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Highway Accident Report - Van/Slow-Moving Farm Vehicle Collision, U. S. Route 6/50 Near Delta, Utah, September 12, 1979

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

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16.Abstract

About 6:25 a.m. and before dawn on September 12, 1979, a 1976 Dodge van, occupied by 14 senior citizens, overtook and collided with a slow-moving farm vehicle near Delta, Utah. The right front corner of the van struck the left rear edge of the 15 1/2-ft-wide cutting attachment that was mounted to the front of the farm vehicle. The van rolled onto its left wheels, traveled off the right side of the road, and struck a concrete bridge parapet that was located 4 1/2 ft beyond the edge of the pavement. Eight van occupants were killed, and six van passengers were injured; the driver of the farm vehicle was not injured.

The National Transportation Safety Board determines that the probable cause of this accident was the farm vehicle's inadequate rear lighting system, which failed to identify the slow-moving, overwidth windrower as a hazard to higher-speed traffic approaching from the rear, and the van driver's inability to detect and avoid striking the projecting cutting attachment on the windrower while operating at the posted speed limit.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: March 20, 1980

VAN/SLOW-MOVING FARM VEHICLE COLLISION U.S. ROUTE 6/50, NEAR DELTA, UTAH SEPTEMBER 12, 1979

SYNOPSIS

About 6:25 a.m. and before dawn on September 12, 1979, a 1976 Dodge van, occupied by 14 senior citizens, overtook and collided with a slow-moving farm vehicle near Delta, Utah. The right front corner of the van struck the left rear edge of the 15 1/2-ft-wide cutting attachment that was mounted to the front of the farm vehicle. The van rolled onto its left wheels, traveled off the right side of the road, and struck a concrete bridge parapet that was located 4 1/2 ft beyond the edge of the pavement. Eight van occupants were killed, and six van passengers were injured; the driver of the farm vehicle was not injured.

The National Transportation Safety Board determines that the probable cause of this accident was the farm vehicle's inadequate rear lighting system, which failed to identify the slow-moving, overwidth windrower as a hazard to higher-speed traffic approaching from the rear, and the van driver's inability to detect and avoid striking the projecting cutting attachment on the windrower while operating at the posted speed limit.

INVESTIGATION

The Accident

About 6:25 a.m., m.d.t., and before dawn on September 12, 1979, a self-propelled windrower 1/ with a 15 1/2-ft-wide cutting attachment mounted to the front was traveling eastbound on U.S. 6/50 near Delta, Utah. (See figures 1 and 2.) The windrower had entered the highway from a field located about 1/4 mile west of the accident site and was traveling between 5 to 10 mph along a 3 1/2-mile, straight, level section of road, which had a posted speed limit of 55 mph. The windrower was being operated with two white headlamps on the front of the machine and one white work lamp 2/ on the rear.

As the windrower approached a bridge over the Deseret-Oasis Irrigation Canal, the driver saw a reflection of light on his windshield and the roadside that he attributed to the headlights of a vehicle that was overtaking him from the rear. He decided to slow and allow the overtaking vehicle to pass him before he attempted to cross the bridge, because he thought the cutting attachment would block part of the other lane on the bridge. He slowed and moved farther to the right so that the left edge of the cutting

1/ A windrower is a farm machine that cuts and stacks grain or hay into rows.
2/ A work lamp is a lamp primarily used to illuminate work areas around the machine while the machine is being operated in a field.

Figure 1.--Aerial view of accident site.

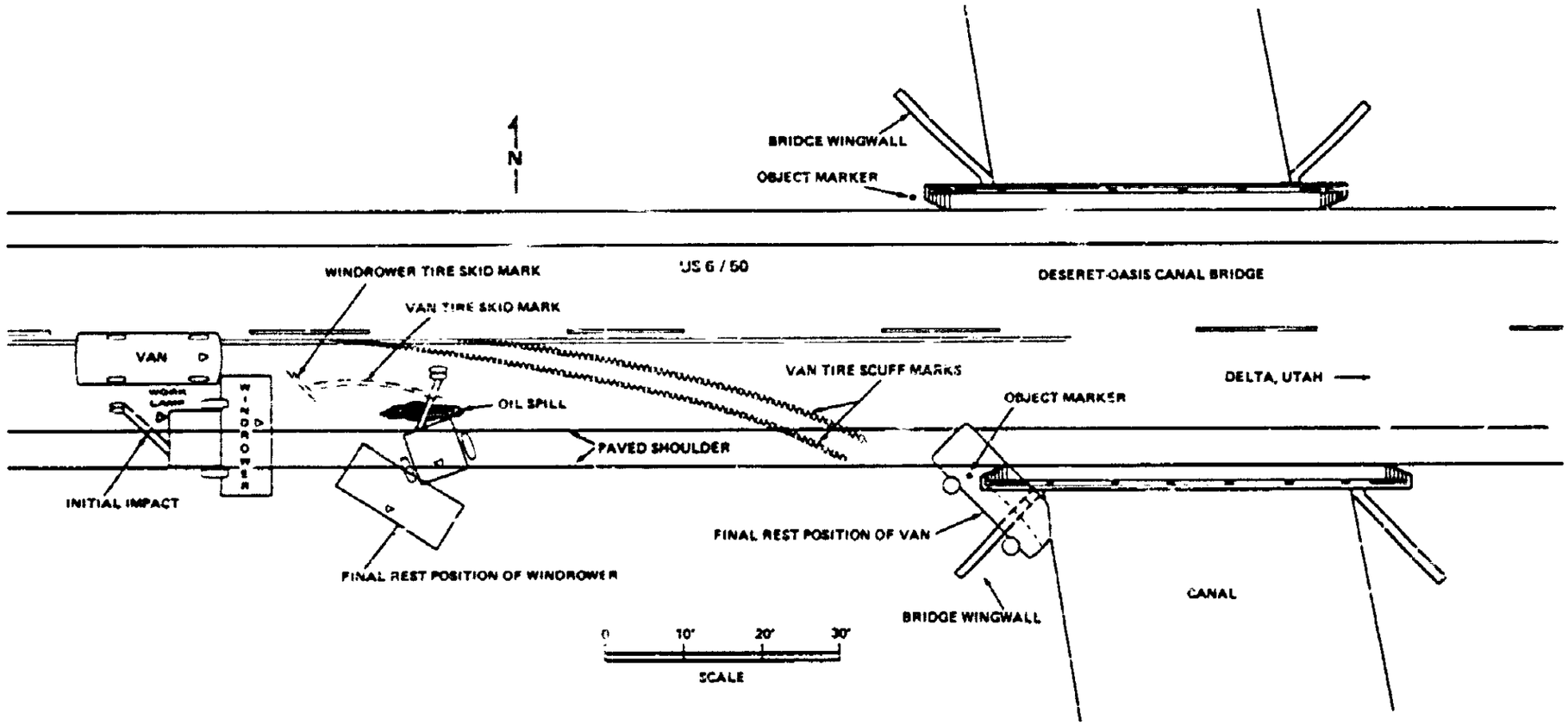

Figure 2.—Plan view of accident site.

attachment was about 4 ft to the right of the roadway centerline and the windrower itself was partially on the shoulder. The driver believed that since he was within 100 ft of the bridge, any further movement to the right would have made it difficult, if not impossible, to maneuver the windrower around the bridge parapet 3/ after the overtaking vehicle passed. At least 3 to 4 seconds before impact, he saw changing light reflections that he assumed were from the overtaking vehicle's headlights being switched from low to high beam and then back to low beam; he was not entirely certain of the order of switching.

