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Highway Accident Report: Multiple-Vehicle Collisions and Fire in Fog, Interstate 15, Near San Bernardino, California, November 10, 1980

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16. Abstract About 7:25 a.m. on November 10, 1980, southbound traffic on Interstate Route 15 suddenly encountered dense fog north of the Highland Avenue offramp near San Bernardino, California, that reduced visibility to between zero and 50 feet. Drivers, whose vehicles were traveling 55 mph on the well-maintained, eight-lane, divided highway, said the visibility obscurement was immediate and unexpected. Some drivers slowed their vehicles partially as they entered the fogbank and others did not. A tractor-trailer combination vehicle braked suddenly to avoid a small car that changed lanes in front of it, and a pickup truck struck the trailer from the rear. This initiated a chain of collisions that involved at least 24 vehicles over a period of 5 to 10 minutes within a distance of 450 feet and resulted in 7 fatalities, 17 injuries, and extensive damage to all vehicles.

The National Transportation Safety Board determines that the probable cause of this multiple-vehicle accident was the failure of the drivers of many of the vehicles involved to reduce speed as necessary to be able to stop in distances compatible with visibility which was severely restricted by dense fog. The initial collision occurred when a tractor-trailer was rear-ended after its driver braked abruptly to avoid hitting an unidentified car which changed lanes immediately in front of the truck. Contributing to the severity of the consequences was the extremely varied sizes and weights of the vehicles in the collisions.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: June 10, 1981

MULTIPLE-VEHICLE COLLISIONS AND FIRE IN FOG
INTERSTATE 15
NEAR SAN BERNARDINO, CALIFORNIA
NOVEMBER 10, 1980

SYNOPSIS

About 7:25 a.m. on November 10, 1980, southbound traffic on Interstate Route 15 suddenly encountered dense fog north of the Highland Avenue offramp near San Bernardino, California, that reduced visibility to between zero and 50 feet. Drivers, whose vehicles were traveling 55 mph on the well-maintained, eight-lane, divided highway, said the visibility obscurement was immediate and unexpected. Some drivers slowed their vehicles partially as they entered the fogbank and others did not. A tractor-trailer combination vehicle braked suddenly to avoid a small car that changed lanes in front of it, and a pickup truck struck the trailer from the rear. This initiated a chain of collisions that involved at least 24 vehicles over a period of 5 to 10 minutes within a distance of 450 feet and resulted in 7 fatalities, 17 injuries, and extensive damage to all vehicles.

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INVESTIGATION

The Accident

About 7:25 a.m. on November 10, 1980, a southbound 1978 Freightliner two-axle tractor towing a semitrailer and full trailer (Vehicle 1) in lane No. 4 1/ entered a fogbank on Interstate Route 15 north of the Highland Avenue offramp near San Bernardino, California. Vehicle 1 approached the fog area at approximately 55 mph, but it began slowing as it entered the fogbank. As the driver of Vehicle 1 reduced his speed to 15 to 20 mph, an unidentified, white, late-model Dodge abruptly, unexpectedly, and with no advance signal, moved from lane No. 3, crossed in front of Vehicle 1, and exited the highway at the Highland Avenue offramp. The driver of Vehicle 1 made a sudden brake application, and a 1977 GMC 1/2-ton pickup truck (Vehicle 2) struck and underrode the rear of Vehicle 1. The two persons in Vehicle 2 were killed.

1/ The collisions occurred in the southbound lanes of Interstate 15, an eight-lane, divided highway. For ease of reference, the lanes are referred to as lanes Nos. 1, 2, 3, and 4, with lane No. 1 being the lane adjacent to the median, and lane No. 4 being the lane next to the right shoulder.

Moments later, a 1972 Datsun sedan (Vehicle 3) struck the rear of Vehicle 2. The driver of Vehicle 3 said he had slowed to approximately 30 mph as he entered the dense fog. He saw someone waving a flashlight and applied his brakes. Before he could stop his vehicle, however, it struck the rear bumpers of Vehicles 2 and 1. He then left his vehicle and joined the person with the flashlight on the right shoulder. As he left his vehicle, a large furniture van (Vehicle 4) stopped within 10 feet of the rear of Vehicle 3. The driver of Vehicle 3 said the visibility was 5 to 10 feet.

Vehicle 4 was struck from the rear by a 1978 Datsun (Vehicle 23) and a tractor-semitrailer (Vehicle 5) and was driven forward striking Vehicles 3 and 2. A spring leaf on Vehicle 2 fractured and punctured the vehicle's fuel tank, causing a fire that involved Vehicles 1, 2, 3 and 4.

Later, during subsequent collisions (see appendix B for a chronology of vehicle collisions and more detailed information), a 1978 Ford Pinto (Vehicle 8) struck and underrode the rear of a tractor-semitrailer combination (Vehicle 6). It is presumed that the driver of Vehicle 8 died in this collision. Minutes later, Vehicle 8 was struck from the rear by a tractor-semitrailer combination (Vehicle 10), a 1979 Ford Fiesta (Vehicle 9), and another tractor-semitrailer combination (Vehicle 7). A 1976 Ford Pinto (Vehicle 12) struck a 1975 Honda sedan (Vehicle 15) and was then struck by Vehicle 9 as it glanced off of Vehicle 8. A passenger in Vehicle 12 was killed. Either before or after being struck by Vehicle 12, Vehicle 15 struck and underrode the rear of a tractor-semitrailer combination (Vehicle 13). The driver of Vehicle 15 died in this collision. Later, Vehicle 15 was struck by a 1980 Chevrolet pickup truck (Vehicle 16). Within the following 5 to 10 minutes, at least 13 more vehicles entered the limited visibility fog area and struck stopped vehicles; many were in turn struck by following vehicles. (See figure 1.)

Following each series of collisions, the drivers and passengers who were able to do so left their vehicles and sought refuge either in the grassy median or on the right shoulder. Several persons returned from these relatively safe locations to assist in the rescue efforts of those not able to leave their vehicles. Four of these persons, who were standing in front of a tractor-semitrailer combination (Vehicle 7) were run down when the vehicle was struck from the rear by Vehicle 10. Two of the persons were killed, and two were seriously injured.

Injuries to Persons

Injuries	Drivers	Passengers	Others	Total
Fatal	3	2	2	7
Nonfatal	14	1	2	17
None	6	1	0	7
Total	23	4	4	31

Vehicle Information

Twenty-four vehicles were identified as being involved in this series of collisions. (See appendix B for damage information.) Nine were tractor-semitrailer combinations, 2 were standard-size 1/2-ton pickup trucks, and the remaining 13 were compact-size import and domestic vehicles. Several unidentified vehicles that apparently had only minor involvement did not stop and are not included in this accident report.

An onscene examination of the 24 vehicles did not identify any major mechanical deficiencies that might have contributed to the causes of these collisions and fire. None of the drivers reported or claimed any vehicle malfunctions.

