seatframes and metal seatback covers. Figure 7 contains the seating positions and AIS injury level 9/ of all the schoolbus occupants. (See also appendix B.)

The dump truck was equipped with a seatbelt on the driver's seat. The truckdriver, who was ejected and killed during impact, was not wearing his seatbelt when the accident occurred.

ANALYSE

General

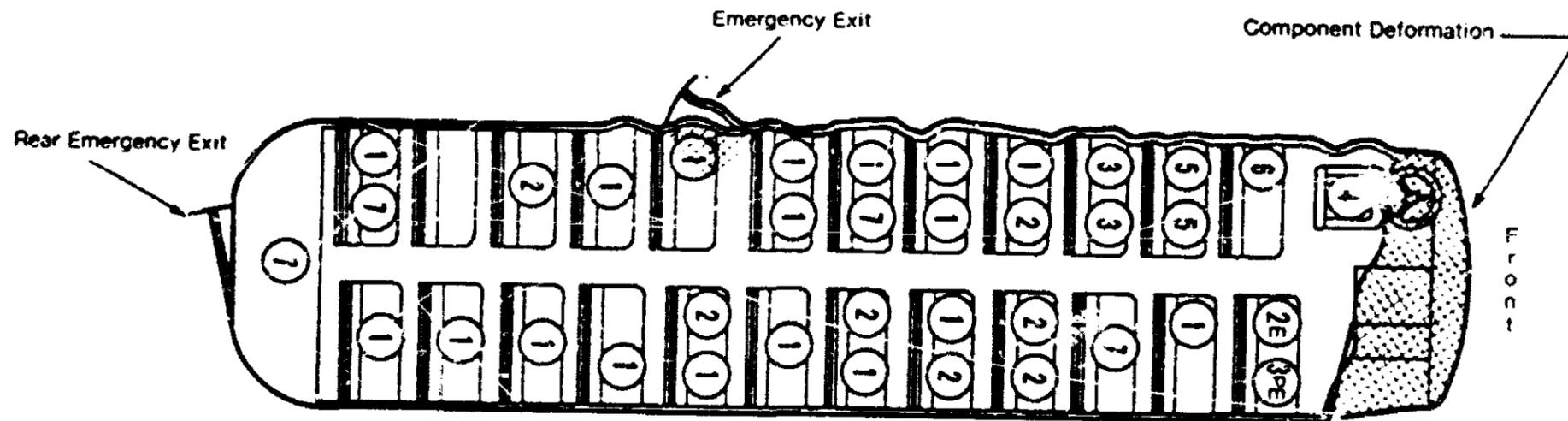
Both drivers involved in this accident held valid operator permits for the type of vehicles they were driving. Neither driver had a record of previous accidents or traffic violations. Postaccident examination of the dump truck did not disclose any preaccident mechanical deficiencies with the brakes, tires, steering, or suspension which might have influenced the truckdriver's ability to maintain vehicle control. There was no evidence of medical or physiological problems which might have influenced the preimpact performance of the schoolbus driver. The weather was not a factor in this accident.

The Accident

There was no evidence to indicate that the dump truckdriver had difficulty maintaining his vehicle in the proper traffic lane before reaching the accident site. The truckdriver had successfully negotiated several tight radius curves located about 0.4 mile from the point of impact. The critical speed for the dump truck for the tightest of these curves was about 46 mph. As the dump truck skidded sideways into the southbound lane, it rotated at a sharp radius before impacting the schoolbus. Based on witness statements, the dump truck did not tip over or upset before impacting the schoolbus. The speed at which the dump truck would have upset was calculated to be about 38 mph. 10/ Based on the fact that the dump truck had successfully negotiated the tight radius curves, and the fact that it did not upset before impact with the schoolbus, it is estimated that the truck was traveling into the straight section of road at less than 46 mph and that it had slowed to a speed of less than 38 mph when impact occurred. The truck struck the schoolbus at about a 52° angle, relative to the preimpact direction of the schoolbus. The skidmarks

9/ Abbreviated Injury Scale (AIS) developed by a joint committee of the American Medical Association, the Society of Automotive Engineers, and the American Association for Automotive Medicine to characterize the degree of highway accident injury. For details, see "Abbreviated Injury Scale, 1980 Revision, American Association for Automotive Medicine, Morton Grove, Illinois."