The overtaking vehicle, a 1976 Dodge van occupied by 14 senior citizens en route to the Utah State Fair in Salt Lake City, overtook and collided with the windrower. (See figure 3.) The right front corner of the van struck the left rear edge of the cutting attachment. (See figure 4.) The van was traveling about 55 mph as it approached the windrower.

None of the six surviving van passengers could recall what they were doing or what was happening inside the van before impact. At the last second, one passenger shouted, "Look out," or something similar, and two van passengers recalled seeing a white light ahead of the van for the first time. One survivor thought that the van may have been maneuvered slightly to the left just before impact. No one remembered any significant braking before impact, and no skidmarks were found on the roadway before the point of impact.

At impact, the tires on the left side of the van were on the roadway centerline. (See figure 5.) The van rolled onto its left wheels and traveled off the right side of the road. The left side of the van then struck the front of the concrete bridge parapet that was located about 4 1/2 ft beyond the edge of the pavement. The right front passenger and a passenger seated on the right side of the first bench seat were ejected through the windshield and into the irrigation canal. The van came to rest on its left side; the front of the van rested on top of the bridge wing wall, below and beside the parapet. The windrower came to rest facing the right shoulder of the road, and the cutting attachment had separated from the front of the machine.

Injuries to Persons

Injuries	Driver	Passengers	Other
Fatal	1	7	0
Nonfatal	0	6	0
None	1	0	0

The ages of the van occupants ranged from 59 to 80 years. (See figure 6 for the age, seating position, and the degree of injury to van occupants.) The ejected right front passenger was hindered by a shoulder injury but managed to swim to and crawl up the embankment. The other ejected occupant was found several hundred feet downstream. No autopsies of the passengers were performed; the examining doctor noted that the deceased ejected occupant had incurred severe traumatic injuries during ejection and drowning was not the probable cause of death.

3/ A parapet is a low wall or railing along the edge of a bridge.

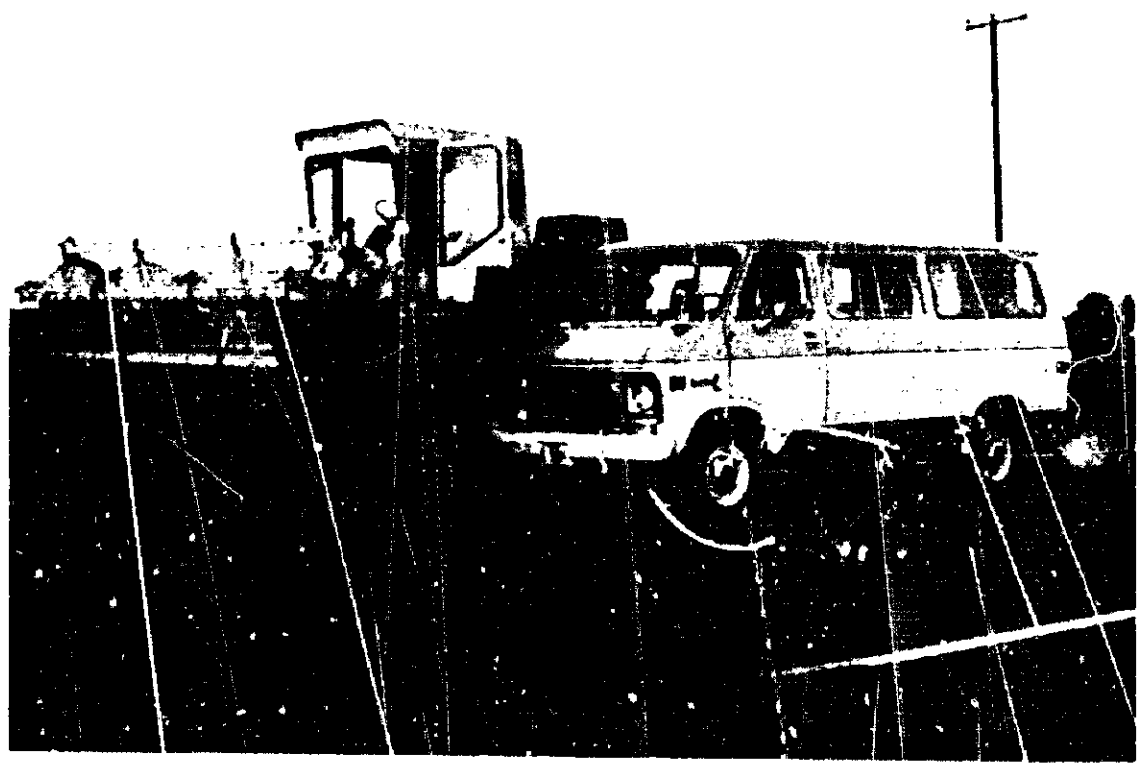

Figure 3.—Impact simulation using two vehicles similar to those involved in the accident.

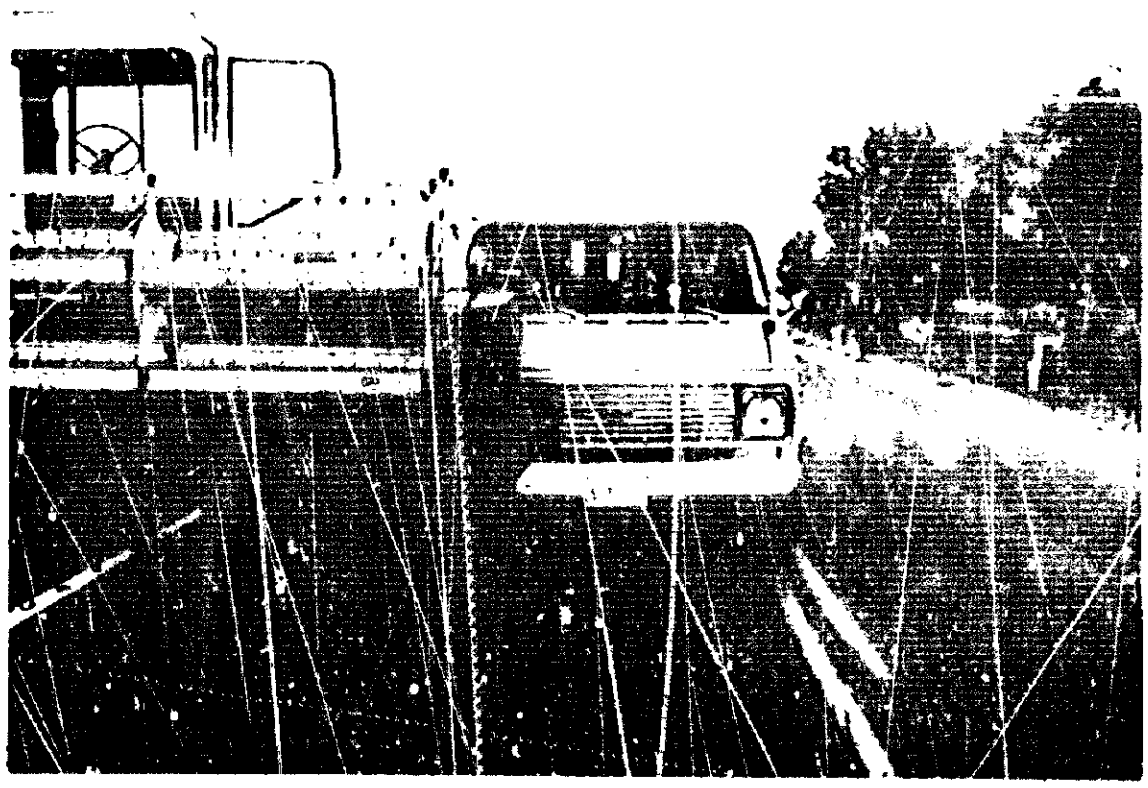

Figure 4.—Impact simulation. Note (1) extent of engagement between van and windrower, (2) left tire of van on road centerline, and (3) tire marks from van after initial impact.