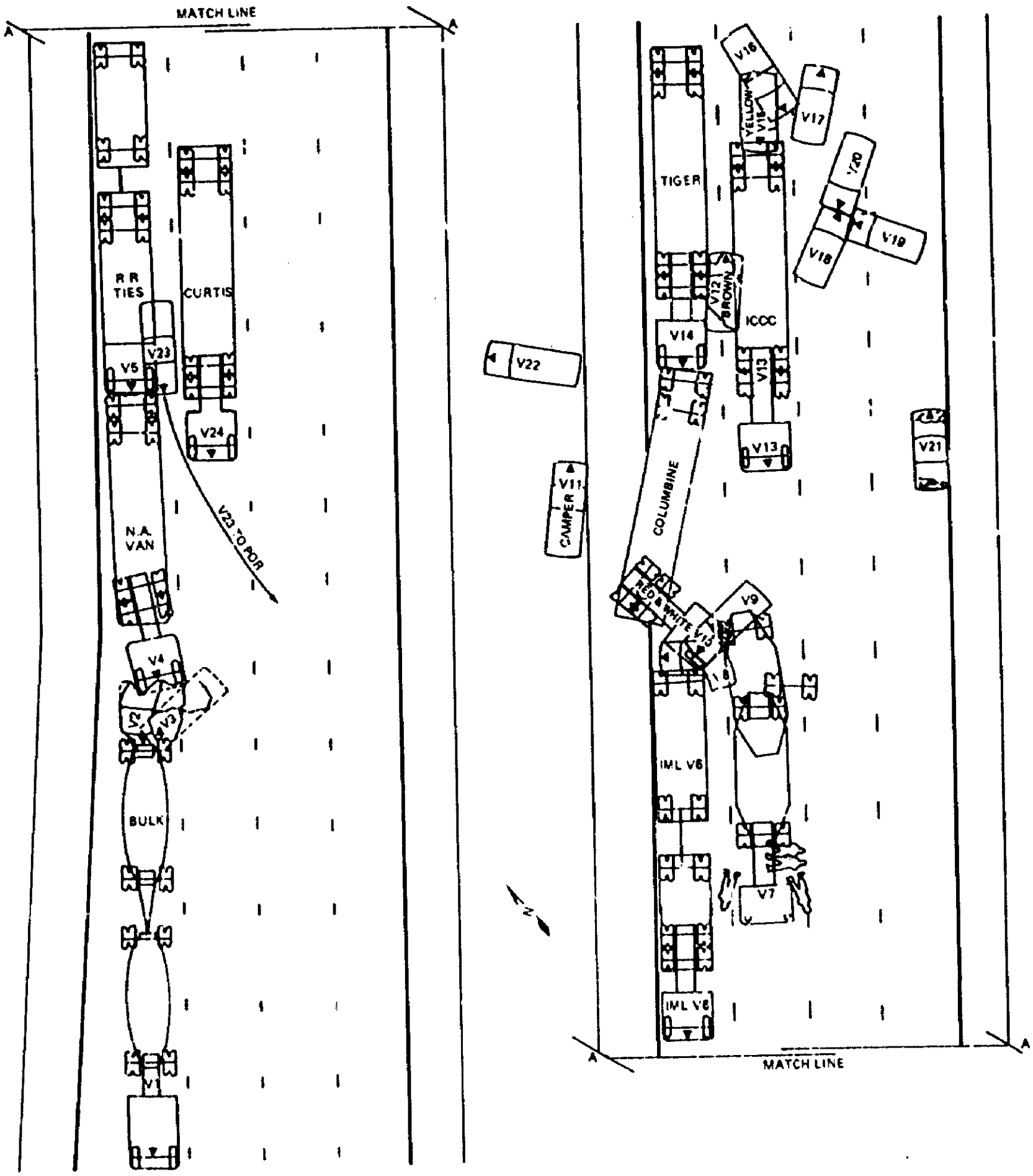

Figure 1.--Plan view of accident site showing sequence of collisions.

Investigators identified three vehicle safety factors as potential contributors to the severity of the injuries and fatalities. These factors were: (1) underride experienced by Vehicles 2, 3, 8, 9, 15, and 23; (2) cargo shift on Vehicles 5 and 14; and (3) headerboard failures on Vehicles 5 and 14.

Underride.--There were six separate collisions in which five passenger automobiles and a pickup truck sustained severe frontal damage when they struck and underrode the overhangs of trailers stopped in their paths. (See figures 2, 3, and 4.) Four of the total of seven fatalities occurred in three of these underride collisions, and all four persons were occupants of passenger vehicles. 2/ Table 1 summarizes data for these six collisions.

All of the impacted trucks were required to meet the criteria in Federal Motor Carrier Safety Regulation (FMCSR) 393.86, "Rear End Protection," which requires that:

> every motor vehicle . . . which is so constructed that the body or chassis assembly . . . has a clearance at the rear end of more than 30 inches from the ground when empty shall be provided with a bumper or devices serving similar purposes which shall be so constructed and located that: (a) The clearance between the effective bottom of the bumper or devices, and the ground shall not exceed 30 inches with the vehicle empty; . . . (d) the bumpers or devices shall be located not more than 24 inches forward of the extreme rear of the vehicle. . . .

However, because of the number of vehicles involved and the need to clear the highway, the rear underride protective guard devices on the vehicles were not documented.

Table 1.--Underride Collision Data

	Impacting Vehicle		Impacted Vehicle	
Injury severity	Number	Type	Number	Type
Driver and front-seat passenger died	2	GMC pickup truck	1	Bulk hauler trailer
No injuries	3	Datsun sedan	1	Bulk hauler trailer
Driver died	8	Ford Pinto station wagon	6	Van trailer
Facial lacerations	9	Ford Fiesta sedan	7	Trailer
Driver died	15	Honda sedan	13	Standard trailer
Head lacerations	23	Datsun 280Z sedan	4	Van trailer

2/ For the purposes of this report, pickup trucks will be considered as passenger vehicles.

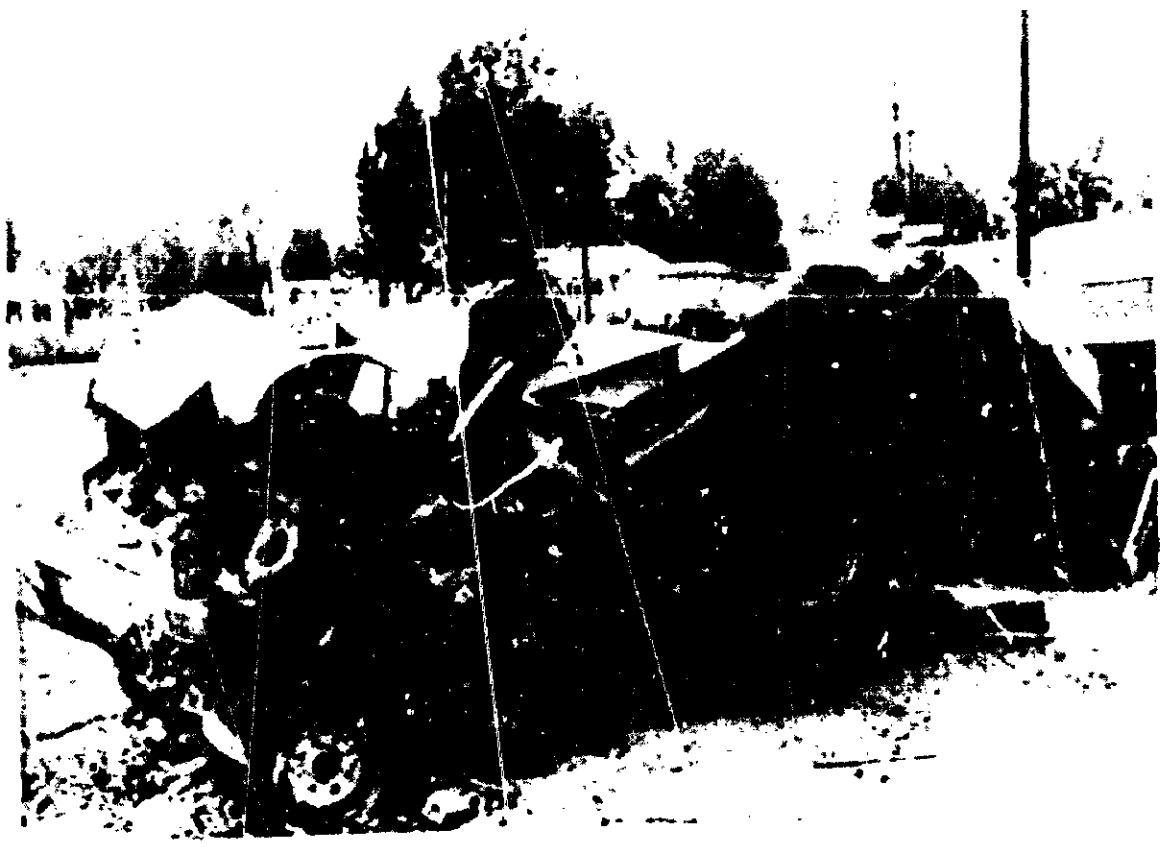

Figure 2.—Front-end underride damage to Vehicle 2.

