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Highway Accident Report - Multiple-Vehicle Collision in a Construction Zone, U.S. Interstate 80 Near Laramie, Wyoming, August 22, 1979

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

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16. Abstract

About 6:25 a.m., m.d.t., on August 22, 1979, a westbound tractor-semitrailer sideswiped an eastbound tractor-semitrailer and then struck an eastbound motor home in a two-lane, undivided roadway in a construction zone on Interstate 80 about 30 miles northwest of Laramie, Wyoming. The driver and codriver of the westbound tractor-semitrailer were killed. Six of the seven persons in the motor home were ejected and killed; one person was partially ejected and seriously injured. The two persons in the eastbound tractor-semitrailer were not injured.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the fatigued driver of the westbound truck to maintain his vehicle within the proper traffic lane. Contributing to the severity of the accident was the excessive speed of the westbound truck.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: February 7, 1980

MULTIPLE-VEHICLE COLLISION IN A CONSTRUCTION ZONE U.S. INTERSTATE 80, NEAR LARAMIE, WYOMING AUGUST 22, 1979

SYNOPSIS

About 6:25 a.m., 1/ on August 22, 1979, a westbound tractor-semitrailer sideswiped an eastbound tractor-semitrailer and then struck an eastbound motor home in a two-lane, undivided roadway in a construction zone on Interstate 80 about 30 miles northwest of Laramie, Wyoming. The driver and codriver of the westbound tractor-semitrailer were killed. Six of the seven persons in the motor home were ejected and killed; one person was partially ejected and seriously injured. The two persons in the eastbound tractor-semitrailer were not injured.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the fatigued driver of the westbound truck to maintain his vehicle within the proper traffic lane. Contributing to the severity of the accident was the excessive speed of the westbound truck.

INVESTIGATION

The Accident

Shortly after 6 a.m., on August 22, 1979, a tractor pulling a 40-foot, refrigerated semitrailer 2/ was eastbound on the four-lane, divided Interstate 80 about 30 miles northwest of Laramie, Wyoming, when it entered a construction zone where eastbound traffic was detoured onto one lane of the two-lane westbound roadway. The eastbound truck was following a motor home and was being followed by another vehicle. For a short distance along the detour, there were double "no passing" lines. As the vehicles came over the top of a hill, the

1/ All times herein are mountain daylight time.
2/ To simplify references in this report, each combination vehicle will be referred to as a "truck."

double lines became a broken single line, and the eastbound truck overtook and passed the motor home, which had slowed to about 10 mph. The driver of the eastbound truck said that after the passing maneuver, the motor home followed her vehicle at a distance of 60 to 120 feet.

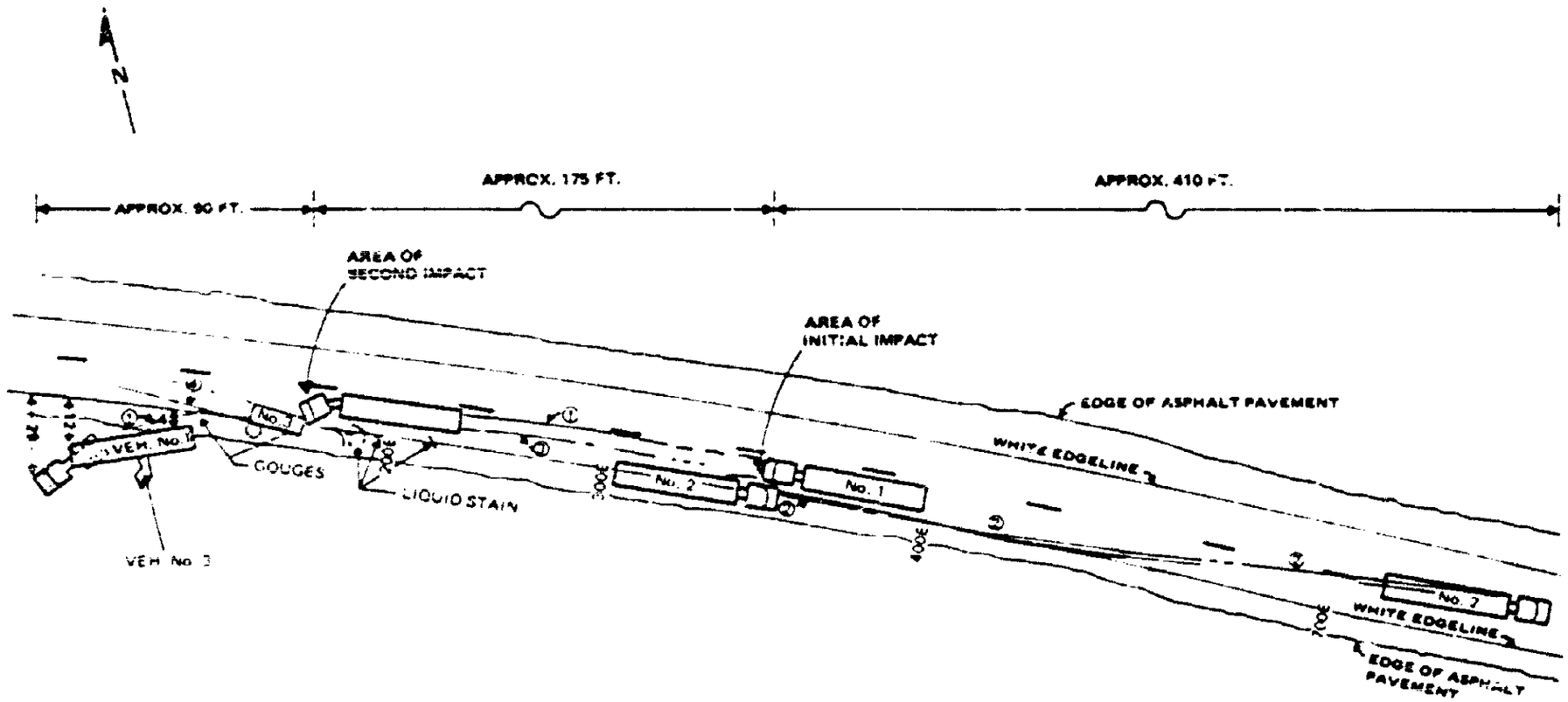
As the vehicles moved down the hill, the driver of the eastbound truck said she saw a westbound truck across a small valley coming down a hill toward her. As the westbound truck, a tractor towing an empty semitrailer, got closer to a curve ahead, she could see that it was in her lane of travel. This did not alarm her because she knew that drivers often travel the inside of a curve, particularly when they are trying to maintain a speed that will help negotiate the next hill faster. The driver of the eastbound truck said she expected the westbound truck to move back into its own lane, but when she concluded it was not going to change lanes, she moved onto the paved shoulder on the right to avoid a collision. At this time she could see that the driver of the westbound truck was sitting behind the steering wheel and was not making any effort to turn the wheel to avoid her vehicle, but she could not tell if his eyes were open or closed.

The westbound truck struck the left driving wheels of the tractor of the eastbound truck, sideswiped the refrigerated semitrailer, hit the left-rear wheels of the semitrailer, and collided head-on with the motor home which had been following the eastbound truck in the eastbound lane. (See figure 1.) The driver and codriver of the westbound truck were killed. Six of the seven persons in the motor home were ejected and killed; one person was partially ejected and seriously injured. The two persons in the eastbound truck were not injured.

Because of the steep shoulder, the driver of the eastbound truck did not move any farther to the right to avoid a head-on collision because she did not want to risk overturning her vehicle. She said she did not apply her brakes and tried to steer smoothly. The westbound truck was completely within the eastbound lane and the eastbound truck was straddling the right road edgeline with most of the vehicle on the paved shoulder when the vehicles sideswiped. The driver of the eastbound truck brought her damaged vehicle back into the eastbound lane and stopped after the accident.

The driver of the eastbound truck said she was traveling about 50 mph as she came down the hill and was traveling about 52 mph at the time of the collision. She said that the westbound truck appeared to be under control and that it was traveling at a speed above the posted speed limit of 55 mph. The driver of the vehicle which was behind the motor home reported that he did not see the accident. The driver of a vehicle that had been following the westbound truck for about 8 miles said that the westbound truck was moving at a high rate of speed and was not being operated erratically.

The Wyoming Highway Patrol established the time of the accident from a damaged wristwatch found in the wreckage at the accident scene. The watch was stopped at 6:25 a.m. The patrol received a telephone notification of the accident at 6:45 a.m. According to its past experience, a 20-minute delay in notification was considered normal.



VEH. No. 1 – 1977 PETERBILT TRACTOR-SEMITRAILER
VEH. No. 2 – 1978 INTERNATIONAL TRACTOR-SEMITRAILER
VEH. No. 3 – 1979 LINDY MOTORHOME

1 TIREMARK FROM VEH. No. 1
2 TIREMARK FROM VEH. No. 2
3 SCRATCH FROM VEH. No. 1
4 TIREMARK FROM VEH. No. 3

NOT TO SCALE

Figure 1.—Plan view of accident site.

