NATIONAL TRANSPORTATION SAFETY BOARD

HIGHWAY ACCIDENT REPORT

JESUS AYALA SCHOOLBUS-TYPE BUS
RUN-OFF ROADWAY/DRAINAGE DITCH SUBMERGENCE
BLYTHE, CALIFORNIA
JANUARY 15,1974

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20594
REPORT NUMBER: NTSB-HAR-75-1

SS-H-35

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15. Supplementary Notes

This report contains Highway Safety Recommendations No. H-75-1 through H-75-2.

16. Abstract

This report describes and analyzes an accident involving a schoolbus-type bus which ran off the roadway while attempting to negotiate a right-angle turn and vaulted into a farm drainage ditch. The bus came to rest on its left side, partially submerged. Nineteen of the 47 occupants, including the driver, died in the accident. For each fatality, the cause of death was drowning.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the bus to that required to negotiate the turn, despite the presence of a turn warning/advisory speed sign. Contributing to this failure was a lack of driver alertness induced by fatigue.

This report contains recommendations to the Riverside County Road Commission.

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FOREWORD

The accident described in this report has been designated a major accident by the National Transportation Safety Board under the criteria established in the Safety Board's regulations.

This report is based on evidence obtained by the California Highway Patrol, the Federal Highway Administration (Bureau of Motor Carrier Safety), the Riverside County, California, Coroner's Office, and the Ward Bus Company.

The conclusions, the determination of probable cause, and the recommendations herein are those of the Safety Board.

The facts in this case were discussed with the National Highway Traffic Safety Administration before its rulemaking action on Docket 73-3, which establishes minimum requirements for schoolbus seat and seat anchorage strength.

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SYNOPSIS

At 6:30 a.m., P.d.s.t., during hours of darkness on January 15, 1974, a bus transporting 46 Mexican farm laborers, was traveling northbound on Rannells Boulevard, about 9 miles southwest of Blythe, California. The bus' speed was between 45 and 55 mph--a speed too high to negotiate a limited radius, right-angle turn onto 20th Avenue. A right turn warning sign in combination with a 20-mph advisory speed sign was posted about 350 feet before the curve.

The bus left the roadway, crossed the shoulder, and vaulted into the bottom of a drainage ditch. There was an 18-foot drop from the top ledge of the ditch to the water below. The bus came to rest on its left side, partially submerged. At impact, all seats, except for the last rear, across-the-bus seat and a corner of the driver's seat, were torn from their mountings. Nineteen of the occupants of the bus, including the driver, died in the accident. The cause of each death was drowning.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the bus to that required to negotiate the turn, despite the presence of a turn warning/advisory speed sign. Contributing to this failure was a lack of driver alertness induced by fatigue.

FACTS

The Accident

At 6:30 a.m., P.d.s.t., during hours of darkness on January 15, 1974, a schoolbus-type bus, 1/ which was transporting 46 Mexican farm laborers, was traveling northbound on Rannells Boulevard, approaching a 90° right turn on to 20th Avenue, about 9 miles southwest of Blythe,

1/ The bus involved in this accident was reportedly manufactured specifically for farm labor use. However, its general construction is similar to that of a schoolbus.

California. The bus had separated from a two-bus convoy and was en route to the High and Mighty Farms near the accident site. The bus was traveling in the middle of the 23-foot-wide street at 45 to 55 mph, a speed too high to negotiate the turn. A right turn warning sign in combination with a speed advisory sign, which was posted about 350 feet before the turn, warned of the turn and recommended a maximum speed of 20 mph. According to witnesses, as the bus approached the turn, the driver seemed to hesitate and then began to steer sharply to his right in an attempt to negotiate the turn. He did not apply the brakes nor did any witness describe an attempt to accelerate through the turn. The bus crossed the edge of the pavement on the far side of the road, about midway through the turn and traveled 37 feet diagonally across the dirt shoulder to the edge of an 85-foot-wide drainage ditch, which paralleled Rannels Boulevard. (See Figure 1.)

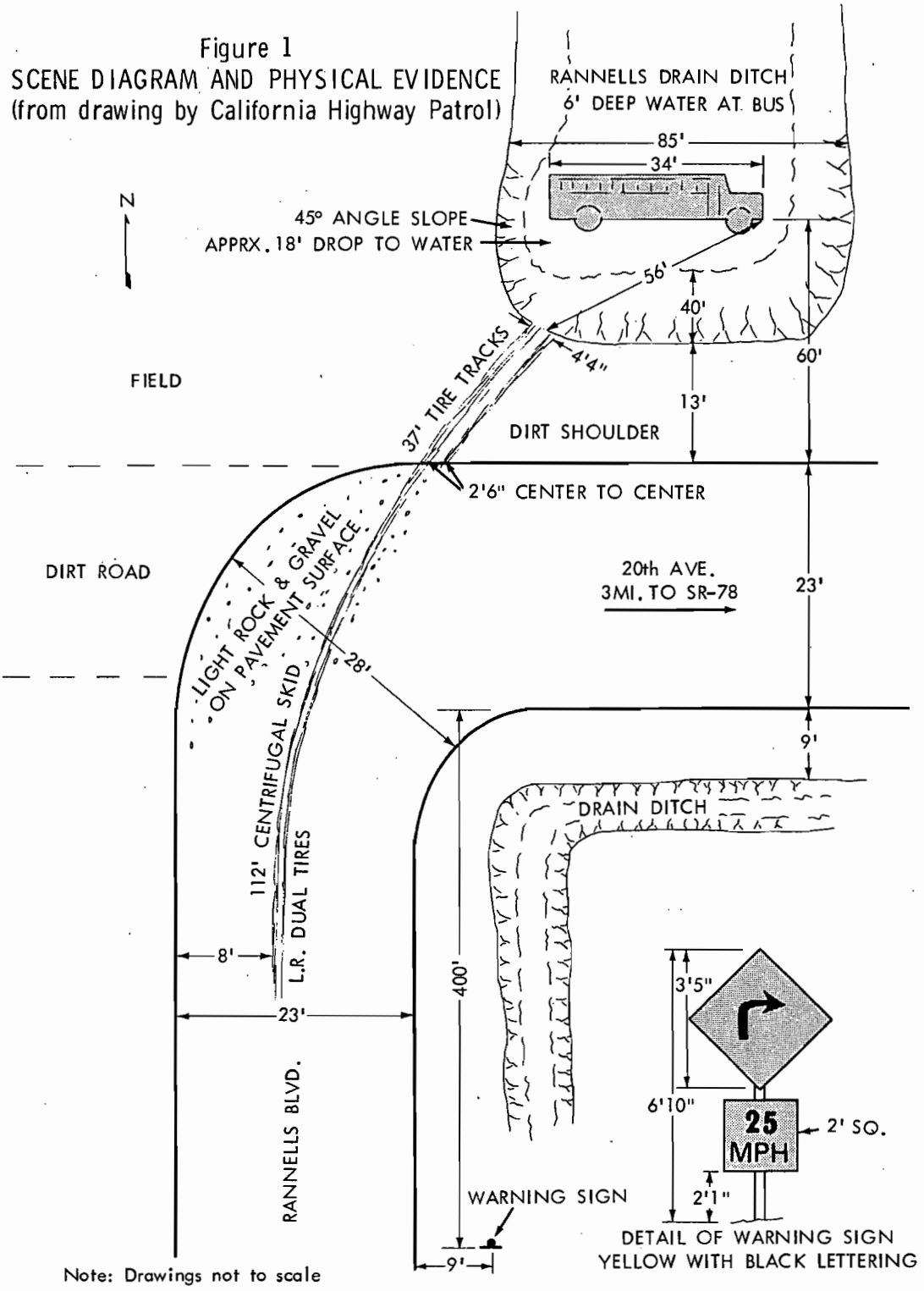
The bus vaulted through the air 56 feet horizontally and fell 18 feet vertically into the water below. The bus was traveling at an estimated 35 mph when it left the top ledge of the ditch. The damage and physical evidence indicate that the bus contacted the bottom of the ditch at an estimated 40 mph in a nosedown attitude, while in a clockwise yaw and rolling to the left. It came to rest on its left side and perpendicular to its original direction of travel. Although the water at the center of the ditch was 6 feet deep, the bus bridged the sloping sides of the ditch and was therefore only partially submerged. The water level was 28 in. high inside the bus.