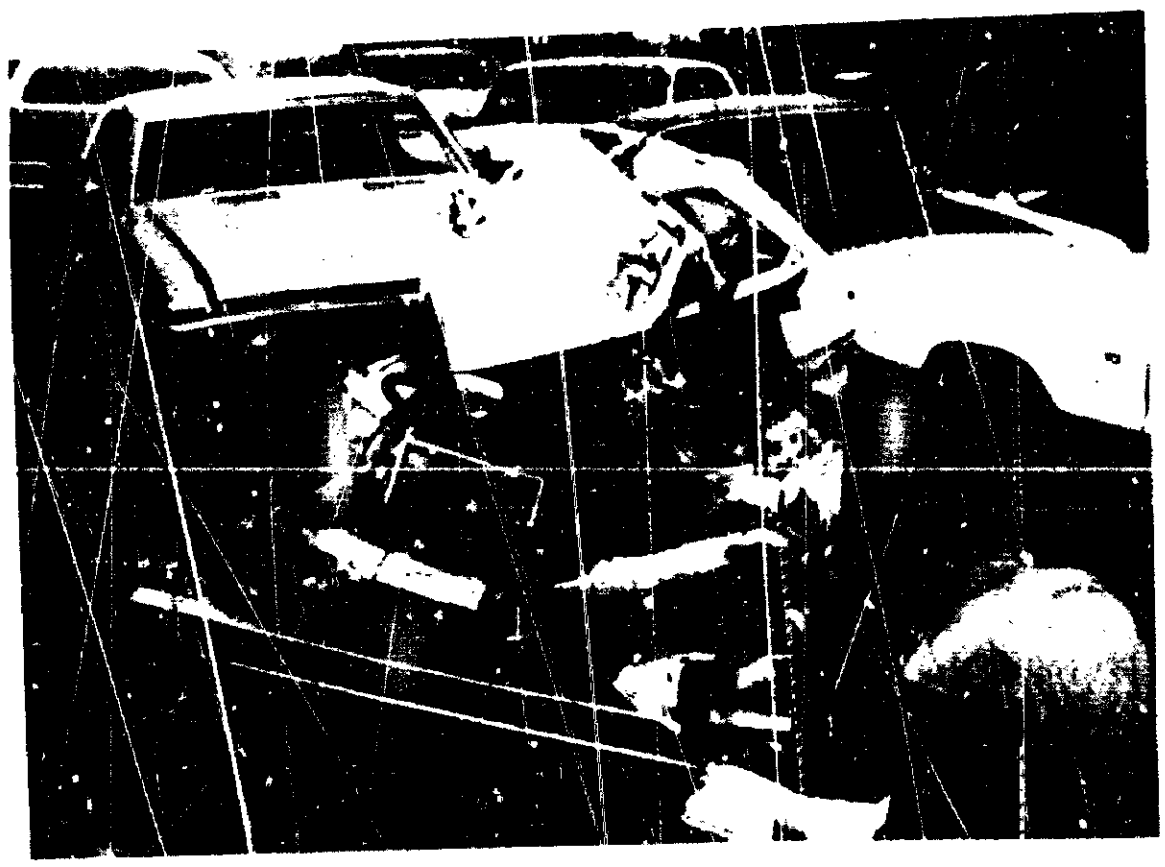

Figure 3.—Front-end underride damage to Vehicle 9.

Figure 4.—Front-end underride damage to Vehicle 15.

Following its investigation of a truck/automobile underride collision on Interstate Route 495 near New Carrollton, Maryland, on June 19, 1970, 3/ the Safety Board recommended on December 1, 1975, that the National Highway Traffic Safety Administration (NHTSA) initiate an additional effort to develop Federal Motor Vehicle Safety Standards (FMVSS's) for bumper protection of motor vehicles to provide predictable and compatible crash performance between vehicles of considerable difference in size and weight.

On March 24, 1977, the Insurance Institute for Highway Safety petitioned both the Bureau of Motor Carrier Safety (BMCS) of the Federal Highway Administration (FHWA) and the NHTSA to initiate rulemaking to establish FMVSS's for the rear ends of trucks, trailers, semitrailers, and similar types of vehicles to prevent or reduce the probability of other vehicles underriding them in rear-end collisions.

On August 26, 1977, the BMCS and the NHTSA issued a joint Advance Notice of Proposed Rulemaking (ANPRM) titled "Rear End Underride Protection" (BMCS Docket No. 77; Notice 77-6 and NHTSA Docket No. 1-11; Notice 07). The stated purpose of the ANPRM was to request comments on the need to reassess FMCSR 393.86 and the need for an FMVSS. As a part of the joint program, the NHTSA and the BMCS let contracts for two research projects. 4/ On January 8, 1981, the NHTSA issued a proposal to amend 49 CFR Part 571 by adding a new safety standard titled "Rear Underride Protection." The proposed standard would establish rear underride protection requirements for heavy vehicles of a gross vehicle weight rating (GVWR) of more than 10,000 pounds. The standard would lower the vertical distance of the underride guard to 21.65 inches, as

3/ Highway Accident Report--"Truck/Automobile Underride Collision on Interstate Route 495 Near Maryland Route 450, New Carrollton, Maryland, June 19, 1970" (NTSB-HAR-71-9).

compared to the 30-inch requirement in FMCSR 393.86, and establish performance requirements. The proposed effective date for this standard is September 1, 1983.

Cargo Shift and Headerboard Failure.--Vehicle 5 was a 1973 Freightliner three-axle, cab-over-engine, flatbed truck towing a 1967 Fruehauf two-axle, flatbed trailer. The truck was equipped with a headerboard constructed of 5/8-inch-thick plywood attached to four 4-inch channel iron upright supports. The truck and trailer were loaded with railroad ties. The ties were secured in place by the headerboard and 4-inch by 5/16-inch web straps. Vehicle 5 ran into the rear of Vehicle 4, a 1980 GMC three-axle, cab-over-engine tractor towing a 1977 Kentucky two-axle van trailer transporting household cooking ranges. At impact, the railroad ties surged forward (see figure 5), the headerboard failed, and the ties penetrated and destroyed the cab, pinning the driver inside.

FMCSR 393.106, "Front End Structure," requires that every cargo-carrying motor vehicle be equipped with a headerboard or similar device of sufficient strength to prevent cargo shifting and penetration or crushing of the driver compartment.

FMCSR 393.102, "Securement Systems," establishes requirements for the prevention of cargo shifting during transit. Subsection (b), "Tiedown Assemblies," requires that the static breaking strength of the tiedown assemblies (chains, cables, steel straps, or fiber webbing) used to secure an article against movement in any direction must be at least 1 1/2 times the weight of the article.

FMCSR 393.104, "Blocking and Bracing," requires that cargo not firmly braced against a front-end structure be secured so that when the vehicle decelerates at the rate of 20 feet per second per second, the cargo will remain with the vehicle and not penetrate the vehicle's front-end structure.

Vehicle 14 was a combination of a 1974 Peterbilt three-axle tractor towing a 1979 Alloy two-axle, flatbed semitrailer. The tractor was equipped with an aluminum headerboard installed 1 1/2 feet behind the cab. The semitrailer was equipped with a 4-foot-high plywood headerboard. The semitrailer was loaded with aluminum sheets of assorted sizes with an estimated weight of 46,000 pounds. The aluminum sheets were palletized, but the pallets were not tied down within the semitrailer side rails.