Figure 5.--View of roadway beyond point of impact. Note the left-side tire scuff marks of the van leading to the bridge parapet, and the diagonal object marker in front of the parapet.

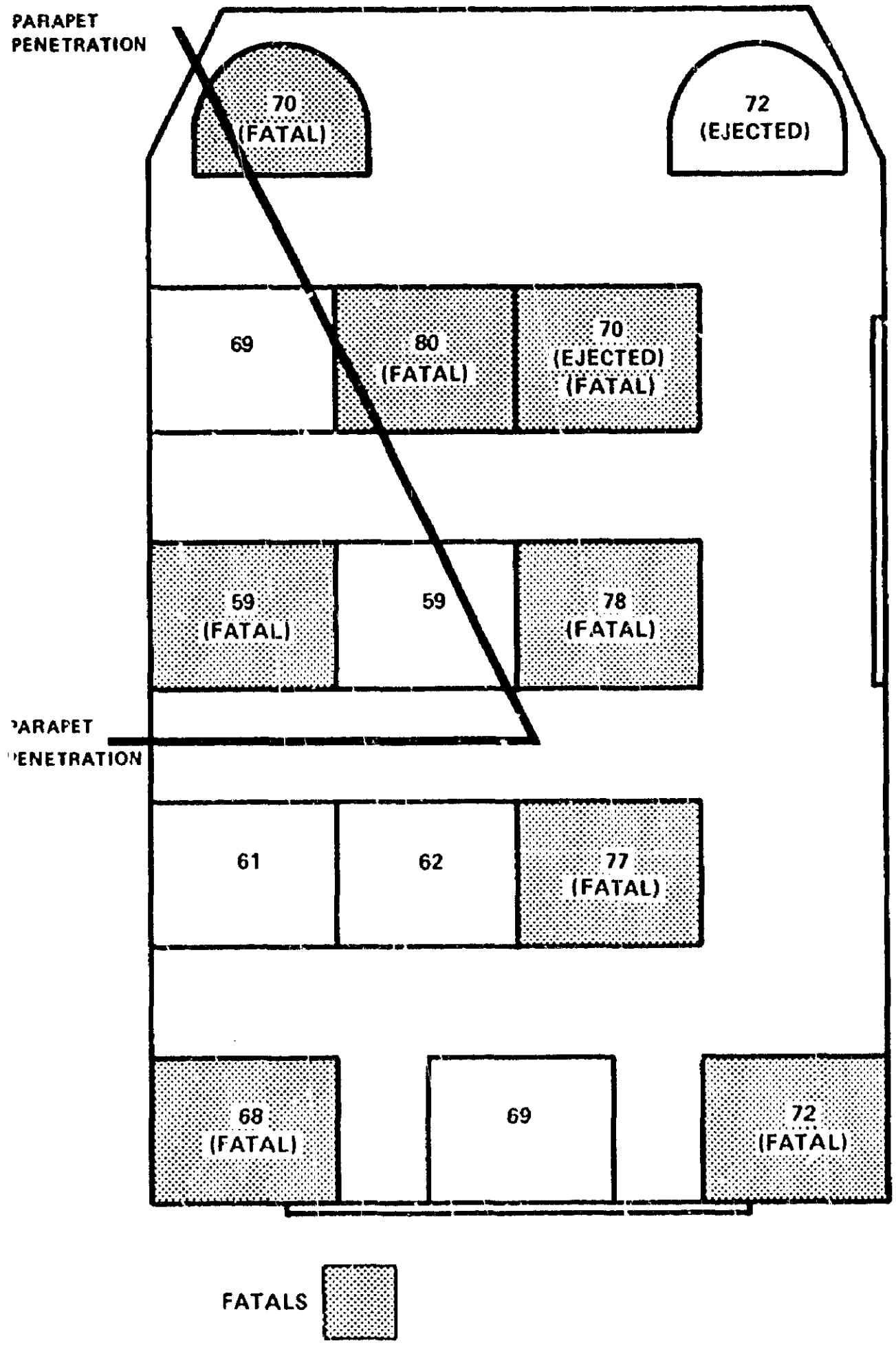

Figure 6.—Van seating chart showing occupant ages and injuries.

Vehicle Information

The 1976 Dodge Maxivan, VIN B36BD6X091517, was purchased new by the Beaver County Senior Citizens Organization and was used primarily for transporting senior citizens to various social functions. It was equipped with a 440-cu-in engine, cruise control, power steering, and power brakes. The cruise control mechanism was damaged in the accident, and it was not possible to determine by inspecting the components if it was in use just before impact. The headlight dimmer switch, located on the floor, was found in the high-beam position. The van had a 15-passenger seating capacity. Although each seating position was equipped with a seatbelt, the driver was the only occupant wearing a restraint. No evidence of preimpact deficiencies or unusual conditions of the van were noted.

An imprint from the left rear edge of the windrower cutting attachment was found at the right front corner of the van. (See figure 7.) The right front corner of the van was deformed about 10 in rearward into the center of the right front tire tread, puncturing the tire and jamming the wheel so that it could no longer rotate. An imprint from the bridge parapet was found at the top of the left front fender and at the top of the left side of the instrument panel. (See figure 8.) The left side of the van was severely buckled and deformed rearward up to the front of the rear tire as a result of the rearward collapse of the side and roof supports. The driver's seat and the first two bench seatbacks were also deformed rearward; the rearward deformation to the seatback of the second bench seat was at the middle of the seat.

The windrower was a 1973 International Harvester, Serial No. 1310055C004244, and was owned by the driver's father. It was equipped with a 232-cu-in engine and a direct planetary drive gear; its maximum road speed was about 10 mph. The exterior lighting and delineation system complied with the American Society of Agricultural Engineers (ASAE) guidelines applicable for 1973 year models and consisted of the following: 4/

1. Two white headlamps were mounted at the same level, one on each side of the front of the cab, facing forward. (See figure 9.)

2. One multimode combination white work lamp/red tail lamp was mounted on the driver's left side at the rear of the engine compartment. (See figure 10.) A switch mounted on the rear of the lamp housing was designed for selection of either the white light for use as a work lamp or the red light for use as a tail lamp. The switch was not labeled.

3. One triangular, reflectorized slow-moving vehicle (SMV) emblem was mounted on the left rear of the engine compartment.

4. Two strips of 1-in-high by 6-in-wide red reflective tape were mounted on the rear, near the left and right ends of the cutting attachment.

5. There were two double-faced hazard warning lamps, designed to signal a flashing amber light both to the front and the rear. One lamp was mounted on the driver's side and at the rear of the engine compartment; this lamp

4/ American Society of Agricultural Engineers, "Agriculture Engineer's Yearbook," ASAE Standard S279.5, 1973 Edition.

Figure 7.—Front view of right front corner of van. Note damage imprint from left rear edge of windrower cutting attachment.