Injuries to Persons

Injuries	Drivers	Passengers	Other
Fatal	2	6	0
Nonfatal	0	1	0
None	1	1	0

Vehicle Information

The eastbound truck was owned by Mr. and Mrs. M. Fase and leased to Hagen, Inc., of Sioux City, Iowa. It was loaded with 43,507 lbs of cargo. The gross combination weight of the tractor-semitrailer was 76,087 lbs. The tractor was a 1977 International Harvester, conventional Model Transtar 4370, VIN DZ137GG824735, with a diesel engine. It was equipped with a sleeper compartment. The tractor was equipped with FMVSS-121 air mechanical brakes on all axles. The tandem-axle semitrailer, VIN 28703, was manufactured by American Trailers, Inc. It was a 40-foot-long, insulated van with a Carrier refrigeration unit.

The motor home, manufactured by the Skyline Corporation, was a Lindy Class C 2002 RB, serial no. 8680-0541M, and was built on a 1-ton, 20-foot-long, Dodge chassis, VIN F3KT9V-710577. The odometer registered 3,200 miles. It was owned by one of the passengers. The vehicle was carrying seven persons and approximately 250 lbs of luggage. The vehicle's curb weight was 7,315 lbs. Its estimated weight as loaded was 8,630 lbs. The vehicle was equipped with a 360-cubic-inch, V-8 engine and a rear axle with dual tires on each side. The motor home had four manufacturer-designated seating positions--the driver's and right-front passenger's seats, and the forward-facing dinette seat. These four seating positions were equipped with Type 1 seatbelts (lap belt only).

The westbound truck was owned by the KNT Leasing Corporation and leased to the Savage Brothers Trucking Company, both of American Fork, Utah. The gross combination weight of the unit was 27,690 lbs. The tractor was a 1977 Peterbilt, three-axle, conventional Model 359A, VIN 106953P, with a sleeping compartment. The sleeper berth was equipped with occupant restraint as required by Federal Motor Carrier Safety Regulation (FMCSR) 393.76. It was equipped with a six-cylinder, NTC-400 Cummins diesel engine, a Fuller Road Ranger transmission RTO 12513, and air mechanical brakes that complied with Federal Motor Vehicle Safety Standard (FMVSS) 121. A tachograph was mounted on the dashboard forward of the steering wheel. The semitrailer was a 1978 Fruehauf, two-axle, Model No. HAR-FZ-1500, VIN FRZ702406, four-compartment, bulk trailer equipped with a tandem axle assembly.

Vehicle Damage

After the westbound truck struck the motor home, it came to rest off the road adjacent to the eastbound lane. Its right-rear semitrailer tire was 4 feet from the eastbound lane edgeline and the right-rear tractor bogie tire was 12 feet from this edgeline. (See figure 1.) The right-front wheel of the tractor was 27 feet from the eastbound lane edgeline. The right-rear corner of the semitrailer came to rest about 39 feet 6 inches from the point of impact with the motor home. The motor home came to rest adjacent to the left side of the semitrailer on the south side of the road. The motor home was located 16 feet from the left front of the semitrailer and 16 feet from the left rear of the semitrailer. The motor home's skidmarks measured 62.5 feet for the right tires and 54.8 feet for the left tires.

A posterash inspection of the three vehicles failed to disclose any mechanical defects that may have caused or contributed to the accident.

Damage to the eastbound truck was confined to the left-side, outside tires and to minor scratches on the semitrailer. There were black rubber transfer smudges on the left trailer support and on the refrigeration unit's fuel tank.

The motor home was demolished. The initial impact occurred on the left-front side. The impact force completely separated the motor home body from the chassis. The fiberglass body was shattered into several large pieces. Interior fixtures were not available for inspection. The rear body section, although separated from its frame, remained intact. Massive damage to the vehicle steering, brake, and suspension systems precluded any meaningful inspection. (See figure 2.)

The posterash inspection of the westbound truck indicated that the front-end components forward of the engine firewall had been separated from the vehicle and were severely damaged. The left-front tire was stripped from its rim and the front axle was displaced rearward. Both front-frame side rails were bent severely to the left. The entire cab structure had been physically distorted rearward and skewed to the left. The dash and instrument cluster were separated from their mountings. The top half of the steering wheel was bent rearward and the steering column was disconnected from the steering gear. The driver and passenger seatbacks were bent rearward. The roof structure over the sleeping berth had collapsed inward and was deformed rearward with the rest of the cab. Damage to the semitrailer was minimal. The left semitrailer tandem fender was pushed rearward against the tires, but not enough to puncture or preclude rotation of the tires. The remaining structure had only minor damage. (See figure 2.)

Driver Information

The 30-year-old driver of the eastbound truck had been driving trucks for the last 10 years and her driving record was satisfactory. Her log entries complied with Federal requirements.

The motor home had departed Everett, Washington, at 6:15 a.m. on August 30, 1979. Its en route stops could not be determined. The probable driver

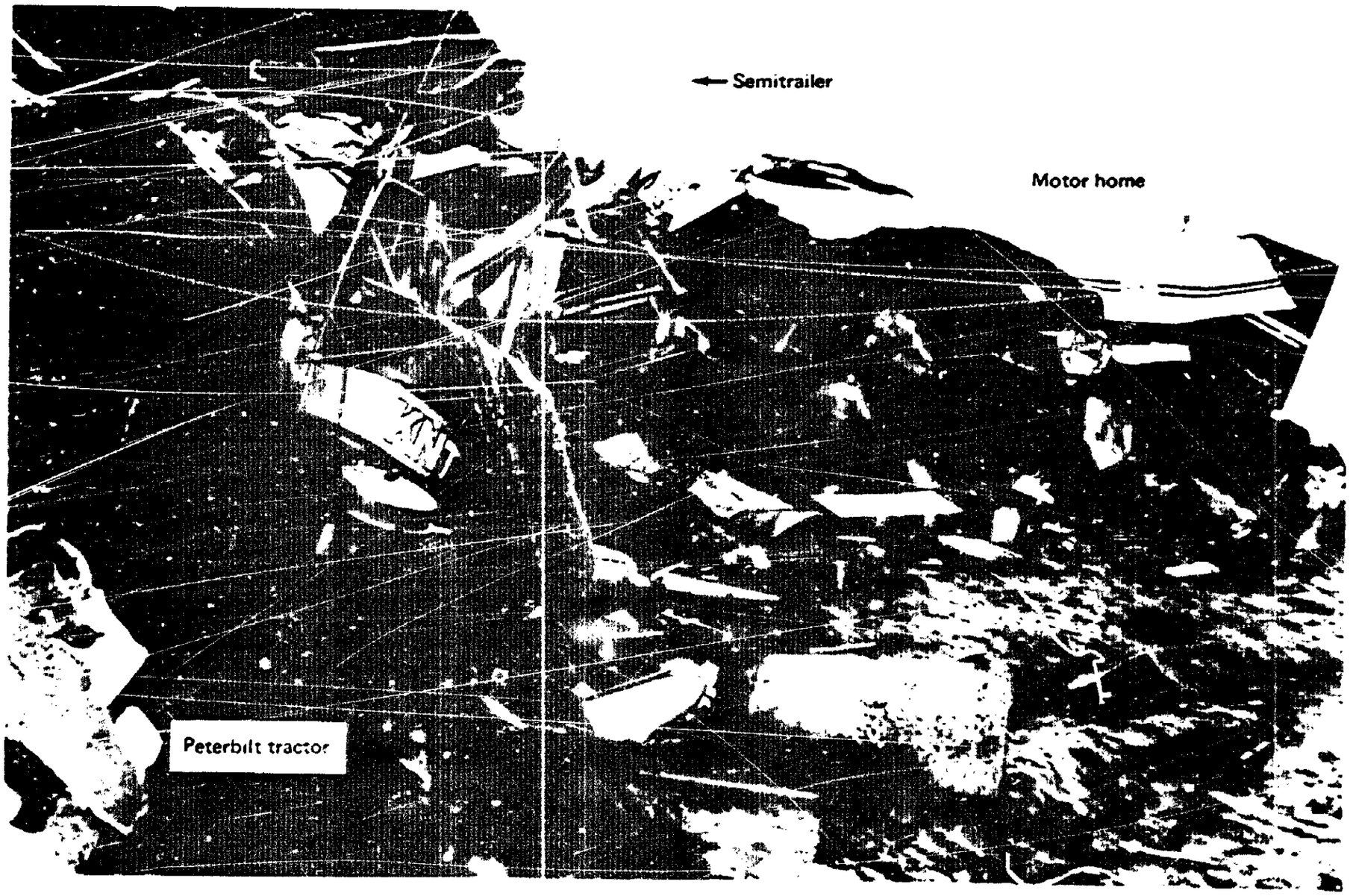


Figure 2.—Impact damage to motor home and westbound truck.

of the motor home was determined through an injury analysis. The person identified sustained injuries which were compatible with a position behind the steering wheel at impact. The probable driver had a good driving record and no known health problem.

The 30-year-old driver of the westbound truck held a valid Utah chauffeur's license with a corrective lenses restriction. The investigation could not determine if he was wearing corrective lenses at the time of the accident. The personal and employment background of the driver was normal. He started working as a truckdriver in 1973. He changed employers often, but all former employers indicated that they would have rehired him. Twice, when driving assignments were not available, an employer made a position available to him as a dispatcher because the driver demonstrated responsibility and intelligence in contact with the public and his fellow employees.