Vehicle 14 entered the fog area following Vehicle 10, a 1979 Peterbilt three-axle tractor towing a Timpte two-axle, van-type semitrailer. The driver estimated his speed at 55 mph. As he first recognized the denseness of the fog, he heard a call on his CB radio to "shut it down" and at the same time saw the brakelights illuminate on Vehicle 10. He locked up his brakes but hit Vehicle 22, a Datsun pickup truck, and then ran into the rear of Vehicle 10. The cargo of sheet aluminum surged forward, crushed the headerboard of the semitrailer, and after being partially deflected by the headerboard of the tractor, penetrated the right side of the cab. (See figure 6.) Although injured, the truckdriver was able to exit the cab and crawl under his semitrailer to the right shoulder of the road.

The California State Administrative Code 5/ has tiedown requirements for steel cargo but not for aluminum cargo. Article 7 of the code is titled "Steel Plate, Sheet, and Tinplate." Section 1360 of Article 7 reads: "This article shall apply to the highway

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4/ BMCS contract with the Texas Transportation Institute and NHTSA contract with Dynamic Sciences, Inc.

5/ California Administrative Code, Title 13, Subchapter 7, "Loading Regulations."

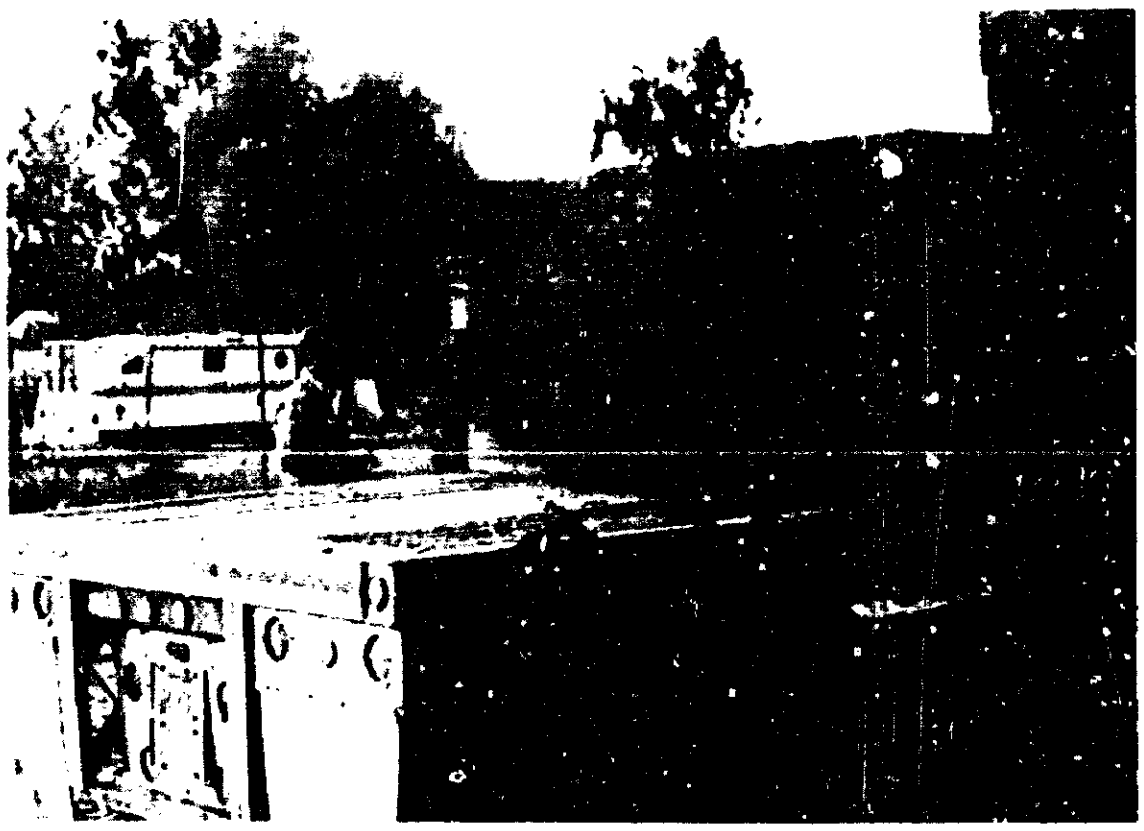

Figure 5.—Cargo shift on Vehicle 5.

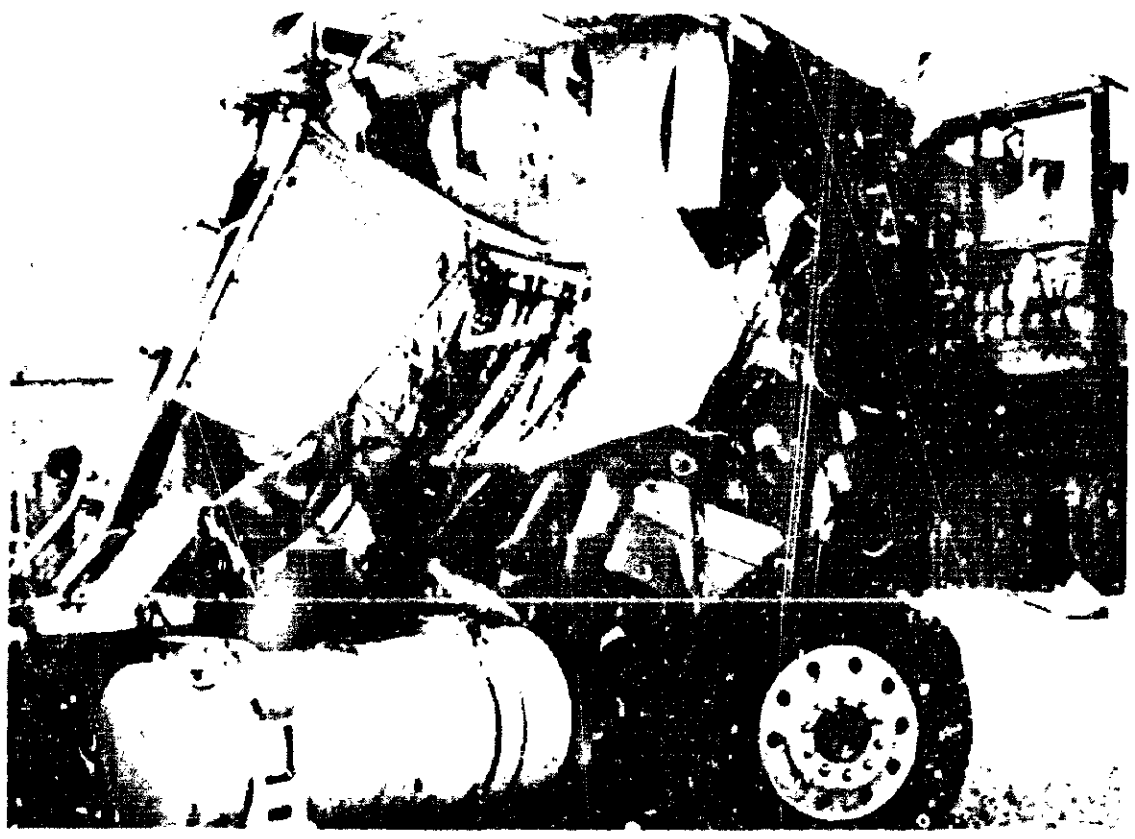

Figure 6.--Right side of Vehicle 14 showing damage to headerboard and truck cab due to cargo shift.

transportation of flat steel products (plate, sheet, and tinplate)...." Section 1362, "General Provisions," states: "The following general provisions shall apply to the transportation of steel plate, sheet steel, and tinplate." Section 1364, "Securement of Lifts," refers to "lifts of sheet steel." And finally, Section 1365, "Stacking of Lifts," applies to "... lifts of steel plate, sheet steel, and tinplate." Nowhere does the code mention "aluminum" in any form.