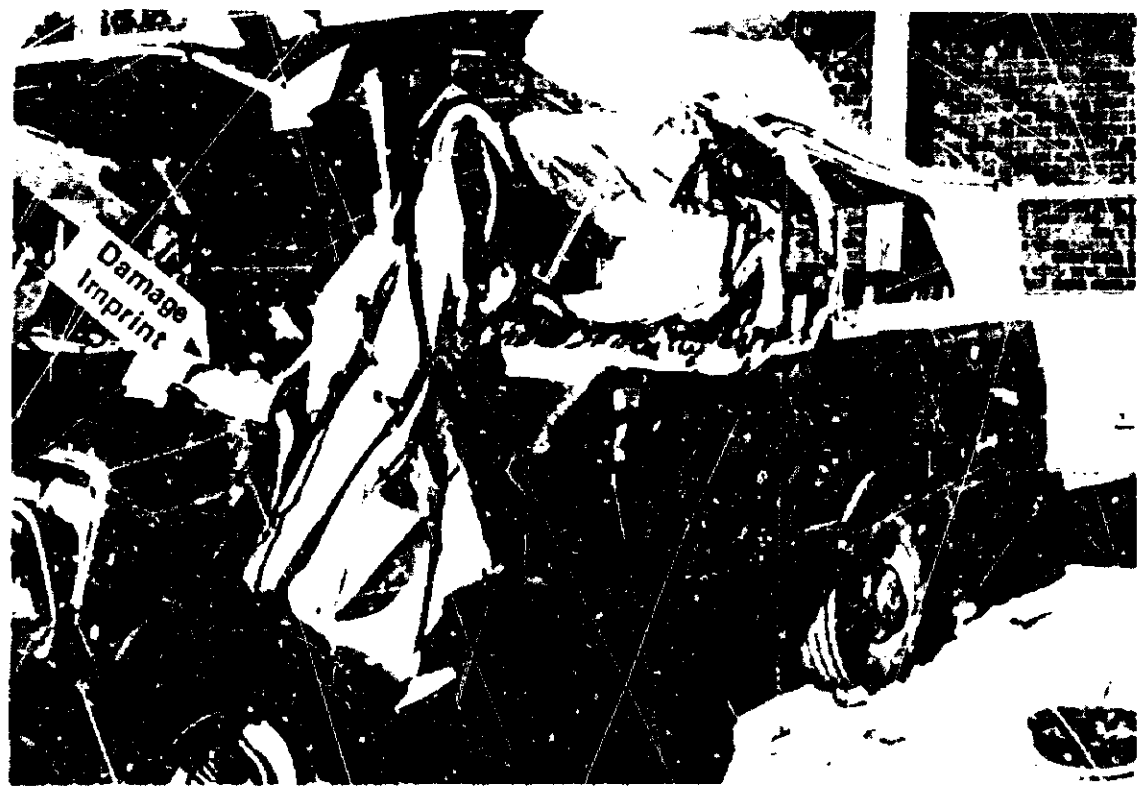

Figure 8.—Left front view of van. Note damage imprint from bridge parapet at top of left front fender and at top of left side instrument panel. Note buckling of side panel back to rear tire area.

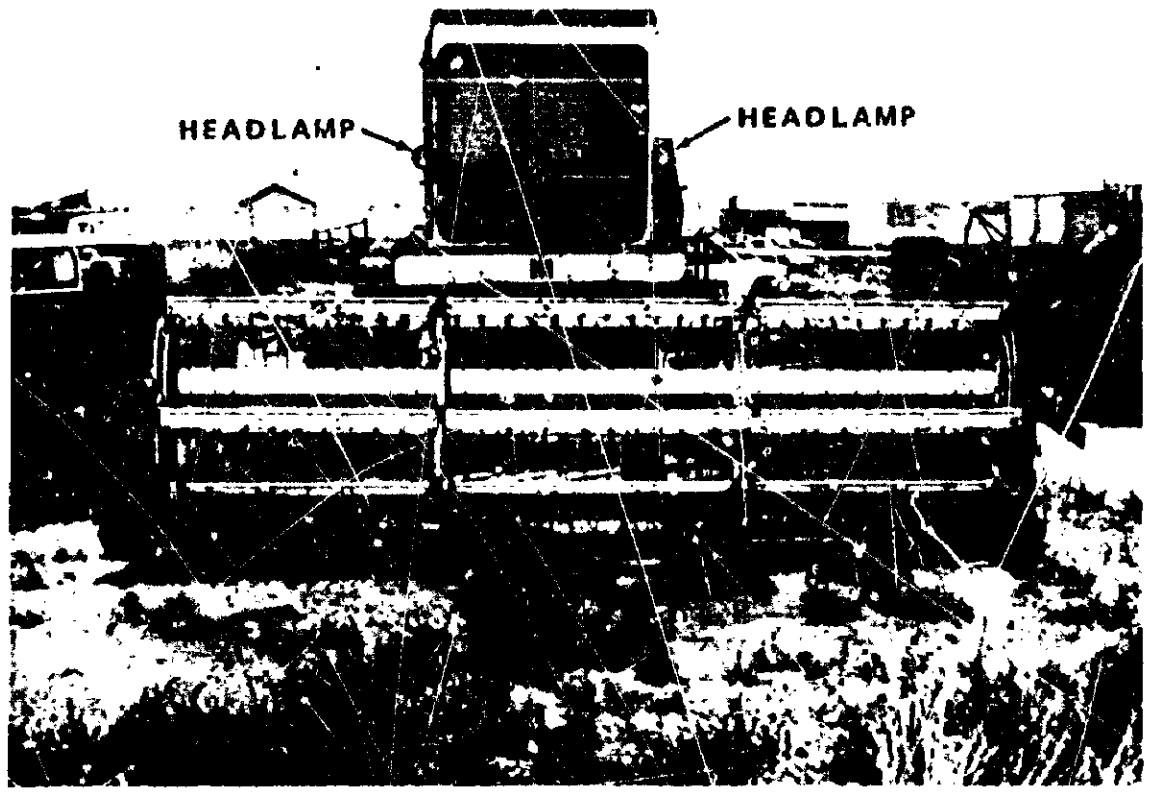

Figure 9.—Front view of windrower. Note two white head lamps, one on each side and at the front of the cab.

Figure 10.—Rear view of windrower. Note combination work lamp/tail lamp on left side, amber lamp above, slow-moving vehicle emblem, and amber lamp inside the engine compartment.

projected beyond the left side of the engine compartment and was visible from the front and the rear. The other lamp was mounted to the right of the driver and inside the engine compartment so that it was only visible from the rear. International Harvester reported that this lamp was originally installed outside of the engine compartment.

A single switch in the cab was designed to activate all of the lamps on the vehicle. The amber flashing lamps were not operable when tested by the Utah Highway Patrol shortly after the accident, and the driver reported that they were not operable at the time of the accident. Investigation revealed that the flasher unit was corroded, that the right side light bulb filament was broken, and that the left lamp appeared to have a poor ground connection.

A damaged area about 7 in wide at the left rear corner of the cutting attachment matched the damage imprint found at the right front corner of the van. The area was about 2 1/2 ft to the left of the rear work lamp/tail lamp. The left side guide tire at the bottom of the cutting attachment was deflated, and the guide wheel was bent outboard about 8 in.

Driver Information

The 70-year-old van driver was a retired automobile mechanic and had operated an automobile dealership. He was an officer in the Beaver County Senior Citizens Organization and shared the responsibility for managing the maintenance of the vans. According to the right front passenger, the driver stated during the trip that the van was performing well in all aspects. The trip had begun about 70 miles before the accident site. The driver had been using the cruise control before turning onto U.S. 6/50, about 3 miles from the accident site, but no one knew if he had reset the cruise control after turning onto U.S. 6/50. He had a valid Utah chauffeur's license and had submitted a medical certificate, dated February 24, 1978, to the insurance company that stated that his "ability to safely operate a motor vehicle was above average."