The operator at the unloading facility in Colorado Springs, Colorado, where the westbound truck was last unloaded, stated that both the driver and codriver appeared tired and that they told him tire trouble had put them behind schedule. The driver asked to use the telephone to call his wife to let her know he was running late. This was not possible because there was no outside telephone at the facility. The operator said that the accident driver was driving the truck when it left at 1:30 a.m. on August 22, 1979.

The logs of the driver of the westbound truck indicate that he was not working and was off duty on August 18 and 19, a Saturday and Sunday. The fatal trip began at 5 p.m. on Monday, August 20, 1979, in American Fork. Cargo was loaded at Green River, Wyoming, and hauled through Laporte, Colorado, and Meeker, Colorado, to its destination in Colorado Springs, where it was unloaded. The westbound truck was returning to American Fork when the accident occurred. It had traveled a total of 675 miles during a 37 1/2-hour period.

The logs of the two drivers of the westbound truck were incomplete. There were no entries in the driver's logs after noon on August 21, 18 1/2 hours before the accident, and the codriver's last entry was at 8 p.m. on August 21, 10 1/2 hours before the accident. The driver's logs showed that over a 19-hour period, he drove 10 1/4 hours, was on duty in the sleeper berth 4 1/2 hours, on duty but not driving 1/2 hour, and off duty 3 3/4 hours. (See appendix B.) The truck had traveled the 233 miles from the facility in Colorado Springs to the accident site in just over 4 hours--an average speed of 58 mph.

Roadway Information

In the area of the accident, I-80 is a four-lane highway with two eastbound and two westbound lanes separated by a 330-foot-wide median. The road and shoulder surface material is recycled asphalt. The 9-mile-long construction zone was from mileposts 286.6 to 277.7. The accident occurred at milepost 281.4, 5 miles from the western entrance to the construction zone. The westbound lanes had been resurfaced in July 1979, and at the time of the accident the eastbound lanes were closed for resurfacing.

Both eastbound and westbound traffic had been routed onto the westbound lanes, creating a two-lane, two-way traffic pattern. The temporary eastbound lane was 12 feet 8 inches wide, and the temporary westbound lane was 12 feet 10 inches wide. The shoulder for eastbound traffic was 8 feet 1 inch wide, and the westbound shoulder was 12 feet 11 inches wide. The first 3 feet of the eastbound shoulder had a 0.035 foot/per foot (ft/ft) slope. The next 3 feet had a 0.236 ft/ft slope. The roadway superelevation was about 0.06 ft/ft. (See figure 3.) Only the first 3 feet of the eastbound shoulder appeared to be usable to traffic; the rest of the shoulder appeared too steep for safe use. Adjacent to the paved shoulder was a rock-strewn median which was not conducive to safe travel. (See figure 4.)

Eastbound drivers had their first unobstructed opportunity to see approaching westbound traffic at a point 2,890 feet west of the initial point of impact. Immediately before reaching the point of impact, westbound traffic must traverse a 3,438-foot left curve which had a radius of 3,820 feet. The initial point of impact of the trucks was approximately 350 feet east of the west end of this curve. (See figures 5 and 6.) The point of impact of the westbound truck and the motor home was located approximately 170 feet west of the initial impact.

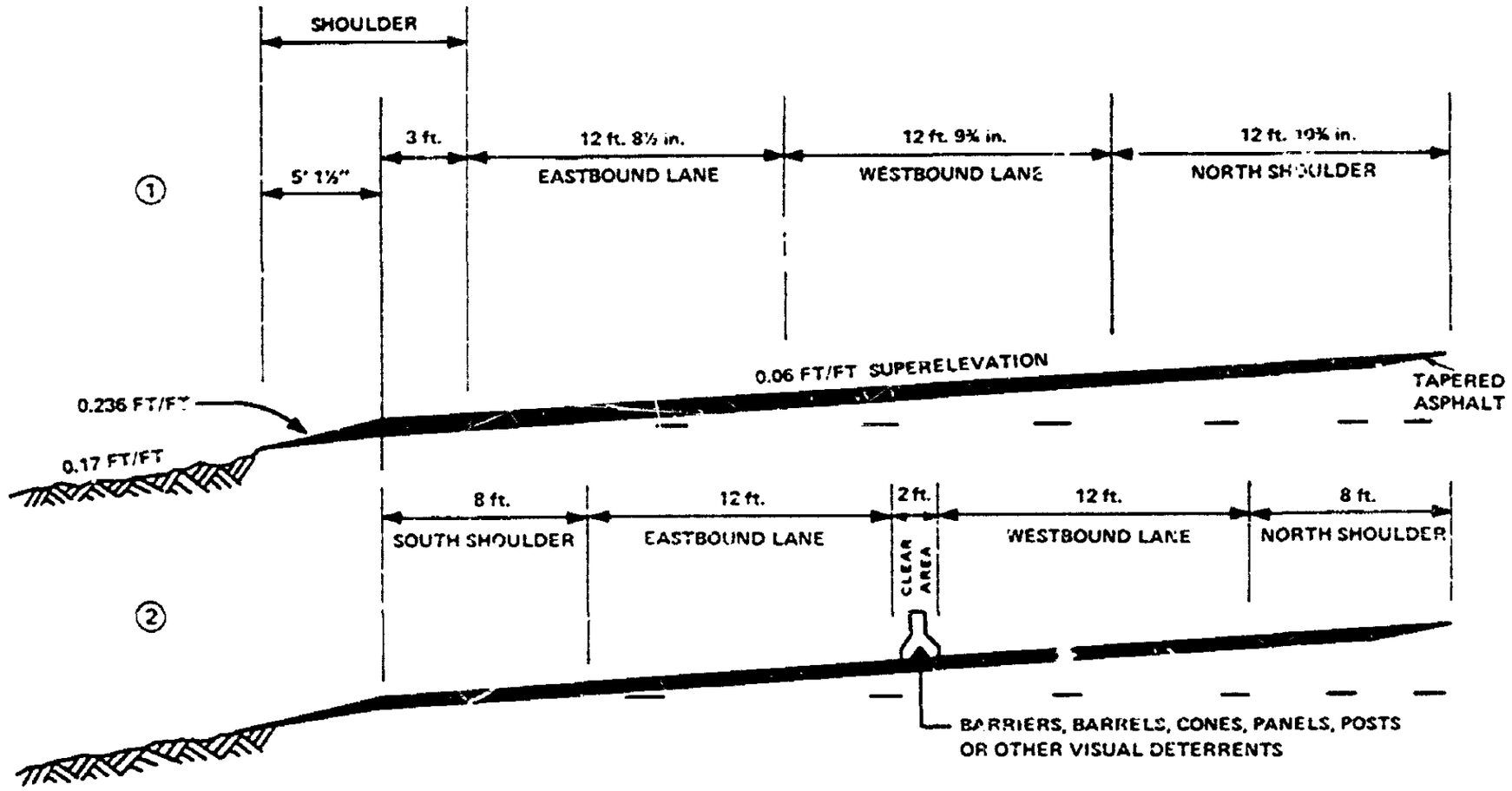
"Two-Way Traffic" signs were placed at one-half-mile intervals throughout the construction zone. One such sign was facing westbound traffic 0.26 mile east of the point of impact. The posted speed limit through the construction zone was 55 mph. Westbound traffic encountered the last 55-mph speed limit sign about 4 miles east of the accident scene. Eastbound traffic encountered a similar sign about 0.8 mile west of the impact area. The contract for the construction project called for the placement of speed limit signs at 1-mile intervals. At the point of impact, the centerline was a single 10-foot-long yellow dash line. The spacing between dashes was 30 feet. Both edgelines were white. All signs and markings conformed with the Manual on Uniform Traffic Control Devices (MUTCD). 3/

The Wyoming Highway Department daily traffic counts taken during the month of August indicated that an average of 196 vehicles, of which 75 percent were trucks, passed through the construction zone between 6 a.m. and 7 a.m. The average daily traffic in the area was 7,412 vehicles, of which 38 percent were large commercial vehicles.

Meteorological Information

There was no precipitation or other weather condition which could have influenced the accident. The temperature was about 43° F. Visibility was 50 miles. The sunrise was at 6:15 a.m. and the sky was light enough to drive without lights, even though all vehicles involved still had their lights on. The driver of the eastbound truck said she could have seen the westbound truck even if its lights had not been on.

3/ Manual On Uniform Traffic Control Devices (1978) approved by the Federal Highway Administration as the national standard for all highways open to public travel.



① CROSS SECTION IN AREA OF IMPACT
② POSSIBLE ALTERNATE USE

Figure 3.—Cross-section view of roadway at accident site.