FMCSR 393.100C(4), "Miscellaneous Metal Articles," states that an article must be secured by at least one tiedown assembly over its top for at least every 8 feet of its length and at least two tiedown assemblies securing each individual article or combination of articles (pallets and sheets) banded or otherwise secured together and handled as a single unit. This section applies to all metals, which according to the BMCS includes aluminum.

Driver Information

The 24 drivers involved in this accident were from 21 to 83 years of age. Twelve of the drivers were commuters who drove the highway regularly. The remainder were common carriers traveling in either intrastate or interstate commerce who were not generally familiar with the environment. All but one of the drivers held valid operator licenses and were experienced drivers.

The driver of Vehicle 5 was driving on a revoked California driver license. His driver record listed numerous previous convictions for alcohol-related violations. Two other drivers had records of convictions for traffic violations and one, the 83-year-old driver of Vehicle 2, had an accident 3 months prior to this one.

No alcohol or drug checks were made of any of the drivers.

As the drivers approached and entered the fog area, they reacted in various ways. Of the eight drivers interviewed, seven said they reduced their speed and four said they turned on headlights and four-way-emergency warning flashers. Several drivers were able to stop without striking other vehicles only to be struck from behind.

Highway Information

Interstate Route 15 is a divided, eight-lane, north-south highway separated by a 54-foot-wide grass median. The accident occurred 109 feet north of the Highland Avenue offramp, 518 feet north of milepost marker 9.00.

In the area of the accident, the highway is elevated with the right-of-way bordered by vineyards on both sides. The southbound roadway consists of an 8-foot-wide asphalt left shoulder, four 12-foot-wide grooved-concrete traffic lanes, and a 10-foot-wide asphalt right shoulder. The southbound roadway has a -2.02-percent grade and a 2-percent superelevation from the left shoulder to the right shoulder. The right shoulder has a slope of 5 percent. North of the accident area, the grade increases as the roadway climbs out of the valley to the El Cajon Pass. The southbound vehicles had been descending this grade and had just started to level off on the valley floor when they encountered the fog conditions.

The northbound roadway was parallel to and at the same grade as the southbound lanes. Its dimensions were similar. The accident on the southbound lanes did not affect northbound traffic. The vehicles had been in less dense fog for several miles and had previously adjusted their speeds. At the accident scene, northbound drivers could not see across the median and apparently were not aware of the collisions in the southbound lanes.

The offramp to the Highland Avenue gore point marking was 409 feet north of milepost marker 9.00. A 10-foot by 20-foot burn area where the fire involving Vehicles 1, 2, 3, and 4 was centered was 539 feet north of the marker. At 690 feet, bloodstains remained on the roadway where Vehicle 7 ran over four persons. A large number of predominant skidmarks were visible, primarily in lanes Nos. 3 and 4, beginning at 803 feet and ending at approximately 935 feet. (See figure 7.)

The average hourly traffic volume on Mondays between 7 a.m. and 8:00 a.m. in the accident area, calculated from the California Department of Transportation (Caltrans) 1980 quarterly traffic volumes, was 648 vehicles per hour--54 vehicles every 5 minutes, without considering seasonal variations and unusual local traffic patterns. According to witness statements, the time between the first collision and the last was approximately 5 to 10 minutes. Based on the average vehicle count, as many as 50 to 100 vehicles could have entered the collision area in that timeframe. It is not known how many vehicles actually passed the accident scene. The average daily traffic in the vicinity of the accident area was 23,100 vehicles for 1979; an estimated 13 percent of these vehicles were heavy trucks.

Caltrans reported 20 accidents on the 2-mile section from milepost 8.00 to milepost 10.00 from the opening of this section of Interstate Route 15 (September 26, 1976) through 1980. None of these accidents involved limited visibility due to fog.

The roadway was well-maintained with no defects. The travel lanes were separated by dashed white lines which were clearly visible between lanes Nos. 1, 2, and 3 with the line between lanes Nos. 3 and 4 somewhat dimmed by traffic wear. The right lane was delineated by a solid white edgeline and the left edge by a solid yellow edgeline.

Signing in the area consisted of reference to the Highland Avenue offramp and further offramps and distances to cities. There was no permanent or temporary signing referring to visibility problems. Caltrans has various mobile signs with selective messages for all types of emergency situations which are available for 24-hour use by highway emergency groups when circumstances warrant. An established extensive notification procedure for these circumstances is used infrequently. There had been no previous fog conditions of this density in this area requiring the implementation of this procedure, and a travel alert did not specify "dense" fog even though the National Weather Service (NWS) had forecasted dense fog. A previous patrol by the California Highway Patrol (CHP) through the area about 1 hour before the accident had not identified a need for special signing.

Meteorological Information

The accident occurred during daylight at 7:25 a.m., about 1 hour after sunrise, at an elevation of about 1,500 feet above mean sea level (m.s.l.). The temperature was about 45° to 50° F with variable wind speeds of less than 5 knots.

Fog was reported at airports near the accident site by certified weather observers. At Ontario, California, about 9 miles southwest of the accident site, obscured skies and surface visibility of zero were reported at 6:45 a.m., and surface visibility of 1/8 mile was reported at 7:47 a.m. At Riverside, California, about 13 miles south of the accident site, the visibility varied from 1/16 mile at 6:45 a.m. to 1/8 mile at 7:45 a.m. Norton Air Force Base, 15 miles east of the accident site, reported partially obscured skies with a visibility of 1 1/2 miles at 6:38 a.m. About 1 hour later, the visibility was reported at 1/16 mile.