10/ Speed estimate based on estimated height of vertical center of gravity (3.5 feet) for the dump truck and skidmark curve radius of 118 feet.



- | | | |
|------------------|--------------------------------|------------------------|
| AIS 1 — Minor | AIS 4 — Serious | AIS — 7 (Unknown) |
| AIS 2 — Moderate | AIS 5 — Critical | E — Ejected |
| AIS 3 — Severe | AIS 6 — Virtually Unsurvivable | PE — Partially Ejected |

Figure 7.—Schoolbus crash damage patterns.

present in the northbound lane indicate that the truckdriver had applied his service brakes before impact. The truck then rotated counterclockwise about 111° during the impact sequence and came to rest adjacent to the schoolbus facing in the opposite direction of original travel. (See figure 8.)

The physical evidence indicates that the schoolbus driver, having perceived that the oncoming dump truck was crossing into the northbound lane, attempted to avoid impact by steering his vehicle to the right, while simultaneously applying his service brakes. Skidmarks present in the southbound lane indicate that the schoolbus was braking while being steered to the right at about a 5° angle relative to the road. The busdriver stated that he was traveling between 45 and 50 mph when impact was imminent. At impact, the heavier and faster schoolbus had a higher momentum than the truck. As a result, the schoolbus continued forward after the collision and caused the truck to rotate counterclockwise.

Analysis of the evidence indicates that the truckdriver was applying his service brakes for the last 40 feet before impact with the schoolbus. Assuming normal perception and reaction and brake activation times of 1.5 and 0.5 seconds, respectively, the truckdriver was apparently aware of the impending danger at least 4 seconds (264 feet) before impact.

The truckdriver had successfully negotiated a series of sharp curves, yet lost control of his vehicle shortly after entering the straight stretch of road where the accident occurred. Given the truckdriver's medical history, the possibility that he could have experienced some acute medical impairment just prior to the collision must be considered. While the truckdriver had previously suffered from medical problems which could cause dizziness or loss of consciousness and vision, and the onset of these medical conditions could occur fairly rapidly and cause incapacitation, there is no medical evidence to indicate that any of these conditions occurred before impact, or that any physical condition caused him to veer leftward into the path of the oncoming schoolbus. A review of available medical records on the truckdriver did not indicate that he was currently being treated for any condition which could cause incapacitation.

Given his reputation, the truckdriver may have been daydreaming while driving and not been fully attentive to the pickup truck traveling ahead of him. His coworkers previously stated that he was careless and inattentive when performing his work and driving duties. The truckdriver could have suddenly become aware of an increased closure rate on the pickup truck in front of him as it slowed to make a left turn, misjudged the distance, and overreacted with a "panic" braking maneuver to avoid a collision.

The truckdriver could have experienced a mechanical failure in the steering linkage, thus causing the driver to lose steering control of the vehicle. However, the Safety Board concluded that the drag link ball-joint failure had resulted from an overstress condition that had occurred during the impact sequence. The fractured components displayed features typical of a single event gross overload failure. There was no metallurgical evidence indicating that the drag link ball-joint either had separated before impact or had been loosely connected and not operating properly prior to this accident.

Survival Aspects

It is unlikely that the truckdriver would have survived this accident even if he had been restrained by a seatbelt. The passenger compartment of the cab was severely mangled during the impact sequence and did not provide adequate resistance to prevent intrusion. The sheetmetal roof structure directly over the driver's seat collapsed