His driver license, dated June 26, 1977, did not require the use of corrective lenses. Yet, about 3 years before obtaining this license, he had a cataract removed from one eye. Without a contact lense or a prescription eyeglass, he could see nothing out of that eye. About a year before the accident and a year after receiving his license, he had a cataract removed from his other eye. His ophthalmologist reported that the driver wore either contact lenses or prescription eyeglasses to correct his vision to 20/30, left eye, and 20/40, right eye, and that he had no particular problems with depth perception or night vision. The driver was wearing contact lenses at the time of the accident. The State of Utah and a majority of the States require at least vision corrected to 20/40 in order to obtain a driver license and operate a motor vehicle. None of the surviving occupants of the van noticed if the driver had any particular vision problems during the trip. In fact, one survivor noted that earlier in the trip the driver had seen and had successfully and easily avoided a small dead animal in the road.

In response to a Safety Board inquiry, the State of Utah investigated the issuance of the van driver's driver license. The Motor Vehicle Administration's director reported that the van driver's previous license was restricted to the wearing of corrective lenses, and at the time of his June 26, 1977, renewal, his application indicated that he no longer needed glasses. He took and passed the eye examination, apparently wearing a contact lense without the knowledge of the examiner, and the restriction was removed. The examiner who conducted the examination was not available for further investigation.

Utah State records indicated that the van driver had no previous accidents or traffic convictions. A blood test indicated no evidence of alcohol.

The 18-year-old windrower driver had driven farm equipment for about 8 years. He had a valid Utah driver license, and had no previous accidents. He had operated the windrower for about 4 years and had moved it regularly from field to field by way of the highway. He told police that he had previously moved farm equipment on the highway at night; however, he told investigators from the International Harvester Corporation that this was the first time he had moved the windrower in the dark.

The driver reported that the windrower was operating with the two front headlamps and the one rear white work lamp illuminated at the time of the accident, and that he was aware that the two amber flashing lamps were not functioning. He said that he thought that the switch on the housing of the rear combination work lamp/tail lamp was for turning the white work lamp off while turning the amber flashing lamps on. Also, he was not familiar with the laws regarding the type of lamps required for moving farm equipment on the highway in the dark.

Applicable Regulations

Section V of the Utah Department of Transportation (DOT) Regulations 5/ states that vehicles over 9 ft wide are prohibited from operating during hours of darkness. Daylight is defined as 1/2 hour before sunrise and 1/2 hour after sunset with darkness defined as any other hour. A special permit and special procedures are required to move oversized vehicles during daylight hours. The Utah Traffic Code 6/ exempts farm vehicles from this regulation. The national Uniform Vehicle Code 7/ also exempts farm vehicles (implements of husbandry) from size, weight, and load regulations.

The Utah Traffic Code requires slow-moving vehicles to be equipped with a slow-moving vehicle emblem and requires that farm vehicles with an electric lighting system (emphasis added) have the following lighting equipment when operating on the highway:

1. Two single-beam or multiple-beam headlamps;

2. Two red lamps visible from a distance of not less than 500 ft to the rear, or one red lamp visible from a distance of not less than 500 ft to the rear, and two red reflectors visible from a distance of 100 to 600 ft to the rear when illuminated by the high beams from headlamps. The red lamps or reflectors should be mounted to indicate the extreme left and right projections of the vehicle.

The Utah Traffic Code does not require flashing amber or flashing red signal lamps.

5/ "State of Utah Department of Transportation Regulations—Oversize Vehicles and/or Loads" (no publication date).
6/ "Utah Traffic Code -- Rules of the Road -- 1978" compiled by the Department of Public Safety, State of Utah.
7/ "Uniform Vehicle Code, 1979 Supplement," Chapter 14, Section 14.101—Size, weight, and load.

Since 1970, the Uniform Vehicle Code 8/ has required that slow-moving vehicles be equipped with a slow-moving vehicle emblem and that all farm vehicles (implements of husbandry) operated at night on the highway have the following lighting equipment:

1. Two headlamps;

2. One red tail lamp, visible when lighted from 1,000 ft to the rear and mounted as far to the left of the center of the vehicle as practicable;

3. Two red reflectors, visible when illuminated by lower beams of headlights at all distances between 600 and 100 ft.

The Uniform Vehicle Code does not specify that the red lamps or reflectors be mounted to indicate the extreme left and right projections of the vehicle on self-propelled vehicles, but has such a requirement for towed units. The Code does require that all self-propelled vehicles be equipped with four-way flasher, hazard warning lights, and that they be displayed whenever the vehicle is operated on the highway.

The following is a comparison of the three lighting and delineation system requirements applicable to the 1973 Windrower:

	Two front headlamps	Rear red tail lamp(s)	Amber hazard warning flashers	SMV emblem	Red lamp/reflectors designating vehicle extremities
Utah Traffic Code requirements	X	X		X	X
Uniform Vehicle Code requirements	X	X	X	X	
ASAE guidelines applicable	X	X	X	X	X

Highway Information

U.S. 6/50 is a two-lane, east-west roadway across central Utah and is classified as a Federal-aid primary route. The accident occurred in an agricultural area between the towns of Hinckley and Delta, Utah. Average daily traffic is about 3,300 vehicles. No other traffic was in the vicinity at the time of the accident. The highway was straight and level for about 3 miles before the accident site and continued straight and level for about 1/2 mile after the accident site.

The road was resurfaced with an asphalt "chip seal" coat in 1976. There was no evidence of traffic wear, bleeding, 9/ or smooth aggregate before the point of impact, and

8/ "Uniform Vehicle Code," Chapter 12, Section 12.215—Lamps, reflectors, and emblems on farm tractors, farm equipment, and implements of husbandry.
9/ Bleeding is caused by asphalt rising to the pavement surface.

the skid resistance properties appeared to be good in that area. The traffic lanes were each about 12 ft wide, and the shoulders were paved with asphalt for about 4 1/2 ft.

The traffic lanes remained about 12 ft wide across the canal bridge while the shoulder area narrowed to about 4 ft. The bridge was constructed in 1946. The bridge rail system consisted of 44-in-high by 6-ft-long concrete parapets at each end with a 40-ft-long, metal, panel-type railing between the parapets. The parapets were not protected by an approach guardrail or any similar device. The metal, panel-type railing and unprotected parapets do not meet current American Association of State Highway and Transportation Officials (AASHTO) criteria. 10/

A November 9, 1979, memorandum from the Utah DOT chief structural engineer to the Federal Highway Administration's Utah Division Administrator indicated that though Utah's bridge inventory is not complete, 47 percent of the bridges carrying highways ". . . have approach guardrail which does not comply with current safety standards. . ." and that 17 percent of Utah's bridges cross canals. The memorandum did not specify the nature of the nonconformance.

The white edgeline and yellow centerline markings were in good condition. A solid "no-passing line" for eastbound traffic began about 700 ft before the bridge; passing was permitted for westbound traffic. A 55-mph speed limit sign was posted about 1 1/3 miles before the bridge for eastbound traffic and an object marker sign was posted in front of each bridge parapet. (See figure 5.) In examining the van driver's field of view during his approach to the windrower, three white overhead "yard lights," similar to street lights, were noted south of the roadway. The first two lights were located about 145 ft and 567 ft south of the edge of the pavement and 645 ft east of the bridge. A third light was located 1,667 ft east of the bridge and 650 ft south of the edge of the pavement. At a distance of 1,000 ft west of the accident site, the three lights appeared to be in the same plane, perpendicular to the roadway, and with equal spacing of about 250 ft.