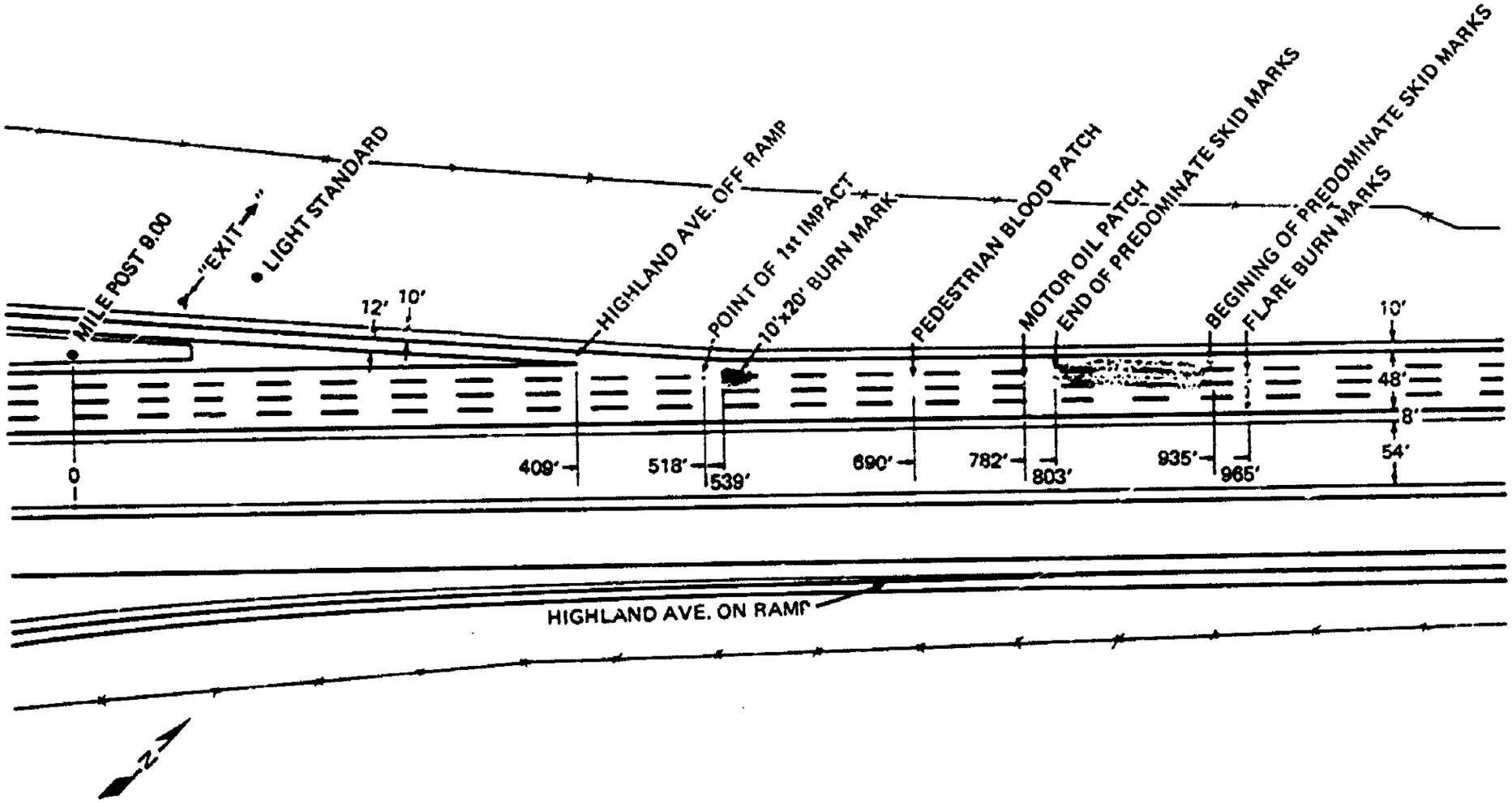

Figure 7.—Plan view of accident site.

Climatological data for Norton Air Force Base showed that the percentage frequency of occurrence of visibility of 1/4 mile or less was 1.2 percent in January, 0.2 percent in August, and 0.4 percent in November. In November, the maximum percentage frequency of occurrence of 1/4 mile or less visibility occurred between 6 a.m. and 8 a.m., local standard time. The annual percentage frequency of occurrence of such visibility was 0.6.

A study of 128 cases of low ceilings and low visibility over a period of 6 years at Norton Air Force Base 6/ revealed that more than 50 percent occurred as a result of stratus along the coast moving onshore early in the evening at Los Angeles or Long Beach, California, and progressing inland to Norton, California. This analysis also revealed that the height of the marine inversion layer was critical in the occurrence of low ceilings and low visibility at the base.

An upper air observation taken at El Monte, California, at 6 a.m. on the day of the accident showed a layer of moist air extending from the surface up to about 2,400 feet m.s.l. with dry air above. Temperature decreased from the surface up to about 2,200 feet m.s.l. and then increased from 2,200 feet m.s.l. to about 4,500 feet m.s.l. An onshore upper wind flow in Southern California was evident from the weather data (850 millibar analysis) prepared by the NWS at 4 a.m. on the day of the accident.

According to an NWS meteorologist, general fog areas can be forecast; however, forecasts of the density of fog for specific areas cannot be made. An NWS forecast for the San Bernardino Valley, issued at 4:30 a.m. on November 10, 1980, called for "dense fog [7/] or low clouds for the San Bernardino Valley in the morning." This forecast was distributed to local radio and television stations and newspapers. It could have been monitored by the CHP.

Personnel at the Caltrans Telecommunications Unit stated that weather information is received by teletype from the NWS from the end of November through April or May. They also stated that reports of fog conditions are transmitted to Caltrans by the CHP in the local Sacramento area but are not received from units farther south. The information received is passed to Caltrans employees. It was stated that one of the main concerns of Caltrans is winter highway closures in the mountains due to snow. A Caltrans recording of current road conditions can be accessed by telephone from San Bernardino. Information on wind, snow, and fog as they relate to road conditions is included in the recording. However, fog conditions are referred to infrequently in the recorded message because their unpredictability has resulted in the recording of misleading fog condition information in the past.

The CHP stated that although snow and road conditions are reported to the CHP by Caltrans, information on fog conditions is not. Weather information from either the NWS or a private weather forecasting service is not monitored by the CHP Headquarters in San Bernardino. The CHP reported that it does not have a fog alert program in the San Bernardino area because while fog is a common occurrence in the area, dense fog does not occur frequently.

The CHP has a fog alert program in the Stockton and Bakersfield, California, areas where fog is reported to be more of a problem. In an attempt to compare the frequency of occurrence of dense fog in the Stockton and Bakersfield area to that in the San

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6/ M.M. Rasmussen, Forecasting check list and study of ceiling less than 200 feet and/or visibility less than 1/2 mile at Norton AFB, June 1969.
7/ Dense fog is defined by the NWS as fog that reduces horizontal surface visibility to about 1/4 mile or less.

Bernardino area, climatological data were compared. Annually, the percentage frequency of occurrence of dense fog was 0.6 for Norton Air Force Base, 1.2 for Bakersfield, and 2.6 for Stockton. It is evident that dense fog is twice as likely to occur at Bakersfield than at San Bernardino and more than four times as likely to occur at Stockton than at San Bernardino.

A Traveler's Advisory is a special weather statement issued by the NWS for weather phenomena (snow, fog, sleet, etc.) expected to produce hazardous driving conditions. For the morning of November 10 for the San Bernardino Valley, there was no Traveler's Advisory in effect. According to the forecaster who issued the forecast for the San Bernardino Valley at 4:30 a.m. on November 10, 1980, a Traveler's Advisory was not considered necessary because dense fog had been mentioned in the forecast. In addition, he said that the patchy nature of dense fog and its variation due to terrain elevations made it difficult to forecast fog conditions for specific locations. The forecaster also commented that since fog is a common occurrence in the area, overuse of the Traveler's Advisory could reduce the effect, thus defeating the purpose, of the advisories.

Those drivers who were interviewed stated that the visibility was good before the accident area and that they had encountered no previous low-lying fog. Some had heard fog conditions reported on the radio, but the report generalized the area into "patchy fog in the valley." They stated that they observed the "curtain" of fog ahead but were unable to judge its density. Some of the drivers turned on their headlights and/or windshield wipers, some turned on flasher units, and most attempted to move to the right to lanes where traffic was moving slower. The local residents involved in this collision said that although there had been fog before at this location, they had never encountered fog of this density. They stated that they were surprised at the density once they entered the cloud. Witnesses said the sight distance ranged from zero to 50 feet at various times. Most drivers interviewed stated that once they had entered the fog, it was so dense that they had to concentrate on the road ahead, and that when they did identify a hazard, they had little or no time to react.

Medical and Pathological Information

All seven victims were pronounced dead at the scene. The coroner's reports indicated that the causes of the deaths were traumatic impact injuries and death occurred instantly. The 17 injured persons were transported to four different hospitals to permit more rapid treatment in the emergency rooms without overloading the facilities. (See appendix C.)

Survival Aspects

According to the available evidence, only 2 of the 31 vehicle occupants were wearing occupant restraints at the time of the crash. Neither was injured.

Fifteen of the 17 persons injured received their injuries while in their vehicles. Eight of these persons had to be removed or extricated from their vehicles because they could not free themselves.

Four persons were standing in the roadway in front of a tractor-trailer combination when it was struck from the rear. Two persons were killed when the tractor passed over them, and two persons were injured.

Two persons were killed when their standard-size 1/2-ton pickup truck was crushed between two truck-trailer combinations and then burned completely. Three persons were killed in three compact cars when the occupant areas were reduced in size by the impacts

to the extent that there was no room for the occupants. Four other compact cars were demolished in collisions that occurred after their occupants had escaped.

The cabs of two truck tractors were crushed due to cargo shift. The drivers in both of the cabs were injured but survived. These were the only truckdrivers injured.

Firefighting equipment called to the scene was delayed because of the low visibility. Two vehicles were totally consumed by fire and parts of two other vehicles were burned before the fire equipment arrived onscene. The fire department rescue equipment was used to extricate the critically injured driver of Vehicle 5.