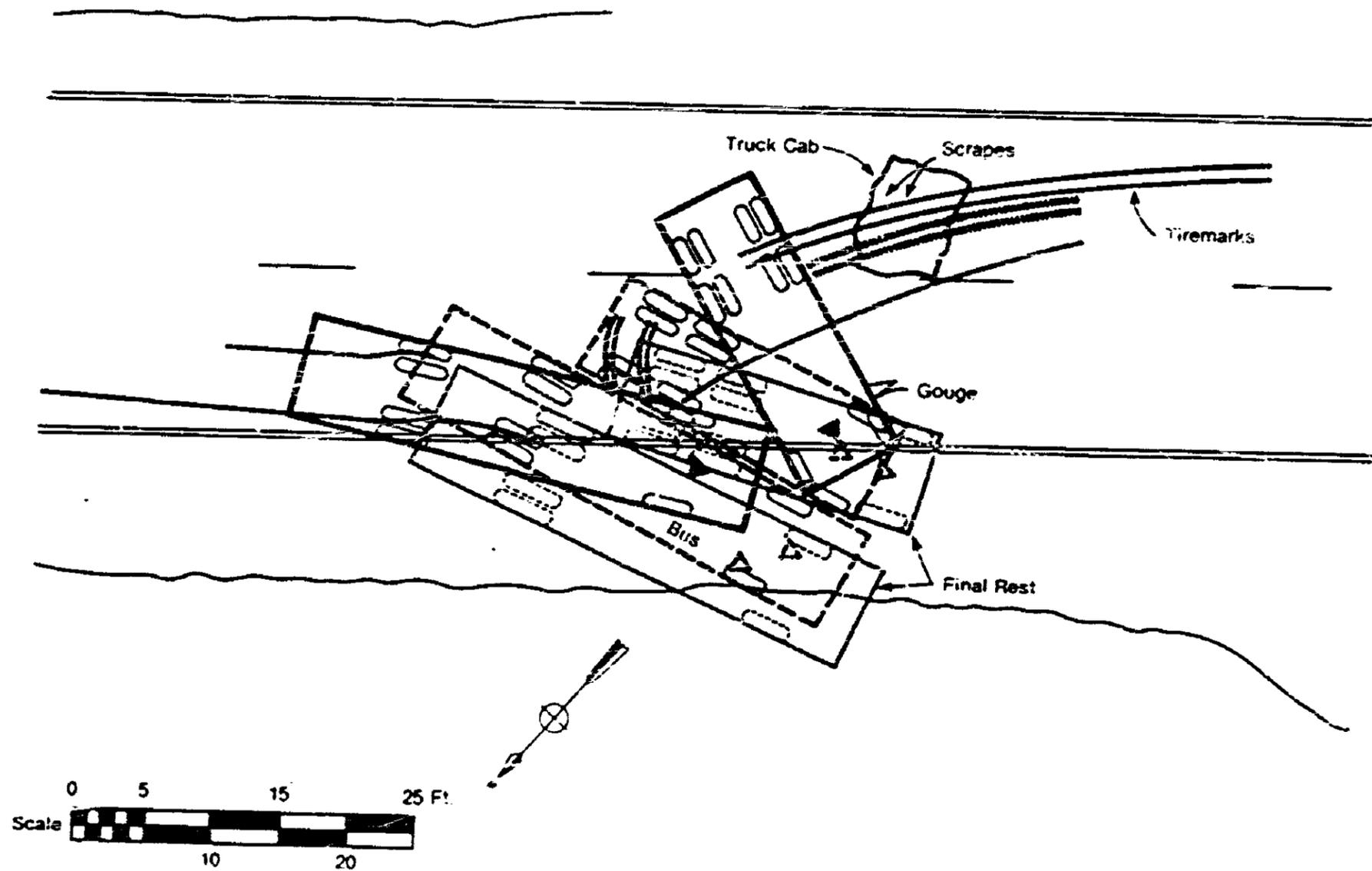


Figure 8.--Accident dynamics sequence.

downward and rearward into the driver's steering wheel. The entire cab separated from the vehicle chassis during impact, and the passenger compartment of the cab came to rest about 20 feet from the body of the truck.

The schoolbus was manufactured in 1972, before the enactment of Federal Motor Vehicle Safety Standard (FMVSS) 222, Schoolbus Seating and Crash Protection, for schoolbus occupant protection. The manufacturer thus was not required to equip the schoolbus with seatbelts, and because of the bus' size (greater than 10,000 gross vehicle weight ratio (GVWR)), the schoolbus would still be exempt today from the seatbelt requirement specified in FMVSS 222. The wooden floor and tubular steel seats within the schoolbus were not designed to accommodate occupant restraints and would have had to have been substantially upgraded to do so. If stronger seats and a more rigid floor structure had been installed, the internal crush dynamics of the schoolbus in this accident probably would have been different. Thus, an accurate assessment of the effectiveness of seatbelts could not be made.