At impact, the seats and passengers were thrown forward and to the left as a result of the collision forces. All seats, except the last rear, across-the-bus seat and a corner of the driver's seat, were torn from their mountings. The seats on the left side of the bus and the passengers who were originally seated on the left side of the bus were compressed together and trapped in the water. The similarly compressed seats and passengers from the right side were piled on top of those on the left. (See Figure 2.) Only 4 of the 23 occupants originally seated on the left side of the bus survived. The cause of each death was drowning. None of the passengers originally seated on the right was killed.

Accident Site

The initial events of the accident occurred on Rannells Boulevard, a north-south roadway on the approach to its paved transition or turn to 20th Avenue, an east-west roadway. (See Figure 1.) To the south of the paved transition, Rannells Boulevard is an asphalt paved road, with a 1-percent downgrade northbound. It was reported to be in good condition with excellent frictional properties. The pavement is 23 feet wide with no centerline or pavement-edge markings. Dirt shoulders, 8 to 10 feet wide, are continuous along each side of the road. The loose dirt from the shoulders provides an irregular definition of the edges of the road. On the pavement,

Figure 1
SCENE DIAGRAM AND PHYSICAL EVIDENCE
(from drawing by California Highway Patrol)



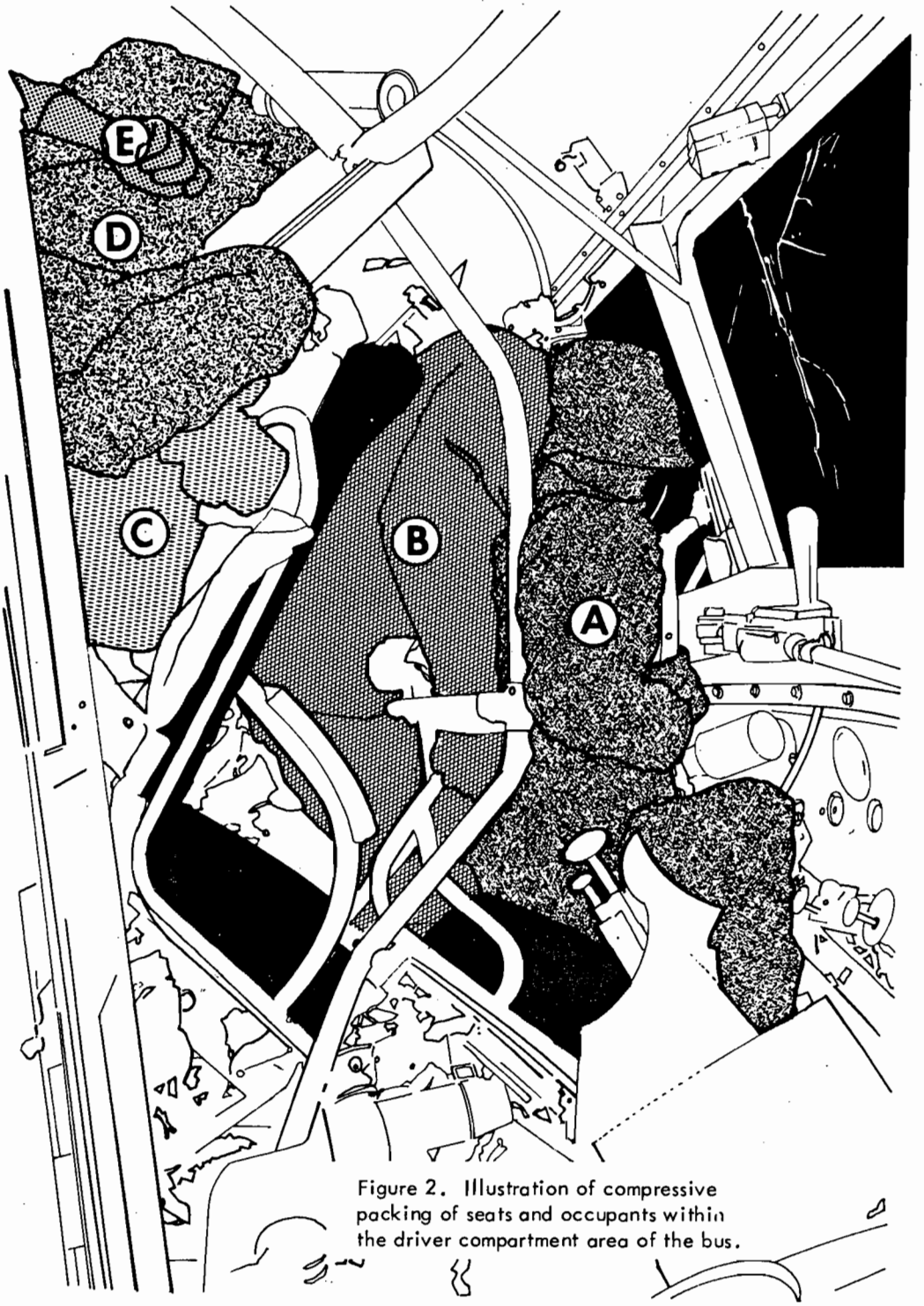


Figure 2. Illustration of compressive packing of seats and occupants within the driver compartment area of the bus.

the most contrasting features were a narrow stained line somewhat along the center of the road, and the path formed from normal traffic use. The path continues through the right turn and along 20th avenue.

There are no obstructions to limit a driver's view to the left or in front for northbound Rannells Boulevard traffic approaching the turn to 20th Avenue. The terrain is level and flat with no distinguishing features that would be recognized, especially at night. To the driver's right, however, a line of brush and piles of earth 8 to 10 feet high parallel Rannells Boulevard and end about 150 feet before the right-angle turn to 20th Avenue. (See Figure 3.) These features would obstruct a driver's view of 20th Avenue to his right, as he approached the turn.

There was an unposted 55 mph speed limit 2/ in effect along Rannells Boulevard, except for that section in which the accident occurred. A warning sign, denoting a right turn, was posted about 350 feet south of the transition from Rannells Boulevard to 20th Avenue. (See Figure 4.) A 20-mph advisory speed plate was attached under the warning sign. The bottom of the advisory speed plate was 25 inches from the ground. The right turn warning sign was a standard size W1-1R and measured 30 in. by 30 in. The advisory speed plate was 24 in. by 24 in.

The Federal Highway Administration's adopted Manual on Uniform Traffic Control Devices for Streets and Highways, 3/ under Section 2C-3, calls for warning signs in rural areas to be normally placed about 750 feet in advance of the turn. The actual location is dependent upon the prevailing speed and prevailing conditions in the area. Section 2A-23 states that signs erected at the sides of roads in rural districts shall be mounted at a height of at least 5 feet, measured from the bottom of the sign to the near edge of the pavement. The height of the speed advisory sign mounted below the right turn sign may be 1 foot less than the appropriate height specified above. Section 2C-36 indicates that 24 in. by 24 in. advisory speed plates should be used in conjunction with 36-in. and larger turn warning signs.

An 85-foot-wide drainage ditch parallels Rannells Boulevard beyond the line of brush and piles of earth. This ditch continues to the right and follows the transition from Rannells Boulevard to 20th Avenue. The ditch connects to a north-south ditch on the north side of 20th Avenue. The latter was the ditch into which the bus vaulted. The side of the

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2/ The maximum speed limit set by State law for highways not posed by signs or addressed by local ordinance.

3/ Manual on Uniform Traffic Control Devices for Streets and Highways, 1971 Edition; U. S. Government Printing Office, Washington, D. C., developed with the cooperation of the American Association of State Highway Officials and the National Joint Committee on Uniform Traffic Control Devices and adopted by the Federal Highway Administration.