ANALYSIS

The Accident

It was difficult to document all of the details of the 24-vehicle accident in which many of the witnesses could hardly see the vehicle or vehicles they struck and could only hear the sounds of crashes in the fog around them. Personal injuries, shock, and confusion further distorted the events in the minds of the participants. The accident sequence described in this report was determined from the vehicle-at-rest positions, paint transfer marks, and vehicle damage. With the exception of the sudden, unexpected lane change by the unidentified vehicle which caused the driver of Vehicle 1 to make a brake application and suddenly slow his vehicle, no one person or vehicle could be identified as the sole initiating factor of any of the series of collisions. Similar driver actions took place in each series, and each series assured the probability of the other collisions that followed.

Each of the drivers was driving in a clear environment descending a grade and could see the fogbank ahead. Some turned on their lights and some reduced their speed slightly because they had often experienced fog in this general area and were anticipating reduced visibility of a limited nature. Others either gave the matter no thought or adopted a "wait and see" attitude and entered the fogbank at their regular cruising speed in the 55-mph range. Some drivers reduced their speed to 40 or 45 mph, and a few further reduced their speed to 10 or 15 mph after entering the fog. Some drivers stopped in time to avoid colliding with vehicles ahead only to be struck from the rear by other vehicles. Some drivers said that they slowed their vehicles to 30 to 40 mph because they could only see 10 to 20 feet ahead of them. This action was not reasonable when it could take 50 to 90 feet to stop a vehicle at these speeds after the driver had made a decision to stop and had already applied the brakes.

Drivers' statements indicated that the lack of caution in some cases resulted from their past experiences with reduced visibility situations that were not so extreme. Other reasons given for lack of caution were lack of knowledge or failure to relate knowledge with actual circumstances and lack of training in evasive procedures. The drivers interviewed did not have definite opinions about what was the best action to take under such circumstances.

This accident demonstrates the need to make safe speed decisions very quickly when entering fog. The collisions occurred very near the fog front. Two witnesses, without specifying a distance, stated that they ran back to the start of the fog to flag approaching traffic to prevent more vehicles from entering the area. Because of the confusion and the constant movement of the fog front, no accurate measurements were obtained. However, most witnesses agreed that they were just barely into the fog when it became extremely difficult to see and the collisions took place. Witness estimates of sight distance varied from zero up to 50 feet. Their statements indicate the lack of

ability to judge accurately distances in a fog environment. Without normal reference points, a person's depth perception is limited.

It is possible to provide aids to assist drivers in limited visibility conditions by establishing reference points at prescribed distances and by teaching drivers to use them. At present, there are dashed white lines on the pavement to delineate the travel lanes. These lines and spaces are a prescribed distance apart. Some roadways are marked with reflectorized delineators that could be set at uniform prescribed intervals. If reflectorized delineators were spaced at equal distances, drivers could gauge their sight distance by observing the number of delineators visible and adjust their speed accordingly. Further education would be necessary in relating an estimate of sight distance to safe speed for the sight distance. Each delineator visible would represent an element of speed and would relate to stopping distances. The Safety Board believes that the FHWA should consider placement of aids for estimating visibility in its limited visibility research program.

If under limited visibility conditions on high-speed highways, trucks and other heavy vehicles were required to travel in the right lane(s), and passenger cars and light vehicles were required to travel in the left lane(s), the extreme mix of vehicle sizes and weights could be avoided because vehicles would be traveling with vehicles more their size and weight. In this accident such a vehicle size/weight separation would have reduced the severity of the collisions. Fatalities might have been avoided, and the degree of injuries and property damage would have been less severe. Given the interaction between the 9 heavy trucks, the 2 standard-size pickup trucks, and the 13 compact cars at 2,000 pounds or less, the incompatibility of small cars versus heavy trucks is graphically demonstrated. No fatal injuries occurred in collisions between vehicles of comparable size.

Five of the compact cars which entered the accident area late in the accident sequence had moved to the left and were not involved in collisions with the large trucks, most of which were in the two right lanes. All of these vehicles received moderate to major damage but did not experience the complete destruction that the compact cars in collision with the trucks in the right lanes received. The occupants of these five vehicles received minor to moderate injuries, but all occupants survived. (See figure 8.)

Following its investigation of a multiple-vehicle collision accident under fog conditions on the New Jersey Turnpike in 1969, 8/ the Safety Board issued a recommendation to the NHTSA 9/ on April 16, 1971, calling for the initiation of a program and procedures to minimize the likelihood of catastrophic, chain-reaction collisions on high-speed, multilane highways in adverse weather or visibility conditions. The recommended actions included: (1) segregating heavy vehicles from light vehicles by the assignment of lanes whenever the safe speed is below the posted speed; (2) prohibiting the overtaking of slow vehicles; (3) use of four-way flashers by all vehicles; (4) prohibiting stopping on the traveled portion of the highway unless conditions will not permit otherwise; and (5) evacuating stopped vehicles under such adverse conditions. The NHTSA referred the recommendation to its research institute and then, in 1974, to the Operations Subcommittee of the National Committee on Uniform Traffic Laws and Ordinances of the Uniform Vehicle Code (UVC). The subcommittee decided that this was a State jurisdictional matter and not a subject for inclusion in the UVC.

The Safety Board believes that the NHTSA should reconsider this recommendation for inclusion in Highway Safety Program Standard No. 4 and driver education curricula. This would be an efficient and effective approach to achieving national distribution

8/ Highway Accident Report--"Multiple-Vehicle Collision Under Fog Conditions Followed by Fires on the New Jersey Turnpike, November 29, 1969" (NTSB HAR-71-3).
9/ NTSB Recommendation H-71-17.