Utah DOT accident records from 1974 to 1979 did not contain any reports of accidents involving vehicles striking this bridge parapet or railing or reports of accidents involving vehicles entering the canal. The accident rate for an area within 1/2 mile of the accident scene was 0.64 accidents per 1 million vehicle-miles traveled, while the accident rate between Hinckley and Delta was 0.93--50 percent higher. There was no method to determine the level of enforcement applied to farm vehicles operating on the highway. However, farm industry sources acknowledge that there may be a problem in adequate maintenance of farm equipment lighting systems.

Meteorological Information

The sky was clear, the moon was more than half-full, there was no wind, and the temperature was about 44° F. Official sunrise was at 7:05 a.m., 40 minutes after the accident. The windrower driver said there had been enough natural light to drive his equipment across the field to the highway without headlamps while four of six van passengers said there was not enough natural light to operate a vehicle on the highway without lamps. Observations by Safety Board investigators made 5 days after the

10/ "Guide for Selecting, Locating, and Designing Traffic Barriers," American Association of State Highway and Transportation Officials, 1977.

accident indicated that the sky light from the rising sun was only sufficient to highlight the outline of the mountains in the distance, and there was not enough natural light to drive or to be seen on the highway without lights or reflectors.

Tests and Research

On September 17, 1979, the Utah Highway Patrol, the International Harvester Corporation, and the Safety Board conducted a series of moving and stationary tests to determine the relative visibility of the farm windrower under similar light conditions. The cutting attachment and lights from the windrower involved in the accident were attached to a similar machine, which was parked at the point of impact. A similar van with high beams on was used to approach the windrower, and Safety Board investigators evaluated four windrower lighting configurations. (See table 1.) The Safety Board investigators were aware of the accident circumstances and test conditions.

Under each test condition, some feature of the windrower's lighting and delineation system was visible for more than 1,000 ft. Even with no windrower lamps illuminated, the slow-moving vehicle emblem was visible for more than 1,000 ft. However, when the windrower lamps were turned off, other features that would have served to more fully identify the windrower, such as the red reflectors, were not visible until the van was less than 200 ft from the windrower. During tests conducted with the windrower head lamps and some rear lamp illuminated, the features that served to more fully identify the windrower became visible at greater distances as the brightness of the rear lamps decreased from white to amber to red. For example, the left extension of the machine was visible at less than 300 ft with only the white work lamp on; it was visible at 800 ft with the flashing amber and tail lamp on; and it was visible at 1,000 ft with only the red tail lamp on.

The slow-moving vehicle emblem was not visible at distances beyond 300 ft when any form of windrower rear lighting was in use. The emblem seemed to have been positioned too close to the left amber and red lamps, and its reflected color was too similar to the color of the lights for it to be distinguishable at greater distances. The rear white work lamp "washed out" all other features of the windrower until the van was less than 300 ft from the windrower. At more than 1,000 ft from the windrower, the rear white work lamp was somewhat similar in appearance to the "yard lights" south of and perpendicular to the highway. Individual investigators were able to begin making various judgments to distinguish the work lamp from the "yard lights" at about 1,000 ft from the windrower. These judgments consisted of: (1) the white light from the work lamp was straight ahead, was in the path of the van, and was brighter than the "yard lights," (2) the work lamp was a green-white color while the "yard lights" were a blue-white color, (3) the work lamp was at a lower elevation than the "yard lights," and (4) the work lamp appeared to be a single lamp that could have belonged to an approaching vehicle. However, it was also possible to assume that (1) the road ahead curved to the left and the light was not on the road, and (2) the light ahead was not from a vehicle because it would appear to be almost stationary on a slow-moving vehicle. Although no specific point could be established, there was general agreement that the differences between the windrower white work light and the "yard lights" and the danger of striking the windrower light became more and more obvious as the investigators moved closer to the windrower.

Table 1.—Four windrower lighting configurations and their conspicuity as viewed during visibility testing.

Windrower test conditions	Windrower lighting and delineation features visible for 1000 or more feet	Distance at which the reflectorized SMV Emblem was visible to the rear	Distance at which left extremity of cutting attachment was visible to the rear*	Distance at which machine outline was visible to the rear
1. Simulated Accident Lighting System – Two Front Head Lamps – One Rear White Lamp – Two Reflector Tape Strips Visible from Rear	· rear white light	· less than 300 feet	· less than 300 feet*	· less than 200 feet
2. Simulated Recommended ASAE Lighting System – Two Front Head Lamps – One Rear Red Tail Lamp – Two Amber Hazard Warning Flasher Lamps – Two Reflector Tape Strips Visible From Rear	· rear red tail light · both amber hazard warning flasher lights	· less than 300 feet	· 800 feet*	· less than 200 feet
3. Simulated Utah State Code Lighting System – Two Front Head Lamps – One Rear Rec. Tail Lamp – Two Reflector Tape Strips Visible from Rear	· rear red tail light · left extremity of cutting attachment	· 300 feet	· 1000 feet*	· less than 200 feet
4. No Lights On	· reflectorized SMV Emblem	· more than 1000 feet	· less than 200 feet*	· less than 200 feet

* NOTE: The left extremity of the cutting attachment was visible because light from the front head lamps of the windrower illuminated the attachment. The red reflector tape on the rear of the left extremity was visible at about 200 feet but was not prominent under any test conditions.

ANALYSIS

Slow-Moving Vehicle Visibility

At impact, the right front corner of the van was only 2 1/2 ft to the left of the white light of the windrower, which indicated that the van driver either never saw the light since he almost struck the light head-on or that he saw the light but was at best making a marginal passing maneuver around the light since he did not allow enough side clearance when passing the light. As to whether he saw the light or not, the visibility tests indicated that additional judgments were necessary to distinguish the windrower light from other roadside lights at distances of 1,000 ft or more, but the differences between the lights and the danger of striking the light should have become more and more obvious as the van came closer to the windrower. Also, and although not totally conclusive, the fact that the van was on the centerline at impact and that the van's headlights may have been flashed about 3 to 4 seconds before impact indicate that the van driver did see the light.

While the van driver may have seen the light, the sequence in which the accident occurred and the visibility tests indicated that the van driver may have been looking for additional identifying information about the light before making a complete passing maneuver, and by the time that information was available, it was too late to avoid impact. The van driver could have been waiting for additional information about the light because he was in a no-passing zone as he approached it or he thought that it might be from an approaching vehicle. Other features, such as the slow-moving vehicle emblem and the left extension of the machine, that would have more fully identified the windrower were not visible until the van was less than 300 ft from impact. At this point and at 55 mph, the van was about 3.7 seconds from impact, which was about the time the van driver was reported to have flashed his headlights. Flashing the headlights would not necessarily imply a passing maneuver. This action may have only been an attempt to gain a better perspective of what was ahead by changing the position and intensity of the headlights, or may have been a warning to a perceived approaching vehicle. The time used in flashing the lights would have further reduced the time available to recognize the windrower and to take any further evasive action. Then, by the time the van driver was able to fully recognize the hazard, it was too late to avoid impact. This possibility is supported in part by the fact that the rearward deformation of the right front corner of the van punctured the right front tire at the center of the tread, indicating that the van was being steered straight ahead at impact and the driver was not attempting any drastic last-second steering maneuver.

While the van driver could have made a more cautious approach, for example by slowing or insuring more than 2 1/2 feet of side clearance around the light, his actions were far more understandable than operating the windrower without an adequate rear lighting and delineation system.