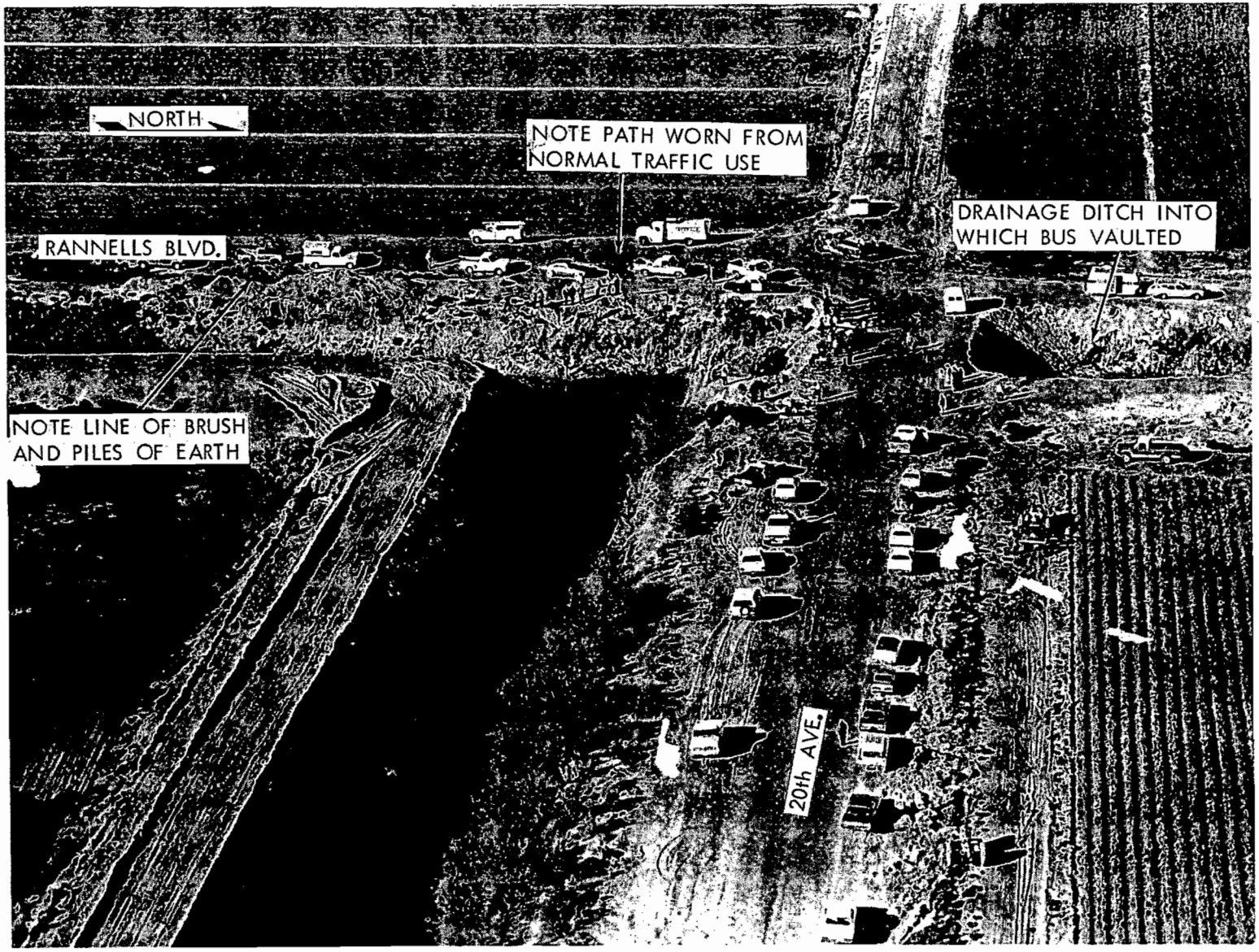


Figure 3. An aerial view of the accident site.

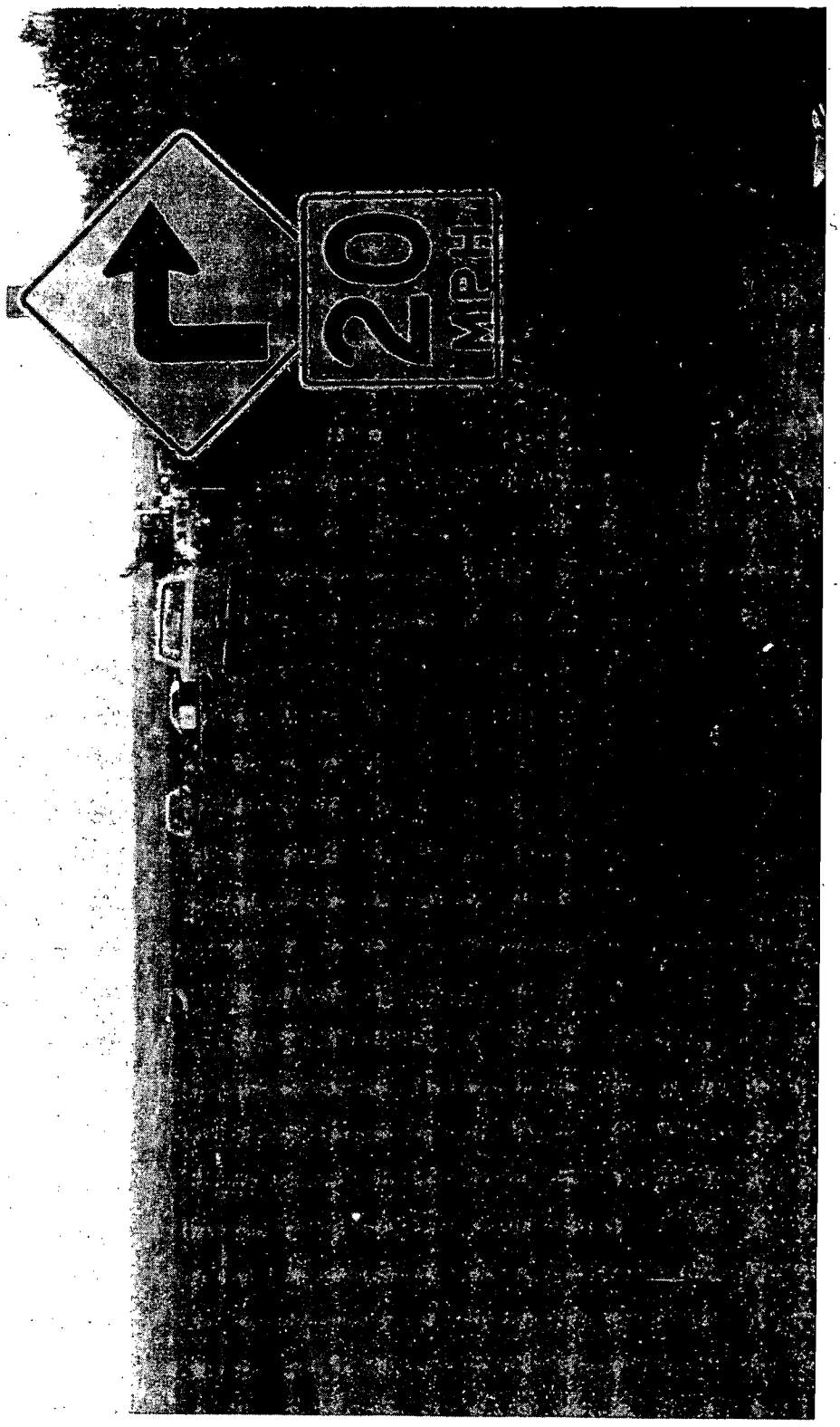


Figure 4. Curve warning/advisory speed sign.

ditch sloped at an angle of 2:1. There was no guardrail, barrier, or other similar device present to prevent errant traffic from entering the ditches at the curve.