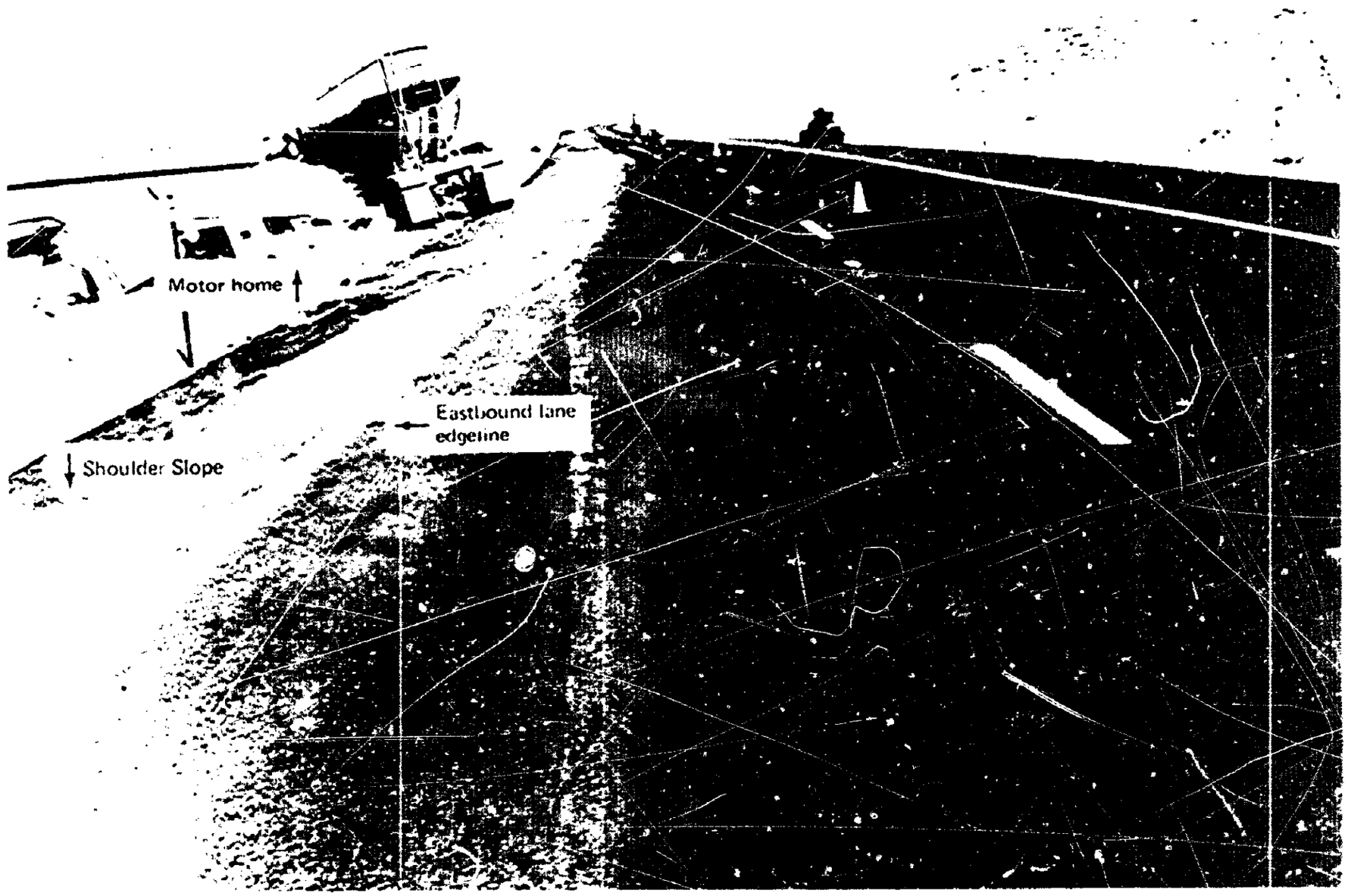


Figure 1.—Westward view of accident site.

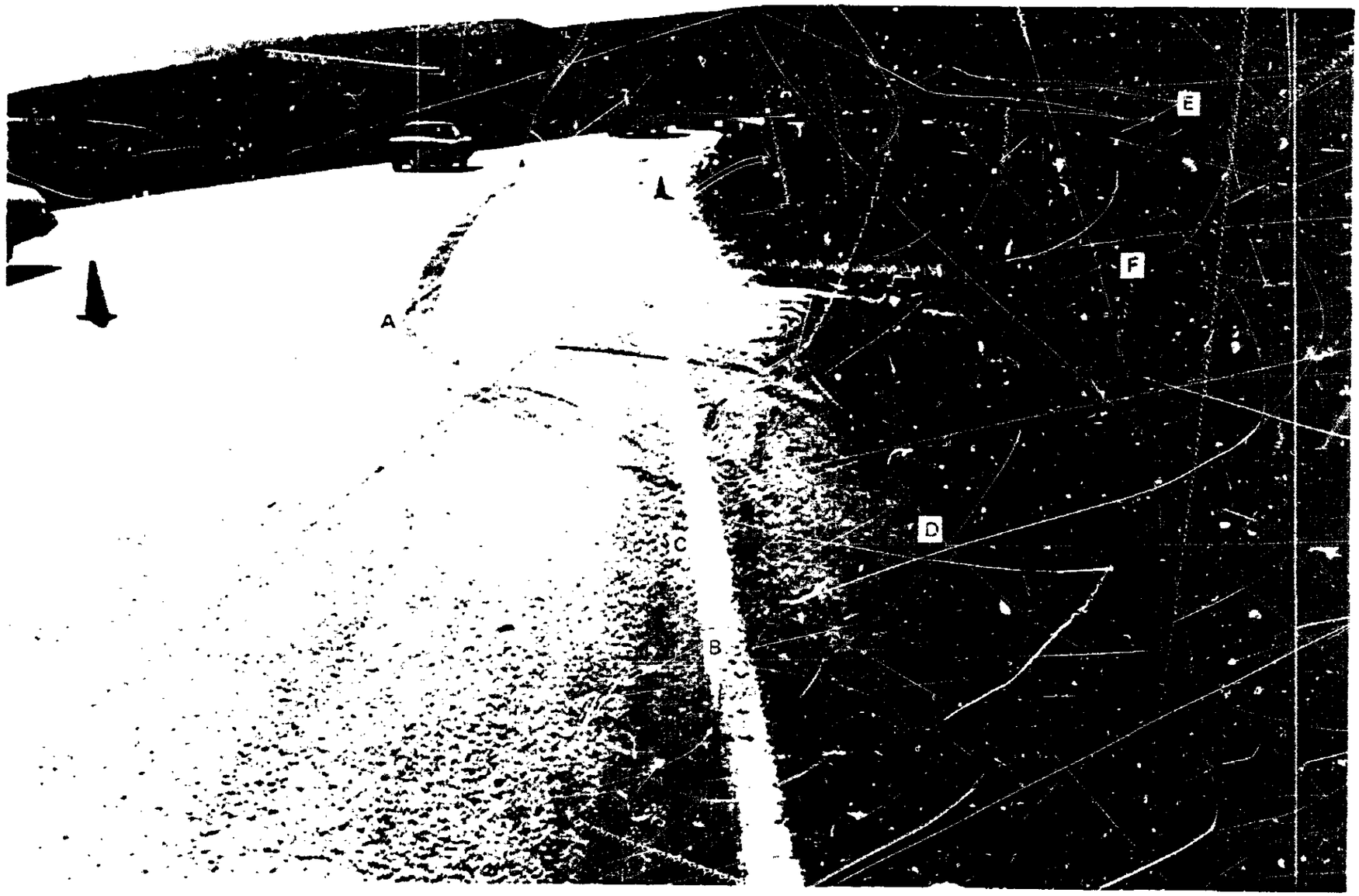


Figure 5.—Eastward view of accident site.
(a) Right-front tire mark from westbound tractor, (b) motor home tire marks, (c) right edgeline for eastbound traffic, (d) shoulder slope, (e) closed section of I-80 being resurfaced, (f) rock-strewn median area.