Vehicle Crash Dynamics

By matching damage patterns to the two vehicles, investigators found that the right front corner of the van struck the left rear edge of the windrower cutting attachment, which was in a raised position about 18 in above the ground. The jammed right front wheel of the van and the off-center impact between the two vehicles caused the van to rotate to the right and off the road. All four wheels of the van were in contact with the ground at time of and immediately after impact as evidenced by the parallel skid and scuff marks produced by the front tires.

The van's right front tire mark ended about 15 1/2 ft after impact, while the left side tire marks continued to the edge of the pavement. If the right front tire had continued to remain on the roadway, the locked tire would have continued to mark the pavement. Since no mark was found, the Safety Board concludes that the van rolled onto its left wheels where the right tiremark ended, and the tires on the right side of the van were elevated. The van probably tipped onto its left tires when the cutting attachment dropped to the pavement and the right front corner of the van partially rode over the side of the cutting attachment. This occurrence is supported by the fact that the guide tire and wheel of the cutting attachment was deflated and bent by a downward force greater than that which would have been produced from the cutting attachment simply falling to the pavement.

The sidewalls of the van's left side tires began to mark the pavement as the van left the road, indicating that the van continued to roll more onto its left side as it traveled off the road. The parapet imprint on the left front side of the van indicated that the van had to be tipped at least 42° with its right tires about 40 in off the ground when it first struck the parapet. (See figure 11.) The path of the left tire marks indicated that the van was at a 30° angle with respect to the alignment of the roadway at first contact with the parapet. Rearward damage to the roof, left side, roof supports, and seatbacks indicated that the parapet penetrated the van on a line along the left side windows from the left front corner of the van to the middle of the second bench seat. (See figure 6.) The van then came to rest on its left side with the front of the van on top of the bridge wing wall.

Contact with the bridge parapet was more significant than the collision between the van and windrower. The Safety Board evaluated whether there would have been any change in accident severity if a conventional impact attenuator or approach guardrail system had been installed in front of the parapet. According to the physical evidence, the van did not slide into the parapet; the parapet was directly in the van's path as it crossed the edge of the pavement at a 30° angle to the roadway. Accordingly, the right front corner of the van had the potential to first strike an impact attenuator or guardrail system about 8 ft west of the parapet.

Crash cushions with redirectional capability are available but probably would not be chosen for installation at this location due to shoulder width constraints at the bridge. At a bridge site such as the accident site, a protection device would be designed to keep errant vehicles from entering the canal as well as to prevent direct contact with the parapet. A conventional approach bridge rail transition system (guardrail) does provide angular impact protection and most likely would have been the type of system in use at this location.

In order to contain and redirect vehicles striking this close to the parapet, a conventional guardrail system is currently designed to be almost as unyielding as the object being protected against contact. Since the guardrail is normally about 27 in high and the right tires of the van were about 40 in off the ground, the right front corner of the van would have passed over the top of the rail and the undercarriage would have snagged the top of the guardrail about 4 ft in front of the parapet. Undercarriage systems such as the fuel system would have been highly vulnerable to impact.

It was not possible to determine whether the rail would have channeled the van into a head-on impact with the top of the parapet or whether the van would have been straightened up and perhaps even missed the parapet but overrode the barrier into the

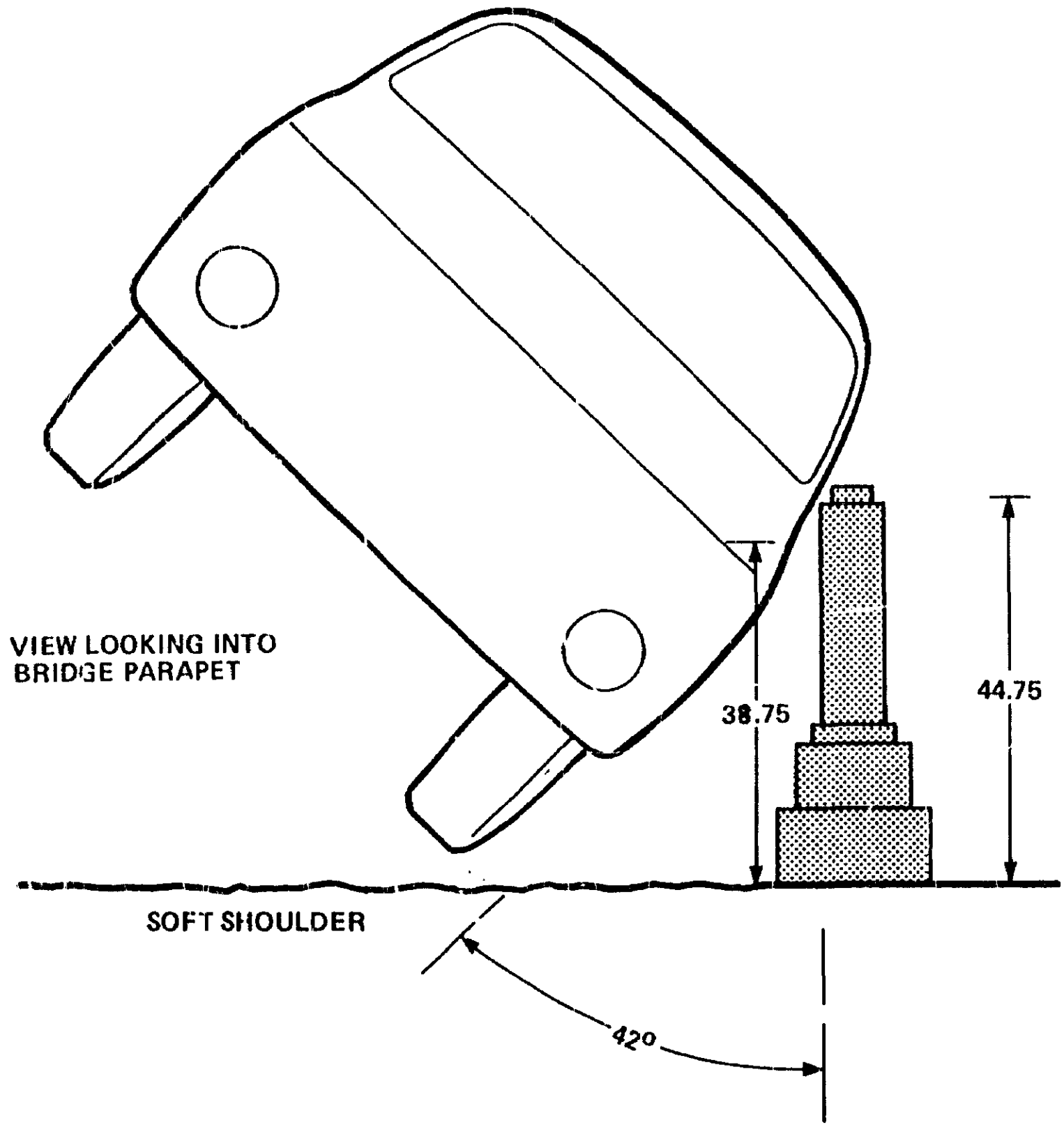

Figure 11.—Angle of impact with bridge parapet.

canal. In any event, the added possibilities of fire, head-on impact, and submergence indicate that the accident had a similar potential for being as severe if a conventional guardrail system had been in place.