In this accident, at least 18 passengers sustained AIS level 1 (minor) and 2 (moderate) injuries to the head and facial area. Blood transfers were noted on the exposed metal seatbacks and seatframes. Several passengers who were interviewed stated that they were thrown forward over the seats in front of them.

If seats approved under FMVSS 222 had been installed in the accident schoolbus, they might have mitigated some of the minor to moderate injuries. Seats approved under FMVSS 222 are designed to absorb energy through controlled yielding, and are covered with padding to reduce occupant injuries associated with direct contact with exposed seatframes and metallic seatback covers. In a 1980 study conducted for the National Highway Traffic Safety Administration (NHTSA) to evaluate the effectiveness of FMVSS 222, ^{11/} it was determined that the requirements of FMVSS 222 are probably very effective in reducing minor to moderate injuries, which are the most severe injury levels experienced in the vast majority of schoolbus accidents. The standard's requirements probably would be less effective in reducing more severe injuries, as may occur in the few violent schoolbus accidents that produce fatalities. The requirements are thought to have only limited effectiveness in the extremely small number of very violent accidents involving, for example, rollovers or collisions with trains. In these types of crashes where there is usually substantial crushing of the schoolbus body into the occupant compartment, passengers are thrown into contact with each other or with broken glass, the walls, the roof, or other interior components.

It is not likely that the installation of seats approved under FMVSS 222 would have mitigated any of the serious injuries in this accident. The schoolbus body passenger compartment was intruded during impact. The entire frontal section of the schoolbus was pushed rearward during impact. Most of the seriously injured passengers were seated in the front-row seats and were thrown into the rearward moving front interior structure during the impact sequence. Two passengers seated in the right front seat were ejected; they sustained moderate to severe injuries. One other passenger seated in the left front seat sustained fatal injuries.

^{11/} Statistical Evaluation of the Effectiveness of FMVSS 222: Schoolbus Seating and Crash Protection, Center for the Environment and Man, Inc., October 1980.

Although transit-type buses are not widely used for schoolbus purposes throughout the country, three western States have schoolbus fleets which include a significant number of transit-type schoolbuses. Because transit-type schoolbuses have a service life which is twice as long as the conventional schoolbus, ^{12/} it is not unusual that they undergo refurbishment, including refurbishment of the interior components. The service life of conventional schoolbuses is relatively short and retrofit with updated seats and interiors probably would not be cost effective. Although the cost estimates for replacement of prestandard ^{13/} seats and barriers would not justify a wholesale retrofit of these buses, the use of poststandard seats should be considered for transit-type schoolbuses when refurbishment includes replacement of existing seats. Thus, the Safety Board urges those States ^{14/} to consider retrofitting their prestandard transit-type schoolbuses with FMVSS 222 seats and restraining barriers, if the schoolbus interior is refurbished at any time during its service life.

The Safety Board contacted the schoolbus manufacturer to determine if the model of bus involved in this accident could be retrofitted with poststandard approved seats. A representative of the schoolbus manufacturer stated that he was aware of one California school district which had purchased poststandard approved seats and installed them into a prestandard schoolbus similar to the accident vehicle.

Medical Issues

The truckdriver did not properly advise his employer of all his medical problems. The truckdriver had two medical examinations between 1980 and 1982; a preemployment physical examination before beginning work with Humboldt County, and another routine physical examination which was performed in conjunction with his driver's license renewal. Neither examination uncovered any of the truckdriver's previous medical problems. Although the truckdriver knew of at least two of his medical problems, there is no record of the truckdriver having reported any of his medical problems during these two examinations. By failing to volunteer this information, the truckdriver hampered the examining physician's ability to diagnose his medical problems accurately and their possible bearing on the truckdriver's ability to work and drive.