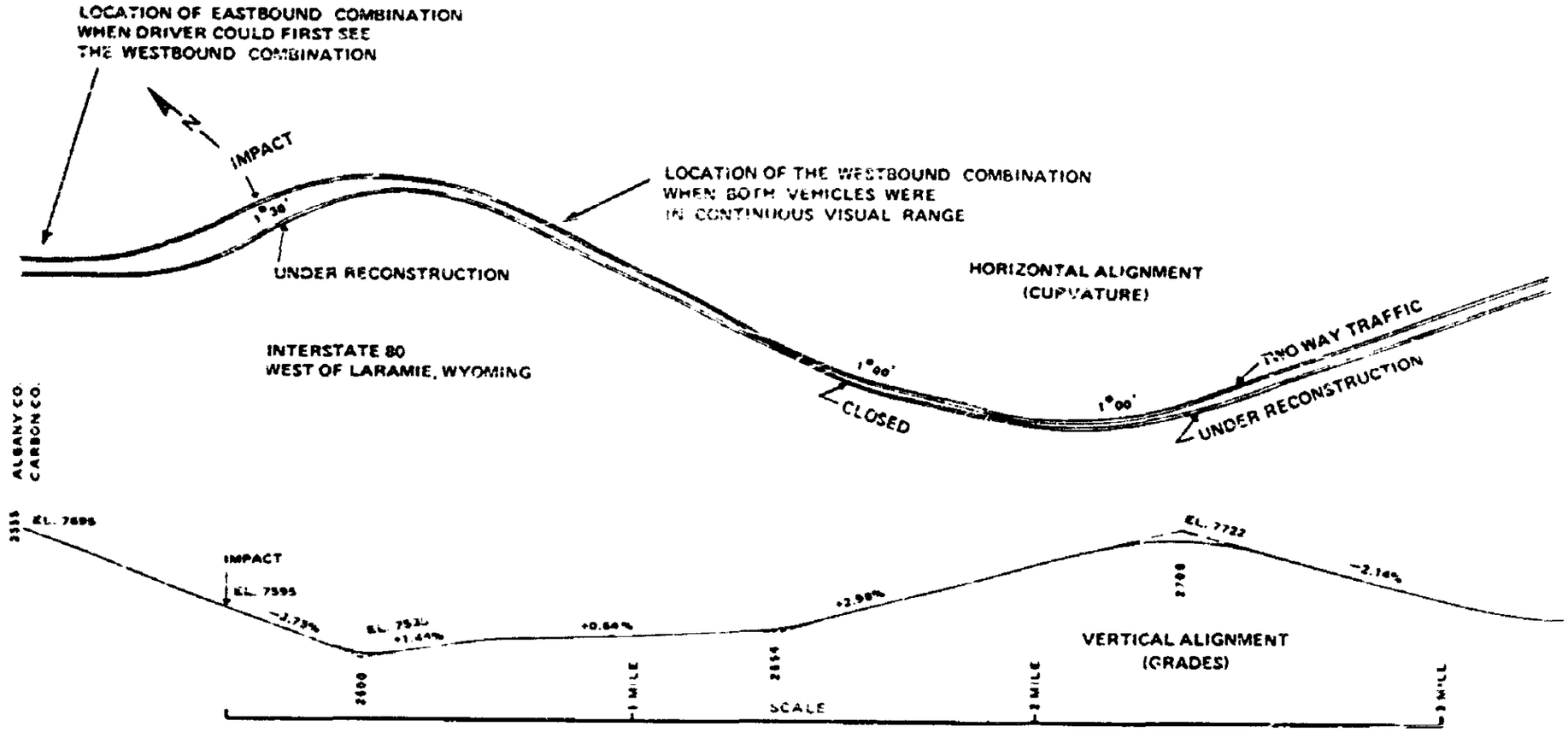


Figure 6.—Plan and profile views of accident site.

Medical and Pathological Information

The medical examiner of the State of Utah conducted an autopsy and a toxicological analysis on the driver of the westbound truck. The general examination did not indicate any acute medical problems and revealed that the cause of death was major brain injuries and skull fractures. The analysis showed no evidence of drugs or alcohol. He had no medical history of blackouts or seizures that might account for his inattention at the time of the collision. No autopsy was performed on the codriver. His death was attributed to a skull fracture, internal head injuries, and abdominal and thoracic internal injuries.

The six occupants of the motor home died as a result of injuries received in the collision. The survivor had suffered internal injuries and shock.

Survival Aspects

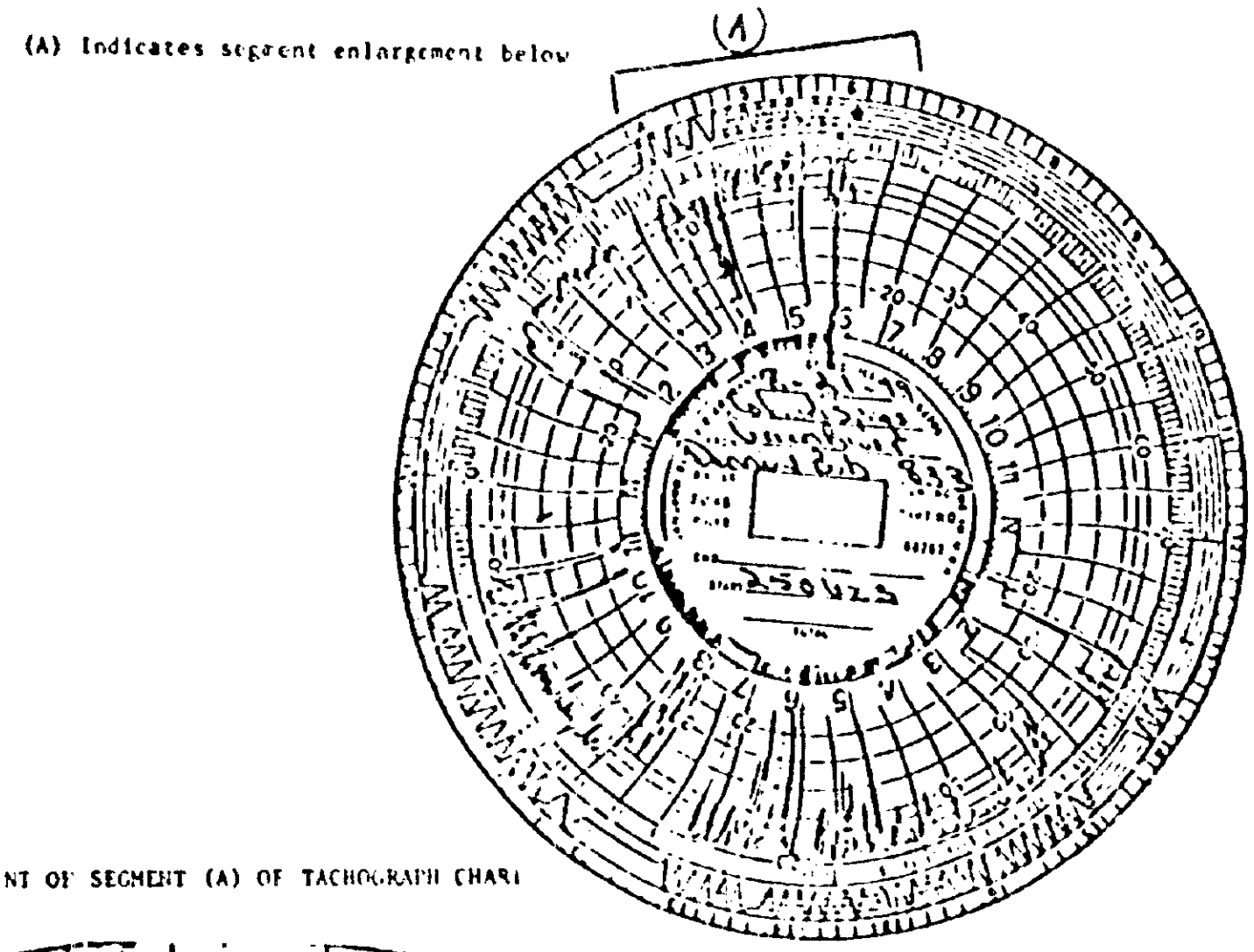
The codriver in the sleeper berth of the westbound truck was not wearing the available seatbelt at the time of the accident. He was thrown forward out of the sleeper berth and his head became lodged between the spokes of the steering wheel. The driver of the westbound truck was not wearing the available seatbelt. None of the seatbelts at the four seating positions in the motor home was in use.

Tests and Research

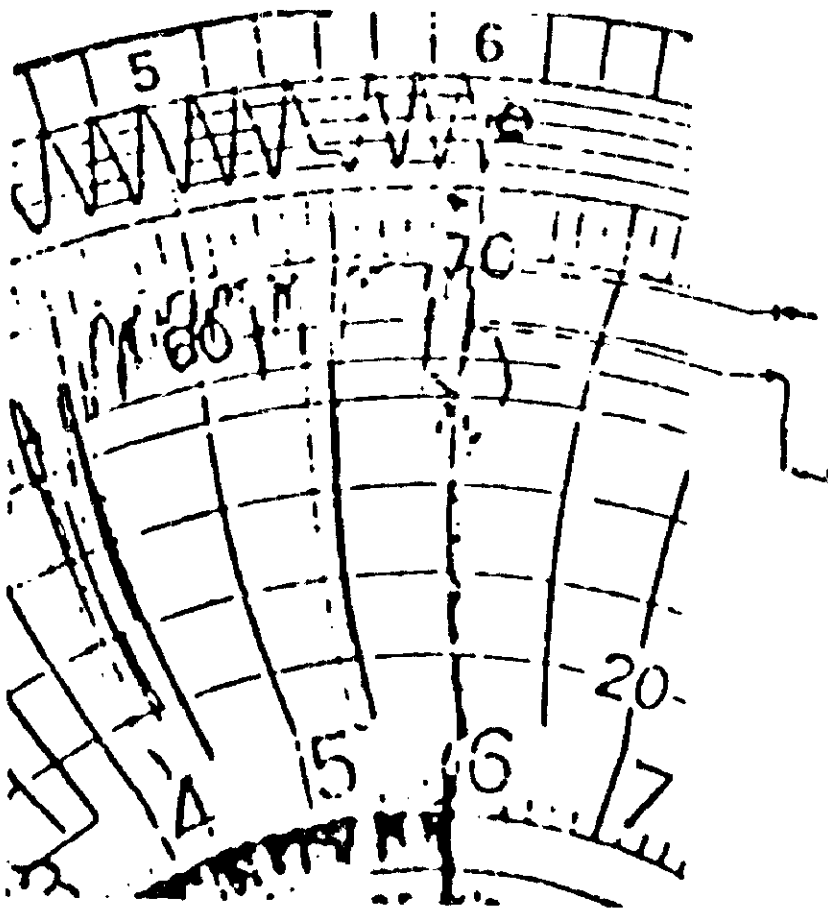
The tachograph in the westbound truck was examined after the accident. It was determined that the tachograph was operating at the time of the accident. The chart recorded speeds as high as 68 mph during its trip through Wyoming and Colorado. It registered the vehicle's speed at 68 mph when the westbound truck struck the eastbound truck, and at 58 mph when the westbound truck struck the motor home. (See figure 7.) The tachograph recorded the time of departure from Laporte at 7:30 p.m. on August 21. The tachograph showed the vehicle en route from 7:30 p.m. until 11 p.m. The cargo was unloaded at the terminal at Colorado Springs from 11 p.m. on August 21 until 1:30 a.m. on August 22. The tachograph shows the vehicle en route from Colorado Springs at 1:30 a.m., a stop at 3:15 a.m. until 3:45 a.m., and a brief stop at 5:20 a.m. The tachograph read 6 a.m. when it ceased operation. The Safety Board was unable to reconcile or explain the difference in the time the recordings stopped on the tachograph chart and the time of the accident established by the Wyoming Highway Patrol.