AASHTO policy 4/ recommends guardrails or guideposts along water courses and deep ditches. The policy permits their omission if the slopes are 4:1 or flatter. 5/

The transition between north-south Rannells Boulevard and east-west 20th Avenue is a limited-radius curve. The two streets, Rannells Boulevard and 20th Avenue, are perpendicular and terminate at this transition, thereby forming an intersection. Two slightly offset dirt farm roads continue to the north and to the west. These roads are similar to the shoulders in color and composition and would not therefore be easily distinguished as roads at night. Beyond the transition, 20th Avenue is similar to Rannells Boulevard. No accident history was reported for this location.

Environmental Factors

At the time of the accident, the road was dry, the weather was clear, and no other traffic was reported to be an influence. It was dark, and there were no street lights. The only illumination was provided by the bus' headlights. After the crash, the head lamps of the bus were still on, but their setting (high or low beam) was not reported.

Marks on the Roadway

There were 112 feet of centrifugal skidmarks from the left rear dual tires of the bus. These skidmarks began at a point to the left of the center of the roadway about 75 feet from the point where the bus crossed the edge of the pavement. (See Figure 1.) These marks continued 37 feet further along and across the shoulder of the roadway to the edge of the drainage ditch. No precrash marks were reported along the side slope of the drainage ditch, which indicated that the bus vaulted from the top ledge to its final position in the water below. The final position of the front of the bus was 56 feet horizontally from the point where the bus vaulted from the edge of the ditch and 60 feet laterally from the edge of the road.

Using the above data, witness' statements, and information concerning the condition of the bus, it was possible to calculate the speed of the bus as it approached the curve (45 to 55 mph), as the driver began

4/ A Policy on Geometric Design of Rural Highways, 1965, American Association of State Highway Officials, page 242 (now AASHTO).

5/ A 2:1 slope is 2 feet horizontally for every 1 foot of vertical drop. A 4:1 slope is flatter, or 4 feet horizontally for every 1 foot of vertical drop.

his evasive action (45 mph), as the bus left the top ledge of the ditch (35 mph), and as it impacted the bottom of the ditch (40 mph).

Events Preceding the Accident

The surviving passengers were the only witnesses to the accident. These surviving passengers, the driver's wife, the owner of the bus, the convoy supervisor, personnel of the restaurant where the bus had made a rest stop, and residents of the area in which the accident occurred, were interviewed to obtain background information. These sources provided the following history of the trip and details regarding the accident sequence.

The bus departed Calexico, California, on the U.S.-Mexican border, at 3:30 to 4 a.m. P.d.s.t. It was bound for the High and Mighty Farms, 20th Avenue, Blythe, California--about 93 miles northeast of Calexico. At 6 a.m., the bus arrived in Palo Verde, California--about 10 miles from the accident site--where it stopped for 13 minutes. None of the survivors could recall any problems with the bus headlights nor did they detect any exhaust fumes inside the bus en route. One passenger mentioned that the speedometer was not working. No one saw the driver drink anything during the trip, other than coffee at the rest stop. Although no one reported any unusual driver behavior, one passenger stated that, "People were saying he had been drinking."

The busdriver followed Route 78 for most of the trip from Calexico to Blythe. The convoy supervisor stated that the driver was familiar with the Blythe area and that this was his third trip to that farm. On the day before the accident, the driver had gone to other fields nearby. The convoy supervisor did not know if the driver had used the same route the day before, but did note that the buses usually followed Rannells Boulevard to 20th Avenue as part of their route. He also noted that the busdriver knew where he was going. The convoy supervisor and another bus came upon the accident because they had missed an earlier turnoff from Rannells Boulevard to another and new set of fields.

As the bus approached the turn where the accident occurred, the driver seemed to hesitate, then began to steer sharply to his right in an attempt to negotiate the turn. According to passengers seated near the front of the bus, the driver did not attempt to apply the brakes or to accelerate through the turn. A majority of the survivors stated that the driver was driving too fast to negotiate the turn.

Busdriver

The busdriver was 54 years old and weighed 125 pounds. He had been employed intermittently by the contractor for 5 to 7 years.

He held a valid Class 2 California Chauffeur's license, issued February 14, 1973, with a Farm Labor Bus Certificate and Medical Examiner's

Certificate issued on that same date. The California Motor Vehicle Administrator's files listed the following convictions with respect to motor vehicle laws:

03-16-72	Stop Sign Violation
03-20-72	Bus Equipment Violation
05-29-72	Defective Lighting

There was no record of any motor vehicle accidents for the driver.

The busdriver was employed as both a driver and field foreman. His field duties included both supervision of laborers and field work. The contractor stated that he uses two drivers on each bus, one to drive to the location and the other to drive back. According to the busdriver's wife, her husband usually left for work between 1:30 and 2:30 a.m. and returned home at 6 to 7 p.m. Field working hours for migrant laborers are from about 7:30 a.m. to about 4 p.m. With the additional duty of driving one-way, the driver would be working an 11- to 12-hour day. When his nonduty travel time was included, the driver was working 16 1/2 hours per day. He had been following this schedule for 3 consecutive days before the accident.

The previous evening, he arrived home from work at about 7 p.m., ate dinner, watched TV for a short time, and then went to bed. He awoke at midnight and left for work about 1/2 hour later. He picked up a friend and they went to breakfast. According to the friend, the busdriver had two tacos and one beer for breakfast. The bus departed Calexico between 3:30 and 4 a.m.

Inasmuch as the transportation of the migrant workers in this case was intrastate, neither the driver nor the vehicle were subject to the Federal Motor Carrier Safety Regulations (FMCSR). Both the vehicle and the driver were subject to the California Motor Vehicle Code 6/ which prohibits the driver from driving more than 10 hours following 8 consecutive hours off duty or driving for any period of time after having been on duty 16 hours following 8 hours off duty.

The driver was pronounced dead at the scene of the accident. He was found in the driver's seat, jammed between passengers who had been thrown from the rear and the steering wheel, instrument panel, and windshield. His major impact-related injuries included a complete fracture of the sternum (breast bone) and fracture of the left ribs in the mid-clavicular line. The autopsy report also noted "probable middle ear hemorrhages, foam in the tracheobronchial tree, and marked pulmonary congestion with intra-alveolar hemorrhage." Death was by drowning.

6/ State of California, California Administrative Register 72, No. 42-B October 14, 1972; Amendments and Additions to Rules and Regulations, Title 13, page 344, section 1269.

Toxicological tests at autopsy indicated a blood alcohol level of 0.03 percent and 5 percent carboxyhemoglobin saturation in the blood. The National Highway Traffic Safety Administration's Highway Safety Program standard on Alcohol 7/ defines a driver as "intoxicated" or "under the influence" of alcohol when he exhibits blood-alcohol concentrations "not higher than 0.10 percent by weight." No barbituates nor narcotics were detected.

The Bus Passengers

All surviving passengers were injured. Seven survivors were injured severely enough to require hospital treatment.

A seating chart was developed to show the positions of all passengers. (See Figure 5.) The fatally injured passengers were seated on the left side of the bus before the crash. There was a "pocket" of survivors located forward of the rear wheel on the left side. Examination of a photograph taken before the bus was removed from the ditch indicates that while seats from both sides of the bus were stacked from floor to ceiling in all other areas of the left side of the bus, there appeared to be only one seat in this "pocket" area. (See Figure 6.) Although this may have been caused by postcrash rescue attempts, there is a possibility that the raised portion of the bus floor over the rear wheels served to limit intrusion into the "pocket."