Neither the Humboldt County medical examination form nor the State of California Medical Information examination report requires the applicant to declare that the statements and answers provided for each physical examination form are true and complete to the best of the applicant's knowledge. There are no provisions regarding fraud or falsification of information on either form. Basically, both forms are formal questionnaires which allow the applicant to disclose only that personal medical history which the applicant deems to be appropriate. It is apparent that the omission of relevant medical facts can encumber the county and State's ability to determine adequately if an applicant ^{15/} is medically qualified.

^{12/} The service life for a schoolbus is estimated to be 10 years for a conventional schoolbus and 20 years for a transit-type schoolbus.

^{13/} "Prestandard" refers to those seats and barriers manufactured before FMVSS 222 became effective. "Poststandard" refers to those seats and barriers manufactured after FMVSS 222 became effective.

^{14/} The States of California and Washington offer incentives to their respective school districts to recondition or refurbish existing schoolbuses within their fleet in lieu of replacement cost.

^{15/} Applicant for a State of California class 1 and 2 motor vehicle operator's license or county driving position which requires a valid class 1 or 2 operator's license.

The Safety Board believes that the requirements for obtaining a class 1 or class 2 motor vehicle operator's license should be expanded to include a provision which requires an applicant to submit complete and explicit medical information. Moreover, if under the existing administrative authority, there are no provisions regarding fraud or the falsification of medical information, pursuant to obtaining a class 1 or class 2 motor vehicle operator's license, then consideration should be given to enacting the appropriate legislation to do so.

A review of Federal Motor Carrier Safety Regulation (FMCSR) 49 CFR 391.43 indicates that there are also no provisions in these regulations prohibiting the falsification or omission of medical information in connection with the medical certification physical examination. The health history section of the examination report requires the applicant to answer certain questions. It is not apparent that the applicant must provide answers that are true and complete. The Safety Board believes that the Federal Highway Administration should consider revising the FMCSR to add therein a provision, similar to 14 CFR 69.20(a), 16/ which relates to the medical certification of airmen, prohibiting false, fictitious or fraudulent statements on interstate commercial drivers' medical certificates of physical examination.

CONCLUSIONS

Findings

1. The weather was not a factor in this accident.
2. There is no evidence of preimpact vehicle deficiencies which might have contributed to the accident. The failure of the drag link ball joint on the dump truck resulted from an overstress condition that occurred during the sequence.
3. Each vehicle driver held a valid operator permit for the type of vehicle he was operating.

16/ Code of Federal Regulations, Title 14, Part 67, Section 67.20(a):

Applications, certificates, logbooks, reports, and records: Falsification, reproduction, or alteration.

(a) No person may make or cause to make-

- (1) Any fraudulent or intentionally false statement on any application for a medical certificate under this part;
- (2) Any fraudulent or intentionally false entry in any logbook, record, or report that is required to be kept, made, or used, to show compliance with any requirement for any medical certificate under this part;
- (3) Any reproduction, for fraudulent purpose, of any medical certificate under this part;
- (4) Any alteration of any medical certificate under this part.

(b) The commission by any person of an act prohibited under paragraph (a) of this section is a basis for suspending or revoking any airman, ground instructor, or medical certificate or rating held by that person.