Other Information

The Wyoming State Highway Department provided the Safety Board with accident data for the segment of I-80 which included the accident site. The fatal accident rate calculated from the data varied between 1.7 and 3.8 accidents per 100 million vehicle miles (mvm) before the 1979 construction work began. The rate escalated to 6.9 accidents per 100 mvm during the construction period, when two-way traffic was operating on one two-lane portion of the roadway. The comparable



ENLARGEMENT OF SEGMENT (A) OF TACHOGRAPH CHART



Speed for initial impact
68 MPH

Speed of second impact
58 MPH

Figure 7.--Face of tachograph chart from westbound truck.

fatal accident rate on a similar two-lane highway was 5.2 mvm. The latest national accident statistics available indicate that Wyoming has both fatal and nonfatal injury rates that are, respectively, 3.3 and 1.8 times the national average on interstate highways.

Between June 17, 1979, and September 3, 1979, 4 fatal, 1 personal-injury, and 4 property-damage accidents, which resulted in 13 fatalities, 4 injuries, and 14 damaged vehicles, occurred in the 9-mile construction zone; all of the fatal accidents involved large commercial vehicles. (See appendix C.) During 1977, there were three accidents in a similar construction zone on I-80, which resulted in one fatality and four injuries; two of these accidents involved vehicles traveling in opposite directions, and one resulted from a vehicle striking a barrel or barricade.

Overturn accidents were the predominant accidents on the 49-mile segment of I-80 between Laramie and Rawlins, Wyoming. It was calculated that 37.7 percent of the accidents, 54.0 percent of the injuries, and 76.9 percent of the fatalities were related to overturning accidents. Of these, 35.2 percent were recorded as occurring during a blizzard or high winds.

On December 20, 1978, the Federal Highway Administration's (FHWA) Office of Highway Safety issued a bulletin on safety in construction and maintenance zones that discussed two-way traffic on normally divided highways. The bulletin states in part:

> There is continuing evidence of severe head-on accidents on divided highways which have been reduced to two-lane, two-way operations because of construction or maintenance. Those responsible for traffic controls through construction and maintenance zones should be reminded that this method of maintaining traffic should only be adopted after careful consideration of all other practical alternatives. Since this situation violates a driver's expectancy, emphasis should be placed on signing, delineation, and barriers which will make it obvious to motorists that they are in restricted, two-way, no-passing situations.
>
> <u>One roadway of a divided highway cleared for reconstruction.</u>--Because of the potential for severe accidents, this situation should be avoided. Before adopting two-way operations on divided highways, consideration should be given to using existing or building extra wide shoulders and adding lanes to maintain divided traffic. If traffic volumes are low and other considerations make it impractical to maintain a divided facility, then positive separation should be provided by using barriers such as the concrete safety shape. If positive separation is not feasible, drums, cones, or vertical panels should be used to provide delineation and channelization. In all cases, signing and striping should, as a minimum, comply with the MUTCD and should be maintained in excellent condition throughout the life of the project. In addition, signs warning of the two-way operations should be placed at frequent intervals, raised pavement markers should be considered to supplement the striping, and project lengths should be kept to a minimum (3 to 5 miles maximum).

On January 19, 1979, the chief of the construction and maintenance division of the FHWA's Office of Highway Operations transmitted to the FHWA's Regional Administrators copies of the Office of Highway Operations' and Office of Traffic Operations' 1978 Joint Field Reviews on Traffic Safety in Highway and Street Work Zones. A final recommendation of that field review, made in nine States including Wyoming, is:

> D. Two-way traffic on one side of high volume/high speed divided highways.--Problems noted during these reviews dealt only with the lack of protection for what was (prior to two-way operation) the trailing end abutment of bridges. However, fatal accident reports received by this office indicate that the potential for head-on collisions and multiple fatalities is significant when the two-way operation option is used for traffic control during construction. All alternatives to two-way operation should be thoroughly explored prior to using this method of traffic control on high speed/high volume highways.

On June 17, 1979, there was a head-on collision between two combination vehicles on I-80 at milepost 277.7 in a similar construction zone. On June 26 the FHWA Division Office discussed this accident and recommendations with the State Highway Department. On June 29, 1979, as a result of this discussion, the FHWA's Wyoming Division Highway Safety Engineer sent a memorandum to the Division Administrator regarding his review of the accident site and recommendations for modifications to the traffic control plan (TCP) for this construction site. The three recommended modifications which had been previously discussed with the State were:

> (1) Stripe the two-way section for "no-passing" for its total length;
> (2) reduce the speed limit on the two-way section to 45 mph and place the required signs at 1-mile intervals;
> (3) place signs at the beginning of the two-way section and at intervals through the section indicating the length of the "no-passing" area.

The State of Wyoming chose not to implement any of these recommendations before the accident on August 22, 1979.

On September 17, 1979, 3 1/2 weeks after this accident, the FHWA issued an emergency final rule (FHWA Docket No. 79-31) entitled "Traffic Safety in Highway and Street Work Zones; Separation of Opposing Traffic." This amendment to 23 CFR 630 was effective immediately. The summary and specific amendment are as follows:

> SUMMARY: The Federal Highway Administration (FHWA) has determined that an alarming number of fatal traffic accidents is occurring where two-way traffic is maintained on one roadway of a normally divided highway. This rule amends existing procedures to require more stringent control measures to reduce the incidence of such accidents on highway construction projects funded by FHWA.

* * *

630.1010 (Amended)

In consideration of the foregoing, Subpart J of Part 630, Chapter I, Title 23, Code of Federal Regulations, is amended by adding a new Subparagraph (5) to 63.1010(a) to read as follows:

(a) * * *

(5) The TCP shall include provisions for the separation of opposing traffic whenever two-way traffic must be maintained on one roadway of a normally divided highway. Two-way operation on one roadway of a normally divided highway shall be permitted only when other methods of traffic control are determined infeasible.

* * *

(i) Where two-way traffic must be maintained on one roadway of a normally divided highway, opposing traffic shall be separated either with positive barriers (concrete safety-shape or approved alternate) or with drums, cones, or vertical panels throughout the length of two-way operation, except for transition zones, where positive barriers shall be used. Where terminal sections of temporary positive barriers are not tied to an existing structure, the barriers shall be flared or fitted with impact attenuation devices. The use of striping and complementary signing, by themselves, is prohibited.

(ii) An exception to the provisions of paragraph (a)(5)(i) of this section may be granted only when it has been demonstrated that the use of positive barriers or delineation and channelization devices is not feasible or practical. An exception shall not be granted where drivers entering the two-way operation cannot see the transition back to a one-way operation. Each exception granted by FHWA will require the written approval of the FHWA Division Administrator.

The American Association of State Highway Officials' 4/ "A Policy on Geometric Design of Rural Highways-1965" (AASHTO Blue Book) states that:

A minimum shoulder width of 4 feet should be considered for the lowest type highway, and preferably a 6 or 8 foot width. Heavily traveled and high speed highways should have usable shoulders at least 10 and preferably 12 feet wide.

* * *

Bituminous surfaced shoulders should be sloped from 3/8 to 5/8 inch per foot [0.03 to 0.05 ft/ft] . . . . A preferred section has a downward slope of about 3:1 or 4:1 [0.33 to 0.25 ft/ft] from the shoulder break point to the drainage channel, with all changes in slope well rounded. . . .

* * *

4/ The association is now named the American Association of State Highway and Transportation Officials (AASHTO).

Shoulder slopes that drain away from the paved surface on the outside of well superelevated sections should be designed to avoid too great a cross slope break. For example, use of a 1 inch per foot shoulder cross slope in a section with pavement superelevation of 0.08 foot per foot results in a 0.16 foot per foot algebraic difference in the pavement and shoulder grades at the high edge of pavement. Grade breaks of this order are hazardous and should not be permitted.

ANALYSIS

The Accident

There was no evidence of any preimpact mechanical defect in any of the three vehicles involved in the accident which might have caused or contributed to the cause of the accident. Based on the damage to the trucks, and marks and gouges in the pavement, it is concluded that the left front of the westbound truck struck all of the left outside wheels aft of the cab of the eastbound truck while the eastbound track was straddling the extreme south edge of the roadway. The loss of the left front tire and the rearward displacement of the front axle destroyed the vehicle's controllability. Because of the high speed and the damage to the westbound truck after the first impact, it appears that the subsequent impact with the motor home was inevitable unless the driver of the motor home could have taken successful evasive action.