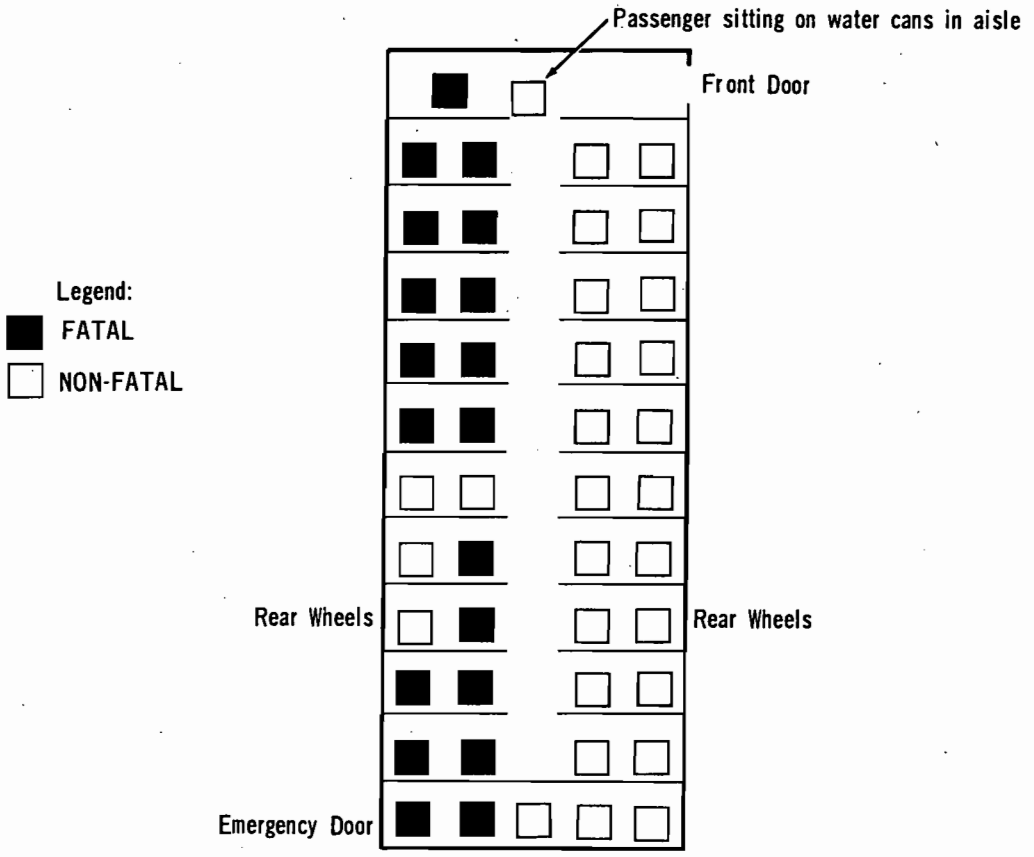
The Bus

The bus was owned by Jesus Ayala, a farm labor contractor. It was a Ward Industries, Inc., schoolbus-type body mounted on a 1955 GMC, two-axle chassis. It was equipped with a six-cylinder gasoline engine, a standard transmission, air brakes with spring-loaded, rear brake chambers, and manual steering. No seatbelts were installed. According to the manufacturer, assuming an engine in good condition and a transmission and rear axle as originally delivered, the top speed of the bus was 57 to 60 mph.

The windows were a drop type, which provided an exit area of 12 in. by 24 in. The right half of the windshield and both back windows remained intact. The left half of the windshield was broken but in place. The emergency door located on the left side at the rear of the bus was blocked, because the bus came to rest on its left side.

Exterior damage was principally to the left front corner of the bus where the bumper was forced rearward against the left front wheel. (See Figure 7.) Of the 12 windows along the left side of the bus, only 2 were in place, and they were broken. Damage to these 2 windows appeared to be a result of loading from the inside since they bulged outward. (See Figure 8.)

7/ Highway Safety Program Standard No. 8, Alcohol in Relation to Highway Safety, U. S. Department of Transportation, National Highway Traffic Safety Administration, October 1, 1973.



NOTE: All surviving passengers were reported to have visible injuries.
Seven of these were injured severely enough to require hospital treatment.
Their identities were not reported.

Figure 5. Bus occupant pre-crash seated position severity of injuries.

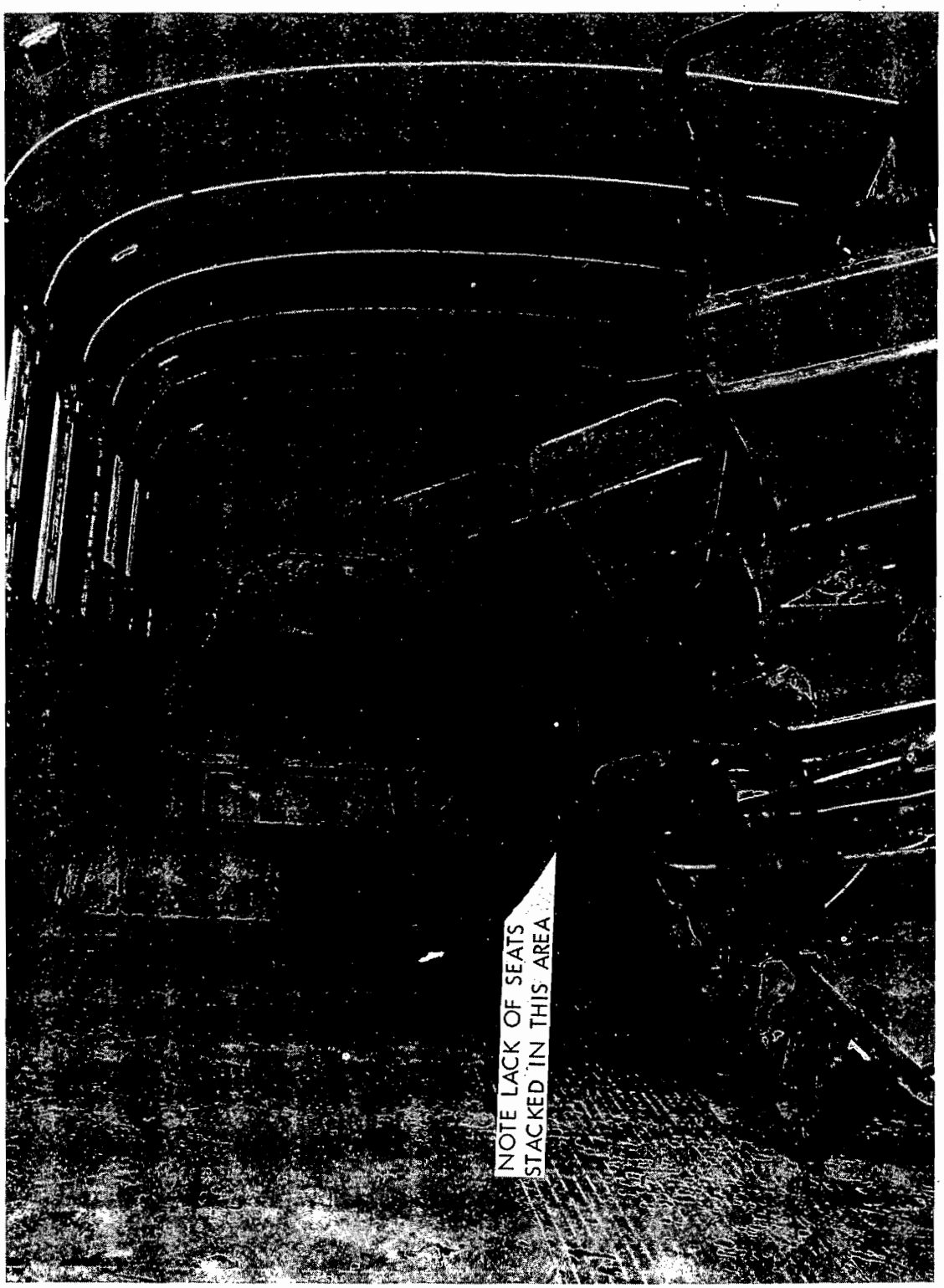


Figure 6. A view showing the seats before the bus was removed.