4. There is no evidence to indicate that the dump truckdriver experienced any difficulty in maintaining his vehicle in the proper traffic lane before reaching the accident site.
5. The truckdriver apparently was not fully attentive to the pickup truck traveling ahead of him.
6. The truckdriver was apparently aware of the impending danger at least 4 seconds before impact. He applied his brakes forcefully, causing the truck to skid sidewise into a sharp radius left turn and impact the schoolbus at a 52° angle relative to the preimpact direction of the schoolbus.
7. The truck speed at impact was calculated to be slightly less than 38 mph.
8. The schoolbus driver perceived the oncoming danger and took evasive action to avoid impact by steering to the right and applying his brakes.
9. The schoolbus speed at impact was estimated to be between 45 and 50 mph.
10. The dump truckdriver was not restrained by a seatbelt, but probably would not have survived this accident in any event.
11. Although the truckdriver had medical problems which could cause dizziness or loss of consciousness and loss of vision, the evidence did not indicate positively that any of these conditions occurred before impact, or that any other physical problem caused him to veer leftward into the path of the schoolbus.
12. There was no metallurgical evidence indicating that the drag link ball-joint either had separated before impact or had been loosely connected prior to this accident.
13. The schoolbus predated the occupant crash protection seat and barrier requirements of FMVSS 222; the schoolbus' size would continue to exempt it from the standard's seatbelt requirements if it were manufactured today.
14. If padded seats and restraining barriers approved under FMVSS 222 had been installed in the accident schoolbus, they might have mitigated some of the passenger injuries associated with contact with the exposed metallic seat-frames and seatbacks.
15. The truckdriver did not fully advise his employer of his medical condition.
16. Neither the Humboldt County nor the State of California medical examination procedures require applicants to declare that all statements on the medical history they submit are true and complete. Moreover, there are no provisions in either jurisdiction regarding the fraud or falsification of information.
17. The Federal Motor Carrier Safety Regulations governing medical certification for interstate commercial drivers currently do not have any provisions regarding the falsification or omission of medical history in conjunction with the driver certificate of physical examination.
18. The truckdriver probably would not have been employed by Humboldt County as a truckdriver had his medical history been known to Humboldt County.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the inattention of the truckdriver to the developing traffic situation ahead and the execution of a braking maneuver that resulted in the truck sliding out of the proper lane of travel.

Contributing to the severity of some of the student injuries were the pre-Federal Motor Vehicle Safety Standard 222 schoolbus seats with exposed metal frames.

RECOMMENDATIONS

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

--the State of California Department of Motor Vehicles:

Expand its medical qualifications requirements for a class 1 and 2 motor vehicle operator's license to include a provision which requires an applicant to submit complete and explicit medical information, including one's medical history. (Class II, Priority Action) (H-83-65)

Consider enacting appropriate legislation to prohibit the falsification and/or omission of medical information pursuant to obtaining a class 1 and 2 motor vehicle operator's license if current administrative authority will not permit the present medical qualifications to be expanded. (Class II, Priority Action) (H-83-66)

--the California State Department of Education and the Washington State Board of Education:

Initiate a program to retrofit (except where the design makes retrofitting economically prohibitive) all transit-type schoolbuses within your fleet that are not equipped with Federal Motor Vehicle Safety Standard (FMVSS) 222 approved seats with FMVSS 222 approved seat and restraining barriers if these schoolbuses are refurbished during their normal service life. (Class II, Priority Action) (H-83-67)

--the Federal Highway Administration:

Revise Federal Motor Carrier Safety Regulation 49 CFR 391.43 to incorporate a provision, similar to that specified in 14 CFR 67.20(a) for airmen medical certification, which will prohibit the falsification or omission of medical information in connection with a medical certification physical examination. (Class II, Priority Action) (H-83-68)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

December 5, 1983

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of this accident through the U.S. Coast Guard National Response Center at 4:00 a.m. e.s.t. on February 25, 1983. Investigators were dispatched from the Washington, D.C. Headquarters on February 25, 1983. Investigators were assisted by representatives of the International Harvester Corporation, the H. R. Sheppard Company, and the Gillig Corporation.

Deposition

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

APPENDIX B

SCHOOLBUS PASSENGER INJURIES

Data were obtained on all 38 persons aboard the two vehicles. (See figure 9.) Their injuries were classified according to the American Association for Automotive Medicine Abbreviated Injury Scale (AIS) and are presented in the table below:

<u>AIS</u>	<u>Severity of injury</u>	<u>Operators</u>		<u>Passengers</u>		<u>Totals</u>
		<u>Schoolbus</u>	<u>Dump truck</u>	<u>Schoolbus</u>	<u>Dump truck</u>	
1	Minor			17		17
2	Moderate			08		08
3	Severe (not life-threatening)			03		03
4	Serious (life-threatening, survival probable)	1				01
5	Critical (survival uncertain)			02		02
6	Virtually unsurvivable		1	01		02
7	Insufficient information			05		05
Totals		<u>1</u>	<u>1</u>	<u>36</u>	<u>0</u>	<u>38</u>