When the motor home driver perceived the danger from the westbound truck, he applied the brakes, leaving skidmarks of 62.5 feet from the right tires and 54.8 feet from the left tires to the point of impact. Using the conservation of momentum theory, the Safety Board calculates that the motor home was traveling about 38 mph at the time its driver perceived the danger and reacted by applying the brakes. At the moment of impact, the motor home would have decelerated to a calculated speed of 12 mph. The closing speed for the two vehicles is calculated to have been 88.25 mph (129 feet per second) over a distance of 221 feet. Therefore, the motor home driver would have had about 1.71 seconds in which to perceive the danger and to take evasive action. The Safety Board concludes that in 1.71 seconds the motor home driver did not have time to avoid the westbound truck.

The evidence indicates that the driver of the westbound truck did not see the eastbound truck. According to the driver of the eastbound truck, the westbound truck was in the eastbound lane as it approached, and, although she expected the vehicle to return to the westbound lane, it remained in the eastbound lane. She said that she moved her vehicle as far toward the right paved shoulder of the roadway as she could without risking an overturn but that the westbound truck never moved from the eastbound traffic lane.

The visibility in the accident area was good at the time of the accident. All of the vehicles' headlights were illuminated. The road, although part of a construction zone, was properly marked, dry, and in good condition. Under these circumstances, unless he was incapacitated, the driver of the westbound truck should have been able to see and avoid the eastbound truck.

Since the autopsy disclosed no evidence of medical problems that might have incapacitated the driver, since there was no evidence that he was affected by personality disorders or suicidal intentions, and since he was not under the influence of alcohol or drugs, it was concluded that his failure to take evasive action to avoid the collisions must have been related to other physiological factors.

Because of the lack of log entries after 8 p.m. on August 21, it is not known who drove the truck during its 3 1/2-hour trip from Laporte to Colorado Springs. According to the plant operator, the accident driver was driving when the truck left Colorado Springs. The tachometer recorded a 30-minute stop from 3:15 to 3:45 a.m. and a brief stop at 5:20 a.m. There may have been changes of drivers during these stops. At least we know that the accident driver had been driving at least 1 hour up to the time of the accident.

During the 11-hour period from 7:30 p.m. on August 21 to the time of the accident, the driver and codriver unloaded the vehicle from about 11 p.m. on August 21 to 1:30 a.m. on August 22. Since the accident driver was driving when the vehicle left Colorado Springs, and was driving at the time of the accident 5 hours later, it is possible that he drove the entire 233 miles to the accident site. Therefore, it is possible that in the 11-hour period preceding the accident, the driver had only 3 1/2 hours of rest, from 7:30 p.m. to 11 p.m. if he was not driving, was awake from 11 p.m. to 1:30 a.m., and then drove for about 5 hours.

The conclusions of a Department of Transportation (DOT) study 5/ indicate that "sleeper driver" fatigue, physiological state, and performance are strongly affected by time of day. The evidence obtained in the study which supports the conclusions was: (1) significantly greater subjective fatigue on trips made in the late night/early morning hours; (2) significantly lower critical tracking task scores in the late night/early morning hours; (3) significant circadian depressions in heart rate on late night/early morning trips; (4) significant elevations in cortical activation during late night/early morning hours, indicating increased effort to remain alert; (5) increased incidences of lane-drifting during late night/early morning trips; and (6) a large number of critical incidents involving signs of exceptional drowsiness or lack of attention in the late night/early morning hours. Additionally, the results of the study were found to closely parallel the data on accidents in which driver fatigue, sleepiness, or inattentiveness were considered to be a major factor. These data showed that a disproportionate percentage of "dozeoff driver" accidents occurred in the hours between midnight and 6 a.m., and

5/ Robert R. Mackie and James C. Miller, "Effects of Hours of Service, Regularity of Schedules, and Cargo Loading on Truck and Bus Driver Fatigue," U.S. Department of Transportation, October 1978 (DOT HS-803 799).

the probability of accident involvement significantly increased after about 6 hours of driving. The study indicated that when drivers of trucks equipped with a sleeper berth were on irregular schedules, significant increases in subjective fatigue and significant degradation in performance occurred after 3 to 4 hours of driving.

Based on the work and driving activities for the trip period, the accident driver's statement to the plant operator in Colorado Springs about subjective fatigue, and the findings of the DOT study, the Safety Board concludes that the most likely explanation for the failure of the driver of the westbound truck to take evasive action to avoid the collisions was fatigue which resulted in his dozing or falling asleep. The driver probably became incapacitated only shortly before the accident since the driver of the vehicle following the westbound truck did not notice any erratic movements of the westbound truck before the accident. The high rate of speed of the westbound truck probably was directly related to the driver's stated concern about being behind schedule.

Survival Aspects

Based on the damage sustained by the westbound tractor, it was concluded that on impact the motor home rode up over the front of the tractor and deformed the cab's frontal area rearward. At impact the unrestrained codriver was thrown forward out of the sleeper berth. He might have survived the accident if he had used the available occupant restraint and remained within the sleeper berth.

After portions of the motor home slid over the top of the tractor cab, it fell off to the left side of the semitrailer. The body of the motor home was destroyed and separated from the chassis. The use of the four available occupant restraints would have had no beneficial effect in this accident because of the impact speeds, internal forces, and destruction of the motor home body.

The Highway

Neither the surface material nor the coefficient of friction of the highway affected this accident. However, the signing, shoulder slope, operating speeds, speed enforcement, and other factors associated with the construction zone warrant discussion.

Signing.--The westbound truck passed a "Two-Way Traffic" sign 0.26 mile, or about 13.8 seconds, before impact. In this case, the signing was in conformance with the MUTCD and was sufficient. It is difficult to conceive of the driver's not being aware that he was on a road with two-way traffic. The westbound truck probably passed 10 to 15 eastbound vehicles in the 4 miles he traveled on the two-way segment of the construction zone before impact. Additionally, he had unobstructed visibility for at least 1.2 miles as he approached the eastbound truck.

Although more speed limit signs could have been erected in the construction zone, the existing signing complied with the MUTCD, and the driver of the westbound truck should have known that the national speed limit is 55 mph. The driver's continued operation of the westbound truck at speeds as high as 68 mph

throughout Colorado and Wyoming, as shown by the truck's tachograph, demonstrated the driver's complete disregard for speed limits.

Shoulder Slope.--The existing shoulder slope at the accident site did not conform to current AASHTO guidelines published in 1965. An FHWA bulletin issued 6 months before the construction zone was established stated that "consideration should be given to using existing or building extra wide shoulders and adding lanes to maintain divided traffic" on one roadway of a divided highway to be used for two-way traffic during construction. At locations similar to the accident, it would appear that a safer environment could be provided if two 12-foot lanes are painted, and at least the remaining usable roadway used to provide equal shoulders. In this case, there was a usable pavement width of about 42 feet. A 2-foot clear area, two 12-foot lanes, and two fully usable 8-foot shoulders could have been provided. (See figure 3.) If the usable shoulder had been wider with a less steep cross slope, the eastbound truck may have been able to avoid impact. However, it cannot be determined if a wider shoulder would have prevented the collision with the motor home.

A Wyoming official indicated that the wearing surface would not be added to the roadway during the construction season and that the construction zone would remain with existing lines where they are, except that the lines would be painted over the appropriate color. This approach was being used to eliminate the cost associated with erasing the lines. The Safety Board believes that the benefits obtained by providing equal shoulders probably would outweigh the added costs. 6/

The accident location shoulder slope was so steep that it discouraged use by motorists. A Wyoming official indicated that the accident location has been graded since September 3, 1979, to eliminate some of the steep break. Since 37.7 percent of the accidents on a 49-mile segment that included the construction zone involved overturning vehicles and, as an example, the September 3, 1979, accident (see appendix C) was affected by the steep slope, the Safety Board concludes that the State of Wyoming should determine all other areas where the shoulder is too steep and grade them also.

Speeds and Enforcement.--An FHWA-sponsored accident study 7/ concluded that construction zones with reduced speed limits do not experience lower accident rates than other zones. Field studies also indicate that reducing speed limits alone does not reduce mean vehicle speed but does increase traffic conflicts in transition areas. These conclusions and findings do not support the June 29, 1979, FHWA recommendation to lower speeds in construction zones and could have been one-

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6/ Using the lane line configuration in place at the time of the accident, the estimated cost for removal (based on FHWA 77-16 costs) and painting of additional lines would be about $20,000. Using 1975 National Highway Traffic Safety Administration accident cost estimates, the cost of this accident alone was about $2,350,000.

7/ "Accident and Speed Studies in Construction Zones," June 1977 (FHWA-RD-77-80).

reason why Wyoming did not choose to implement the recommendations. The FHWA study went on to recommend the use of enforcement as a speed control method on short sections where speed reduction is absolutely necessary. The study further indicates that enforcement is the only speed control method that reduces mean speed, erratic maneuvers, and traffic conflicts.

Speed studies conducted by the State of Wyoming Highway Department indicate that vehicles traveling in construction zones, on interstate highways and other roads within the State, generally exceed the national 55-mph speed limit. In fact, Wyoming is one of five States in danger of losing Federal funds for not achieving the goal to increase by 30 percent the number of vehicles complying with the 55-mph speed limit, as ordered by Congress in 1979.

During 1978 the Wyoming Highway Patrol issued more speed violation citations per officer than any other State law enforcement agency in FHWA Region No. 8 (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming). However, due to limited manpower, these efforts were not sufficient to attain the goal of reduced motor vehicle speeds. It appears that more troopers are needed to increase enforcement of speed limits within and adjacent to construction zones in Wyoming. If speed limits were enforced to a greater extent, the high accident rates on interstate highways in Wyoming, when compared to national averages, probably would be reduced.