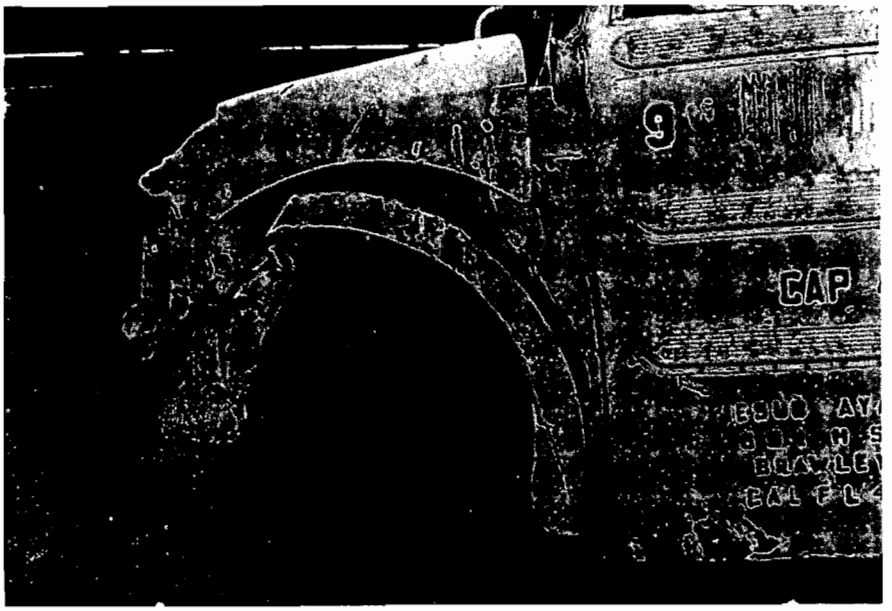


Figure 7. A view of damage in the engine compartment area.

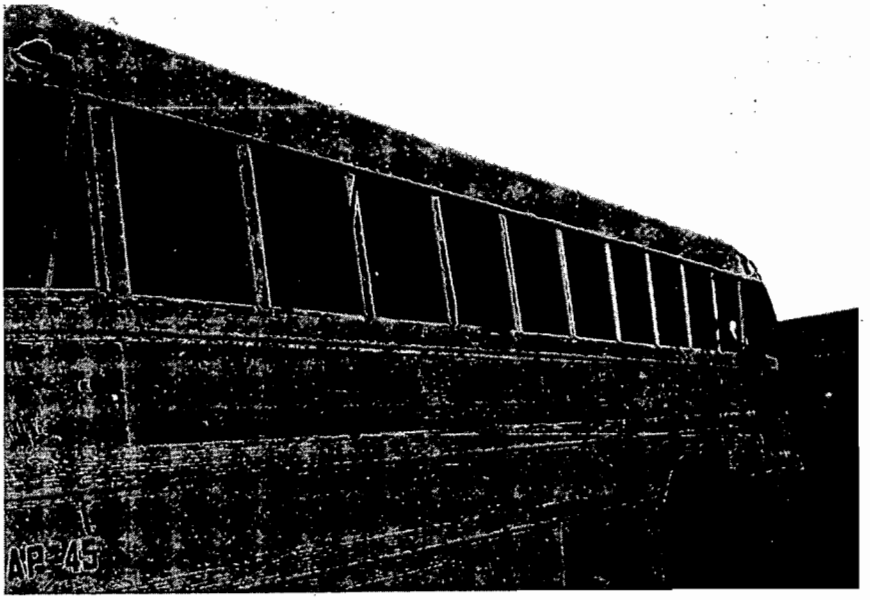


Figure 8. A view of the left side of the bus. Note the broken glass.

Two windows the right side appeared to have been raised and broken out. (See Figure 9.) These window frames were not significantly deformed, and the windows on each side were intact.

The California Highway Patrol inspected the vehicle and reported the following information with respect to its mechanical condition. Brake linings, drums, chambers, and air compressor were in good condition; no air leaks were noted. The emergency braking system did not work at either rear wheel; the spring on the left rear wheel brake drum was retracted, and the spring on the right rear wheel brake drum was broken. None of the controls for these brakes (foot valve, parking, and emergency controls) were found in the "applied" mode after the accident. The position of the transmission was not reported.

The wiring in the vicinity of the light and ignition switches was reported to be in "very poor condition"; the main lead wire to the ignition switch from the battery terminal of the regulator was not properly secured to the terminal. Both headlamps and taillights functioned when an independent power source was applied.

There were no leaks in the exhaust system forward of the rear axle. The tailpipe for the exhaust system terminated 3 feet from the rear of the bus, and several holes were noted in the firewall. These defects could permit entry of exhaust fumes inside the bus; however, none of the survivors noted the presence of exhaust fumes inside the bus. Steering and suspension system components appeared normal, except that the bottom adjusting cap and locking nut were missing from the steering gearbox. These missing items were attributed to postcrash removal of the bus. No mud was observed on the inside of the gearbox, and since the bus was dragged up the bank of the ditch by the tow truck, it is conceivable that sufficient force was generated to pop the adjusting cap out of the threaded body.

There was no evidence of intrusion or significant deformation of the passenger compartment. Passenger seat frames were held in place on the inboard side by two 5/16-in. sheet metal screws that held a floor attachment collar to the floor panel for each of two vertical legs. (See Figure 10.) Each vertical support leg was welded to the inside of the attachment collar. The metal floor measured 0.076 in. thick. The outboard side of the seat was held in place by one 5/16- or 3/8-in. sheet metal screw which held each of two angle brackets to a support rail mounted along the side wall of the bus. The larger 3/8-in. screws were used to hold the seats down in places where the 5/16-in. screws had stripped out previously. A few of the seats were secured to the support rail and floor with 5/16-in. bolts.

In a majority of cases, the seat attachment failed because the sheet metal screws pulled from the floor panel and side support rail.