Although they were not a factor in this accident, an unprotected bridge parapet and outdated bridge railing such as the Deseret-Oasis Irrigation Canal bridge can present a considerable hazard to errant vehicles. National fatal accident records indicate that about 5 percent of the fatal accidents involving fixed objects occurred at bridges, culverts, and ditches, and that based on length alone, bridges are 50 times more hazardous than other roadway sections in single-vehicle, run-off-the-road accidents. 11/ The State of Utah is aware of the problem of outdated bridge crash protection systems at this location and throughout the State and has a Roadside Obstacle Elimination Program to improve such locations on a priority basis. However, there has been little emphasis on the implementation of this program. The Safety Board believes that the State of Utah should reactivate this program and update all substandard bridge rail systems with priorities based on accident history and future traffic needs. Since U.S. 6/50 is a primary highway in central Utah and there is rapid development in that area, future traffic needs may justify an early update of the bridge rail system at this and similar locations along U.S. 6/50.

Farm Vehicle Accidents and Safety Precautions

There are about 160 fatal accidents per year involving farm equipment on the nation's highways, and about 55 of these accidents involve collisions with other motor vehicles. Even with this relatively low number of fatal accidents, the farm equipment industry has taken significant steps toward reducing these accidents. The slow-moving vehicle emblem and two-way flasher systems have been adopted to warn other drivers, and roll-protective equipment has been adopted to protect the farm equipment operator. However, more and relatively simple measures can be taken to reduce further the potential hazards to safe highway operation. As indicated by the visibility tests conducted for this accident, further attention should be given to the placement of the slow-moving vehicle emblem so that other lights on the farm equipment do not mask its message. Better reflector or lighting systems that are not masked or subdued by other lights need to be developed for delineating the equipment. The windrower driver's stated lack of knowledge about operating the multimode light indicates that perhaps these lights should either be labeled so that their use can be understood by all potential operators, or recircuited or not used to avoid confusion.

Action should be taken by the National Committee on Uniform Traffic Laws and Ordinances to amend the Uniform Vehicle Code to provide guidelines for insuring that lighting and delineation systems do not obscure each other and to require systems that will delineate the extreme projections of at least all oversized equipment.

11/ "A Strategy for Selection of Bridges for Safety Improvement," Southwest Research Institute, presented at the 59th Transportation Research Board meeting, January 1980.
12/ "Agricultural Tractor Safety on Public Roads and Farms," a report to the Congress from the Secretary of Transportation, January 1971; "Traffic Laws Commentary—Farm Vehicle Equipment," National Committee on Uniform Traffic Laws and Ordinances, October 1974.

Action should also be taken by the States to adopt the amended Uniform Vehicle Code standards regarding the marking and lighting of farm vehicles (implements of husbandry). In 1970, only 12 States had laws that were in substantial agreement with the tail light and reflector requirements of the Uniform Vehicle Code, 12/ and that number has remained constant through the 70's. Although Utah is one of those 12 States, the amended Uniform Vehicle Code should contain new provisions regarding the marking and lighting of farm vehicles. Without a uniform law, equipment manufacturers cannot provide equipment that will insure uniform advance warning of slow-moving vehicles.

There is a need for some action to motivate owners and operators of these vehicles to properly maintain the safety systems and properly train operators in their use. The only agency with an opportunity to examine these vehicles on the highway is the State highway patrol. The Utah patrol, through its selective enforcement program, should insure proper emphasis is placed on enforcing Utah regulations concerning the safe operation of farm vehicles (implements of husbandry) on the highways.

CONCLUSIONS

Findings

1. According to Utah law and the national Uniform Vehicle Code, the 15 1/2-ft-wide windrower was permitted to operate on the highway during hours of darkness.

2. The windrower was operating with only a white work lamp illuminated to the rear, which made it difficult for the driver of an overtaking vehicle to distinguish the light from other roadside lights. It "washed out" all of the other identifying windrower features until the van was less than 300 ft from impact.

3. The flashing amber lamp system was poorly maintained and inoperable and the driver stated he lacked knowledge about switching the rear white work lamp to a red tail lamp. As a result, he operated the windrower with a less favorable rear lighting and delineation system.

4. The van driver probably saw the light, but was at best making a marginal passing maneuver around the light until he knew more about its source.

5. By the time more identifying information was available about the windrower, the van driver was about 3 to 4 seconds from impact, and ran out of time to avoid the collision.

6. While the van driver could have made a more cautious approach, for example by slowing or by insuring more than 2 1/2 feet of side clearance around the light, his actions were far more understandable than operating the windrower without an adequate rear lighting and delineation system.

7. Although there was no approach guardrail system to protect against impact with the bridge parapet, the accident had the potential to be as severe even if a conventional guardrail system had been in place.

8. Although they were not a factor in this accident, an unprotected bridge parapet and outdated bridge rail system can present a considerable hazard to errant vehicles.

9. Utah's bridge inventory records show that 47 percent of the bridges carrying highways have substandard approach guardrail systems.

10. The State of Utah should reactivate its Roadside Obstacle Improvement Program and update all substandard bridge rail systems with priorities based on accident history and future traffic needs.

11. More and relatively simple measures can be taken by the farm equipment industry to improve the lighting and delineation of farm equipment operating on the highway.

12. The National Committee on Uniform Traffic Laws and Ordinances should amend its Uniform Vehicle Code to provide for more effective lighting and delineation of farm equipment operating on the highway.

13. The States should reexamine and update their laws to provide more effective lighting and delineation of farm equipment operating on the highway.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the farm vehicle's inadequate rear lighting system, which failed to identify the slow-moving, overwidth windrower as a hazard to higher-speed traffic approaching from the rear, and the van driver's inability to detect and avoid striking the projecting cutting attachment on the windrower while operating at the posted speed limit.

RECOMMENDATIONS

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

— to the American Society of Agricultural Engineers:

Reevaluate the present ASAE lighting and marking standards applicable to agricultural equipment being driven on public highways during the hours of darkness to insure that:

(1) current lighting and delineation system requirements do not mask the intended function of each other; and

(2) recommended lighting and delineation system requirements also minimize potential misinterpretation regarding the intended use of various lighting modes.
(Class II, Priority Action) (H-80-36)

— to the National Committee on Uniform Traffic Laws and Ordinances:

Amend the Uniform Vehicle Code to provide guidelines for insuring that farm equipment lighting and delineation systems do not mask each other and to require systems that will delineate the extreme projections of all overwidth equipment. (Class II, Priority Action) (H-80-37)

-- to the States:

Adopt the amended Uniform Vehicle Code standards regarding the marking and lighting of farm vehicles (implements of husbandry). (Class III, Longer Term Action) (H-80-38)

— to the State of Utah:

Insure that its selective enforcement program places the proper emphasis on the enforcement of the Utah regulations concerning the safe operation of farm vehicles (implements of husbandry) on the highways. (Class II, Priority Action) (H-80-39)

"Reactivate its Roadside Obstacle Elimination Program giving emphasis to updating unsafe bridge traffic barrier systems with priorities based on accident history and future traffic needs. (Class II, Priority Action) (H-80-40)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Member, did not participate.

March 20, 1980

APPENDIX

INVESTIGATION

1. Investigation

The National Transportation Safety Board was notified of the accident at 10:40 a.m. on September 12, 1979, by the Utah Highway Patrol. An investigative team from Washington, D.C., arrived in Delta at 12:30 p.m. on September 13, 1979.

Investigative groups were formed for Human Factors/Injury Causation, Highway/Environment Factors, and Vehicle Factors. Representatives of the Utah DOT, the Utah Highway Patrol, the Federal Highway Administration, and the International Harvester Corporation participated in the investigation.

2. Deposition/Hearing

There were no depositions or hearing held in connection with this investigation.