Construction Zones.--The FHWA's December 1978 bulletin and 1978 field reviews recommended that all alternatives to two-way operation should be thoroughly explored before using two-lane, two-way traffic control on high-speed/high-volume highways. The severity and frequency of accidents in Wyoming construction zones reiterates the need for a more positive approach for traffic control.

As a result of traffic control measures used at the Wyoming construction zone site, the Safety Board conducted an informal telephone survey of all FHWA regions and many State highway offices to determine current practices under similar construction zone situations. The survey revealed that practices varied widely and the respondents expressed concern about:

(1) Operational problems with the use of portable concrete median barriers (operational problems include movement, storage, placement, end treatment, the increase in accidents due to a continuous barrier, and other factors);
(2) The high loss of cones, barrels, and flexible posts--as high as 20 to 30 percent daily;
(3) The need for limitations on the maximum safe length of construction zones which should be used for two-way operation;
(4) The need for speed limit restrictions and enforcement;
(5) The need for limitations on the number of days a two-way operation should be permitted;

(6) The lack of guidance on end treatments for barriers;
(7) Problems associated with accommodating wide vehicles, especially near narrow bridges where concrete median barriers are used; and
(8) Problems associated with maintaining traffic where usable shoulders are not available.

Following 16 months in which 17 major accidents resulting in 44 fatalities and 29 injuries occurred in similar construction work zones nationwide, the FHWA issued a final rulemaking on September 17, 1979, which requires more stringent control measures to reduce the incidence of such accidents on highway construction projects funded by the FHWA. The Safety Board believes that these stringent control measures are needed and concurs with the intent of the FHWA rulemaking. However, these constraints should apply to work on all Federal-aid roads, not just those on construction projects funded by the FHWA. In the Wyoming project, no Federal funds were being used on the surfacing project. Projects on high-speed, divided, Federal-aid roadways should be required to adhere to this new regulation, not just "encouraged to apply these requirements to non-Federal-aid projects."

The Safety Board is aware that the FHWA is sponsoring research which will address some of these highway issues, and that operational experience is available to address other concerns. These findings should be compiled into a manual for dissemination to field construction personnel. Although the FHWA is conducting research on the crash-testing of different barrier systems, and the industry is working on and has available plastic type-III barricades, there is still a need for a device that could function as a visual channelizing device. The more massive "portable" concrete median barriers are not practical because of operational problems. There is a need for a safe, inexpensive, lightweight, strongly anchored, structurally sound, small-based device that would function as a visual barrier separating traffic flow. If a physical or visual barrier had been in place in this construction zone at this accident site, it might have alerted the driver of the westbound truck to stay in the westbound lane of traffic.

CONCLUSIONS

Findings

1. The westbound truck struck the eastbound truck and the motor home at speeds of 68 and 58 mph, respectively.

2. Before impact, the motor home was traveling at an average speed of 38 mph. The motor home had decelerated to a speed of 12 mph by the time it was struck by the westbound truck.

3. The westbound truck was completely within the eastbound lane when it struck the eastbound truck and the motor home.

4. The driver of the westbound truck was fatigued due to the length of time on duty, involving tire repairs, unloading cargo, and prolonged driving before the accident.

5. The most likely explanation for the fatigued driver's failure to maneuver to avoid striking the two vehicles is that he fell asleep shortly before the vehicles approached each other.

6. A posterash inspection of each of the vehicles revealed no mechanical discrepancies that could have contributed to the accident.

7. The accident history at this location indicates that accident rates, especially fatal accident rates, increase significantly when an interstate highway is switched from a four-lane, divided operation to a two-lane, two-way operation during construction work.

8. Since there were "Two-Way Traffic" signs every one-half mile, since the driver of the westbound truck may have passed 10 to 15 eastbound vehicles in the construction zone, and since visibility was unobstructed, it appears that he was not paying full attention to his driving responsibilities at the time of the accident.

9. Additional signs probably would not have affected the driving actions of the driver of the westbound truck because of his disregard for speed limits and his fatigued condition.

10. If the usable shoulder had been wider, the driver of the eastbound truck may have been able to avoid impact with the westbound truck. However, it cannot be determined if a wider shoulder would have affected the collision of the westbound truck and the motor home.

11. Many motor vehicles are operating in excess of the speed limits in Wyoming.

12. More enforcement of speed limits within construction zones is needed in Wyoming.

13. Guidelines must be developed to help implement the recent FHWA emergency rulemaking for construction zones.

14. There is a need for a safe, inexpensive, lightweight, strongly anchored, structurally sound, small-based device that would function as a visual barrier separating traffic flow.

15. The Safety Board was unable to reconcile the difference in the time recorded when the tachograph stopped and the time of the accident established by the Wyoming Highway Patrol.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the fatigued driver of the westbound truck to maintain his vehicle within the proper traffic lane. Contributing to the severity of the accident was the excessive speed of the westbound truck.

RECOMMENDATIONS

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

-- to the Federal Highway Administration:

Expand the Emergency Final Rule, 23 CFR 630.1010 to apply to all construction and maintenance zones on divided Federal-aid roads. (Class I, Urgent Action) (H-80-9)

Develop and disseminate a manual which will compile past operational experience and current research findings related to channelizing traffic which is rerouted in work areas. (Class II, Priority Action) (H-80-10)

Promote the development of a traffic control device to fill the gap between the shaped concrete barrier and traffic cones to serve as a continuous visual barrier to separate traffic in work zones. (Class III, Longer Term Action) (H-80-11)

-- to the State of Wyoming:

Conduct an engineering study to determine where regrading of the shoulders is necessary and correct those locations to reduce the number of overturning accidents on Interstate 80 between mileposts 263 and 312. (Class II, Priority Action) (H-80-12)

Take necessary steps to increase the effectiveness of its enforcement of speed limits, especially within and adjacent to construction zones. (Class II, Priority Action) (H-80-13)

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS A. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Member, did not participate.

February 7, 1980

APPENDIX A

INVESTIGATION

1. Investigation

The National Transportation Safety Board was notified of the accident at 10:15 a.m. on August 22, 1979, by the Wyoming Highway Patrol. An investigative team from Washington, D.C. arrived in Laramie at 8:30 p.m. on August 22, 1979.

Investigative groups were formed for Human Factors/Witness, Highway/Environment, and Vehicle Factors. Representatives of the Wyoming Highway Patrol and the DOT's Bureau of Motor Carrier Safety participated in the investigation.

2. Deposition/Hearing

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

APPENDIX B

TOTAL TRIP HOUR ACCOUNTABILITY BASED ON DRIVERS' LOGS

Date & Time	Co-Driver			Accident Driver		
	Off Duty	On Duty	Driving	Off Duty	On Duty	Driving
8-20-79						1
5:00 p.m. - 6:00 p.m.						
6:00 p.m. - 6:30 p.m.		7*		1/2		
6:30 p.m. - 12:00 M						5 1/2
8-21-79						
12:00 M - 12:30 a.m.					1/2	
12:30 a.m. - 2:45 a.m.		6 1/2*		2 1/4		
2:45 a.m. - 6:30 a.m.						3 3/4
6:30 a.m. - 7:30 a.m.	1			1		
7:30 a.m. - 11:30 a.m.			4		4 1/2*	
11:30 a.m. - 12:00 N						
12:00 N - 1:30 p.m.		2			End of Lo	
1:30 p.m. - 2:00 p.m.	1/2					
2:30 p.m. - 7:30 p.m.			5			
7:30 p.m. - 8:00 p.m.	1/2					
	End of Lo					
	2	15 1/2	9	3 3/4	5	10 1/4

Total hours	26 1/2 hrs	19 hrs
Unaccounted hours	11 hrs	18 1/2 hrs
Total	37 1/2 hrs	37 1/2 hrs

* Sleeper berth

APPENDIX C

ACCIDENT HISTORY

The following accident reports were obtained for the accident vicinity during construction:

Date	Severity	Location
6-17-79	3 Fatalities	Milepost 277.7: During construction on the eastbound lane, a westbound truck struck an eastbound truck in the eastbound lane.
6-30-79	Property Damage	Milepost 279.5: Driver ran into construction barrels.
7-11-79	Property Damage	Milepost 285.7: An eastbound vehicle struck a barrel which caused loss of steering. The vehicle jackknived and rolled, and the driver was ejected.
8-3-79	Property Damage	Milepost 287: An eastbound vehicle struck another eastbound vehicle.
8-4-79	Property Damage	Milepost 285: An eastbound truck on the westbound lane was supposed to enter the transition to the eastbound lane when it struck the first three barrels in the transition.
8-23-79	3 Injuries	Milepost 281.3: A westbound pickup truck driver fell asleep; the vehicle ran off the north side of the road and rolled over.
8-31-79	Property Damage	Milepost 281.3: A westbound truck pulling two trailers broke the hitch between the trailers and the second trailer turned over.
9-3-79	1 Fatality	Milepost 281.4: Several westbound tractor semitrailers forced an eastbound truck with two trailers off the shoulder. The rear trailer overturned and slid into the westbound lane. An eastbound truck with two trailers struck the trailer and the front trailer rode up on top of the tractor, killing the driver.