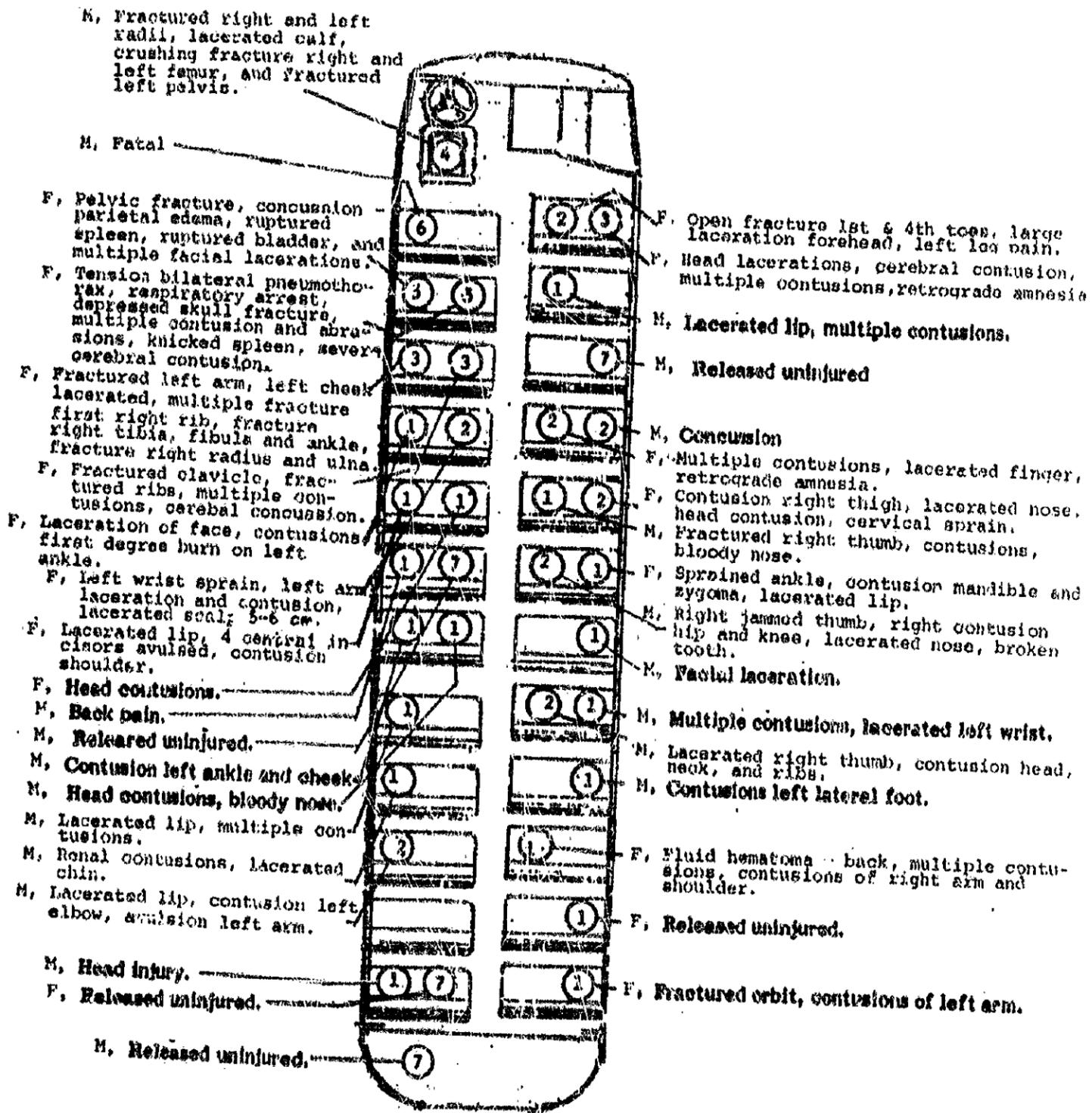


Figure 9.--Schoolbus diagram with probable distribution of occupants and their AIS injury severity code.