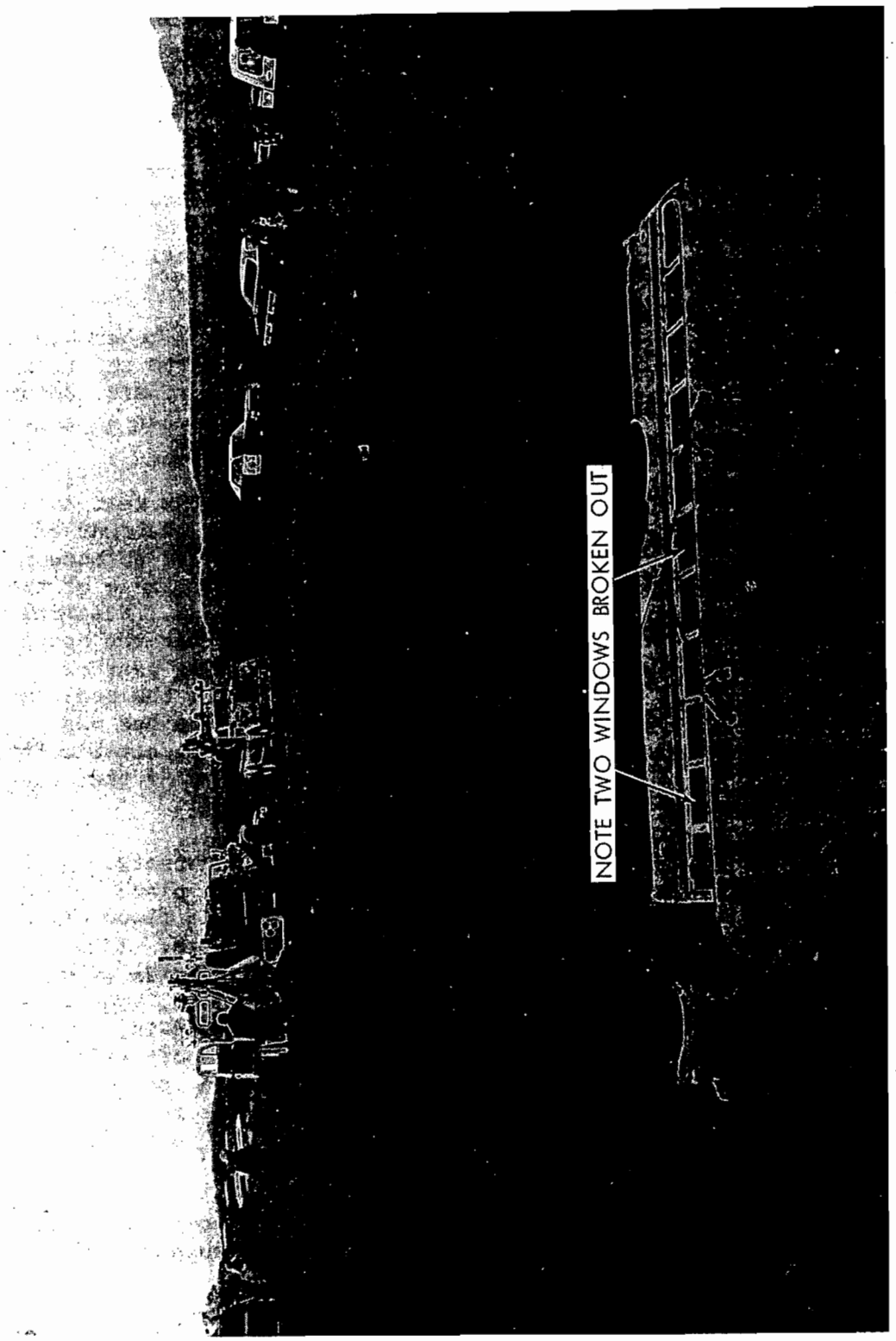


Figure 9. A view of the bus.

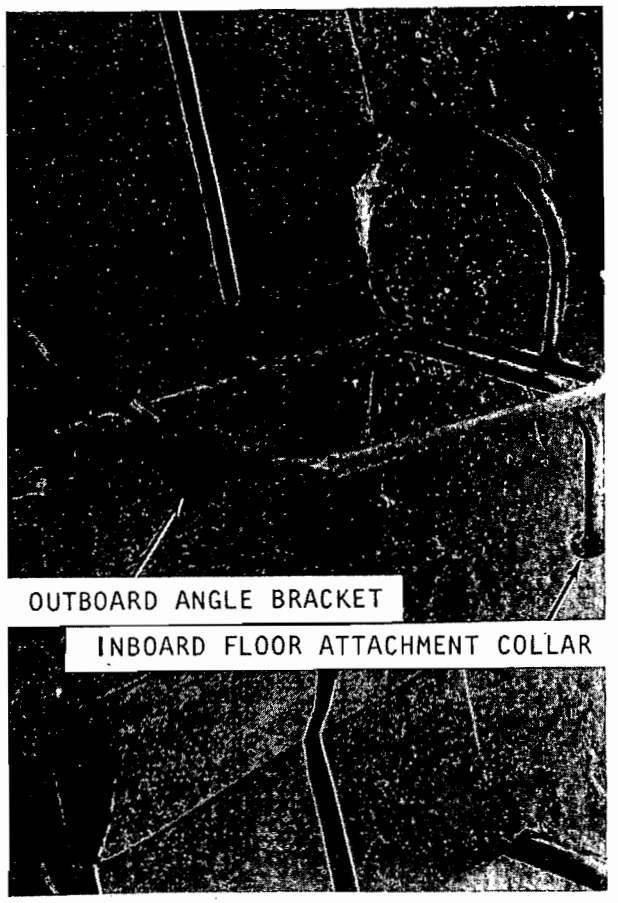


Figure 10. A view of one of the passenger seats in the bus.

In one instance where bolts were used, the inboard attachment collar remained fastened to the floor, but failure occurred at the weld between the vertical tubing support leg and the attachment collar. All tearing of the floor sheet metal was to the forward side of the holes, thereby indicating that the force against the seat anchorages was from the rear toward the front.

Postcrash photographs taken before and after the bus was removed from the ditch indicate that while most seat cushions were separated from the seat frames, most seatback cushions remained with the seat frame. Other interior damage included: (1) The stanchion posts were dislodged from their floor attachment and deformed from occupant loading; and (2) the steering wheel rim and the driver's side of the windshield were damaged from contact with the driver. (See Figure 2.)

ANALYSIS

Potential Physiological Modifiers of Driver Performance

Two physiological factors were examined to determine their potential for influencing the driver's performance: Carbon monoxide and fatigue.

Carbon Monoxide - According to medical experts, a 5-percent carboxyhemoglobin saturation level, as reported by the autopsy report on the driver, represents little more than a trace. For example, any heavy smoker would probably have this amount. "Carboxyhemoglobin concentrations up to 20 percent would be unlikely to be sufficiently disabling to produce vehicular loss of control." 8/

Fatigue - A comparison was made between the busdriver's activities and the provisions of the California Motor Vehicle Code pertaining to hours of service for drivers of a farm labor vehicle. There was no evidence to indicate noncompliance with the provisions of this statute.

When it is considered that while at home, the driver ate dinner and possibly watched TV or performed some similar activity, it is probable that he was getting a limited amount of rest. On the night before the accident, he had spent about 4 hours in bed. It may be possible that the driver slept while in the bus when he was not driving. However, this is not considered to be proper rest, especially in view of the fatiguing effects of manual farm labor and the necessity for the driver to be alert.

A review of those physiological factors which influence driver performance indicates that "It has been well documented that with fatigue comes inattention, inability to sense all of the environmental changes, slowness in sorting out information received by the brain, and loss of active coordination in effecting the proper response." 9/

Turn Warning/Advisory Speed Plate Sign

The turn warning sign with attached advisory speed plate was evaluated with respect to its detectability and provision of sufficent time for the busdriver to comprehend it, react to the message, and perform the required maneuver.

The location, configuration, and height of the turn warning/advisory speed sign did not conform with Sections 2A-23 and 2C-36 of the Manual on Uniform Traffic Control Devices for Streets and Highways.

8/ The Role of Carbon Monoxide, Alcohol and Drugs in Fatal Single Car Accidents; California Highway Patrol; November, 1965.

9/ Medical Conditions and Driving Ability, by Abraham J. Mirkin; published in the Maryland State Medical Journal; pages 54-62; January, 1967.

Road tests made at the accident scene under conditions similar to those which prevailed during the accident indicated the following:

a. Warning sign visible as reflected light:

(1) High beam headlamps - 3,160 feet
(2) Low beam headlamps - 1,056 feet

b. Sign legend visible:

(1) High beam headlamps - 1,584 feet)
(2) Low beam headlamps - 528 feet)

The message 20 mph can be read at a distance of 500 feet

c. Curve visible:

(1) High beam headlamps - 400 feet
(2) Low beam headlamps - 180 feet

Although the configuration and height of the signs were not in accordance with the Manual, the tests indicated there was no difficulty in detecting the sign.

The turn warning/advisory speed plate sign was posted about 350 feet south of the beginning of the transition from Rannells Boulevard to 20th Avenue. According to the Manual: "In rural areas, warning signs should normally be placed about 750 feet in advance of the hazard or conditions."

The visibility tests indicate the busdriver would have had 500 feet, the distance at which he could read the sign legend, plus 350 feet from the sign to the turn in which to reduce speed to 20 mph, or 850 feet to read the sign and slow his vehicle to 20 mph. If the driver was operating his vehicle at 55 mph, an average braking force of 0.11g would be necessary to slow his vehicle to 20 mph. 10/ This is equivalent to the force experienced when bringing a passenger car or a bus to a gradual stop. 11/

The busdriver was considered to be familiar with the Blythe area and the route in the immediate vicinity of the accident. Therefore, it would be reasonable to expect an appropriate reaction to the turn warning/advisory speed sign when it was first visible.

Drainage Ditches

No current barrier, guardrail, or similar crash attenuating system could have predictably controlled the high-speed (35 mph) and high-angle

10/ The calculation assumes 1 second for the driver to comprehend the sign and begin the appropriate action.

11/ Traffic Accident Investigators' Manual for Police; J. Stannard Baker; Northwestern University; Evanston, Illinois, page 531.

of attack (50°) by this heavily loaded bus (weight approximately 20,000 lbs.). A wall or other strong physical barrier would have increased impact forces on the bus and its occupants. A standard guardrail system would have had little effect in containing and redirecting the vehicle and could conceivably have induced rollover or some other undesirable effect.

A system of properly placed signs, markings, and delineators would have provided "positive guidance" to a driver for negotiating the curve and would have reduced the probability of vehicles leaving the road. In February 1974, the Safety Board recommended that the Federal Highway Administration:

> "Expedite development and implementation of a traffic control system of positive guidance to assist drivers in remaining on the intended pathway at narrow highway structures." 12/

While the recommendation addressed approaches to narrow bridges specifically, the principle of positive guidance is applicable to any location where additional measures are needed for increased guidance.

Traffic controls which could be used to provide positive guidance and reduce the probability of traffic's being exposed unnecessarily to the drainage ditch include: (1) A gradual reduction of speed in the area and thereby a reduction in approach speed to the turn warning and advisory speed sign; (2) warnings of both the hazardous turn and the presence of the far-side drainage ditch; (3) an advisory speed for safe negotiation of the turn; and (4) delineation of the pathway around the turn. Identification of more suitable escape or recovery areas (e.g. the dirt farm roads) or delineation of the hazard area would provide information for determining emergency maneuvers, if combined with measures that provide the opportunity to monitor opposing traffic.

With the presence of an extreme hazard and likelihood of similar inattentive drivers operating in the area, traffic control devices that attract driver attention to the warning and advisory message (e.g. rumble strips, redundant signing) are justified.

With respect to protection of the drainage ditches, it is possible that a misinterpretation of the AASHTO policy on the omission of guardrails may result in the provision of a 4:1 slope for the side of the drainage ditch, thereby seemingly satisfying the intent of the AASHTO policy. In this particular accident, and in similar accidents, a flat recovery area would have been required in lieu of a physical barrier or

12/ National Transportation Safety Board, Wilmeth Cattle Company Truck/Bridge/Transportation Enterprises, Inc. - Bus; U. S. 60-84, Fort Sumner, New Mexico, December 26, 1972, NTSB-HAR-74-1.

crash attenuating system. The bus was near the critical point of rolling over as a result of driver maneuvers. The AASHTO policy appears to refer to drivers forced to travel along the side slope rather than down the slope, as was the case in this accident.

NCHRP Report Number 118 13/ states that nontraversable hazards, including permanent bodies of water with depths greater than 2 ft., located within 30 ft. of the traveled way, warrant a longitudinal traffic barrier. Further, because of the extended length of the hazard, it notes that traffic barriers may be needed at hazards located more than 30 ft. from the traveled way. That report recognizes the need for barrier protection irrespective of the distance the nontraversable hazard is located beyond the traveled way. Neither the AASHTO or the NCHRP policies address the hazard that exists when errant vehicles fail to negotiate sharp turns. In October 1974, the Safety Board recommended that the Federal Highway Administration:

> "Study the hazard that exists due to errant vehicles failing to negotiate turns as the road terminates at a 'T' intersection and leaves the traveled way, and develop recommended engineering practices or design standards that will eliminate this problem." 14/

While that recommendation addressed approaches to "T" intersections specifically, the principle of providing hazard protection is applicable to any location at which, by its character, vehicles may leave the roadway at a high departure angle.

While a longitudinal barrier would not have predictably controlled the errant bus involved in this accident, its use is warranted for traffic operating in the opposite direction. If equipped with delineators, it would serve to delineate the mouth of the drainage ditch to traffic traveling in the same direction as the bus.

Bus Seat Performance

Although the speed of the bus at impact was relatively high, damage to the bus exterior indicates a "soft landing," with a low onset rate of collision forces and low peak force levels.

An examination of the autopsy data indicated few, if any, impact-related injuries serious enough to be life-threatening. Impact with a

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13/ Location, Selection and Maintenance of Highway Traffic Barriers, National Cooperative Highway Research Program (NCHRP) Report Number 118, Highway Research Board, 1971.

14/ National Transportation Safety Board, Automobile Intrusion Onto the Long Island Railroad Electrified Tracks and Fire; Garden City, New York; August 8, 1973; NTSB-HAR-74-1.

more hostile environment--that is more rigid seats--may have produced higher degrees of trauma, and the occupants would not necessarily have been retained in their seat area. However, the likelihood of severe trauma appears to have been small. The driver was exposed to probably the most hostile crash environment--and sustained life-threatening, yet survivable, impact-related injuries. He was nearest to the point of impact, impacted the relatively unforgiving forward area of the driver compartment, and was under forces exerted from the rear by other occupants, seats, and debris.

With the seats in place, the passengers should have been able to escape easier and should have been more accessible for rescue purposes.

The fact that some of the 5/16-in. screws had been stripped out would suggest that the other original anchorages may have been in a deteriorated state. In this accident, it was not possible to estimate quantitatively the force levels to which the anchorages were subjected to during impact, or the precrash condition of the bus seat anchorages. Therefore, it was not possible to determine the relative contribution of deterioration of the anchorages insofar as it may have reduced their crashworthiness.

Bus Exits

Escape and rescue attempts were complicated because the bus came to rest on its left side; this prevented the use of the emergency door at the rear of the bus on the left side. The front door, located on the right side and the windows located along the right side of the bus were used for escape. The drop-type windows provided an exit area of 12 in. by 24 in.--adequate only for the escape of small persons. Rescuers presumably raised/broke out two windows to provide larger escape areas.

CONCLUSIONS

1. Although the provisions of the California statue related to driving and on-duty time were met, the 16+ hour per day work and travel schedule for 3 consecutive days before the accident and the inadequate rest during off-duty time by the busdriver resulted in a high level of fatigue.

2. The speed of the bus as it approached and passed by the turn warning/advisory speed sign was estimated to be 45 to 55 mph, which was within the unposted speed limit of 55 mph.

3. Although the driver was familiar with the Blythe area and the route in the immediate vicinity of the accident, he did not adhere to the advice of the turn warning/advisory speed sign.

4. Although the turn warning/advisory speed sign did not conform to the specifications of the Manual on Uniform Traffic Control Devices for Streets and Highways, it must have been visible to the driver and its location was within the range necessary to provide the busdriver the time necessary to comprehend it and to reduce the speed of the bus to 20 mph.

5. The speed of the bus as it entered the turn was calculated to be about 45 mph.

6. The speed of the bus as it vaulted from the top ledge of the drainage ditch was calculated to be about 35 mph.

7. No present-day barrier or crash attenuating system could have predictably controlled this heavily loaded bus.

8. The velocity of the bus as it contacted the bottom of the drainage ditch was calculated to be about 40 mph.

9. Although the speed at impact with the bottom of the ditch was considerable, damage to the bus exterior indicates that a "soft landing" with a low onset rate of collision forces and low peak force levels occurred at impact.

10. The failure of the bus seat anchorages, apparently under low collision forces, resulted in the compressive packing of the seats and occupants, hampered rescue efforts, and therefore contributed to the high number of deaths by drowning.

11. The performance of the bus seat anchorages was inadequate in relation to the apparently low peak forces imposed at impact.

12. Escape and rescue efforts were complicated by the lack of sufficient exits and the small size of window openings.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the bus to that required to negotiate the turn, despite the presence of a turn warning/advisory speed sign. Contributing to this failure was a lack of driver alertness induced by fatigue.

RECOMMENDATIONS

The National Transportation Safety Board recommends that the Riverside County Road Commission:

1. Survey the accident scene and insure that the turn warning/advisory speed signs are installed in a manner that conforms with the Manual on Uniform Traffic Control Devices. (Recommendation H-75-1)

2. Provide delineation of the pathway around the turn. (Recommendation H-75-2)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

March 5, 1975