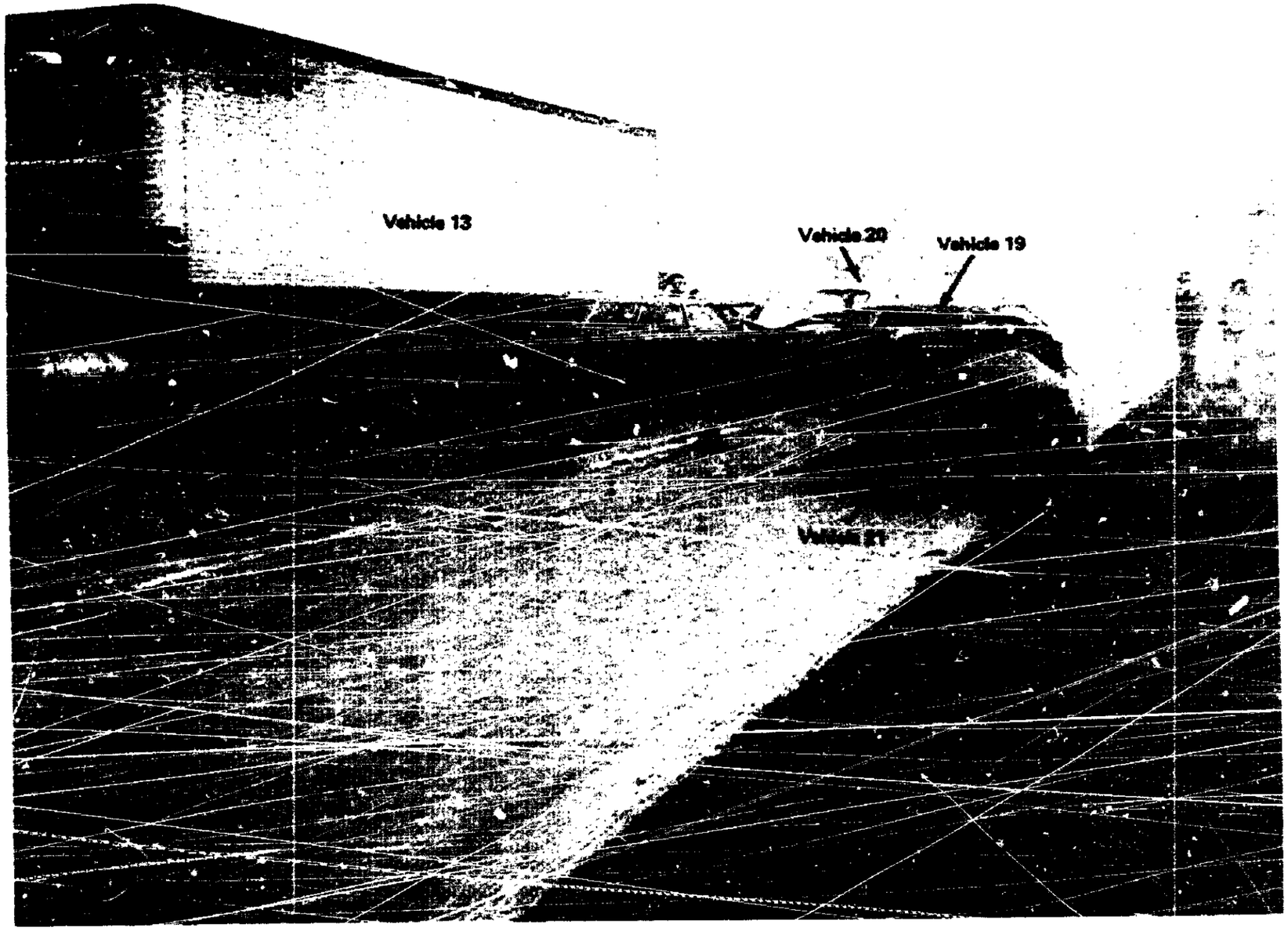

Figure 8.—North view of postimpact positions of Vehicles 13, 18, 19, 20, and 21.

of information and implementation of procedures for reducing accidents in adverse weather or poor visibility conditions.

Injuries to Persons

Thirty-one persons were involved in this series of collisions. Seven were killed, 17 were injured, and 7 received no injuries. Of the 17 injured, 15 received their injuries while in their vehicles. Eight of the 15, had to be removed or extricated from their vehicles because they were not able to free themselves; the remaining seven persons were able to move to the shoulder or median. The seven persons who were not injured exited their vehicles and sought safety on the right shoulder or the median.

The fatality and injury pattern was constant. Those who were able to exit their vehicles and get off of the road and stayed there received no further injuries. Those who exited their vehicles but stayed on the road using heavy vehicles for protection were either killed or injured. Although in this instance the median provided a safe area, it would not necessarily be safe in all cases. By standing alongside the area where the collisions were occurring, the persons were vulnerable to any vehicle that might be steered to the left into the median to avoid the stopped vehicles on the roadway. If the persons had moved farther south beyond the area of recurring collisions and used the wreckage area as a buffer zone, they would have improved their margin of safety considerably.

The two persons who wore the available occupant restraints were not injured. The available evidence indicated that none of the killed or injured were restrained at the time of the collisions. However, considering the severe crush damage to most of the vehicles, it is doubtful that occupant restraints would have prevented any of the fatalities or injuries within the vehicles.

Underride Protection

During the examination of the frontal damage sustained by vehicles 2, 3, 8, 9, 15, and 23, it was not possible to distinguish between the damage imparted to these vehicles as they underrode the overhang of the vehicle they struck and the damage received as a result of subsequent rear-end collisions. In the case of vehicles 2, 3, 8, and 9, there were secondary collisions by heavy truck combinations that imparted additional severe crush damage. The crashes were not simultaneous--there was time between the first crash of Vehicle 2 with Vehicle 1 and the subsequent rear-end collision of Vehicle 2 by Vehicle 4. However, the coroner's reports indicated that the deaths in all cases occurred immediately following impact. This has been interpreted to mean the first impact, and this is confirmed by witnesses.

The circumstances of this accident demonstrate the need for better underride protection. A Notice of Proposed Rulemaking (NPRM) on underride protection currently being considered by the NHTSA 10/ is especially timely as cars continue to be downsized and there are more small cars on the highway. In a letter to the public docket on April 8, 1981, the Safety Board supported the rulemaking proposal and suggested that the NHTSA modify the proposed ground clearance of the rear underride guard from 21.65 inches to no less than 18 inches. This would insure that the guard would engage the front tires and wheels of small cars. Actual measurement of seven popular-model small cars revealed that the top of the front tire was 20 to 23 inches above the ground and the top of the rim was 17 to 18 inches. At the Board's recommended height, the guard would engage the

10/ NHTSA NPRM "Rear Underride Protection" Docket No. 1-11, Notice 8, January 8, 1981.

engine block as well, even if the striking car is in a preimpact braking mode. The lower measurement would also avoid the guard skimming the hood off and back through the windshield and into the occupant compartment. The NHTSA should consider the Safety Board amendments and expedite the rulemaking.

Cargo Shift

The shift of the cargoes of railroad ties in Vehicle 5 and sheet aluminum in Vehicle 14 was possible because the tiedown web straps on the railroad ties were inadequate to prevent their forward shift and the palletized aluminum sheets were not secured to the trailer. In both cases, the headerboards were not capable of retaining the forward surge of the cargo. FMCSR 393.106(e) requires a headerboard to retain cargo at a deceleration rate of 20 feet per second per second. This is the equivalent of the forces exerted during a locked-wheel stop. However, both vehicles, in striking the rear ends of loaded trailers, developed deceleration rates and forces that exceeded their headerboards design specifications. If the palletized sheet aluminum on Vehicle 14 had been tied down as required by FMCSR 393.100C(4), the combined strength of the tiedowns and the headerboard might have retained the cargo. The State of California should evaluate accidents involving vehicles transporting loads of aluminum and other metal products to determine if such accidents and any attendant injuries could be prevented or their severity reduced by requiring such loads to meet the securement requirements for steel products contained in Title 13, Subchapter 7 of the California Administrative Code.

Highway Factors

There are no highway defects or highway design problems that contributed to this accident. From an operations standpoint this location is not an area of known recurring dense fog and the accident history does not indicate it to be such a problem area.

Meteorological Factors

About the time of and in the area of the accident, horizontal surface visibility ranged from zero to 50 feet in dense fog. The fog that developed over the area of the accident was the result of a stratus cloud moving onshore from the California coast on a westerly wind flow. The top of the stratus layer coincided with the top of the marine layer, 11/ while the base of the stratus layer was about 900 feet m.s.l. On the morning of the accident, the top of the marine layer was approximately 2,200 feet m.s.l. This was approximately 700 feet above the 1,500-foot elevation of the accident site. Therefore, fog conditions were expected below the top of the marine layer.

Although the major process in the production of fog on the morning of November 10 was the inland progression of coastal stratus, other factors such as the lifting of air by local terrain, cold air drainage from surrounding higher elevations, and turbulence and heat generation by vehicular traffic all contributed to the density of the fog.

The State of California has demonstrated its concern for the hazards presented by limited-visibility conditions such as fog. Although there is no fog alert program for the San Bernardino area, in several areas the State has developed and implemented programs for "adverse weather and road conditions." 12/ These programs include: (1) problem area

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11/ In this case the top of the marine layer occurred at the base of the temperature inversion.

12/ Highway Accident Report--"Multiple-Vehicle Collisions in Fog Near Corona, California, February 28, 1975" (NTSB-HAR-75-7).

identification and evaluation; (2) fog forecasting and alert procedures; (3) route selection; (4) public education "Sig Alert" or traffic advisories; (5) use of engineering support for signing, striping, and barricades; (6) training of supervisors and officers; (7) traffic controls; and (8) "round robin" escort services. Such a program was used successfully in the Riverside area in 1975.

The State should identify other areas having a high potential for experiencing adverse weather conditions (fog, snow, sand, or dust storms, etc.) that may seriously affect major highway routes and/or traffic corridors and should develop contingency plans in those areas for warning and/or guiding traffic through affected areas, redeploying personnel resources, and notifying other government agencies should weather conditions reach the plan implementation threshold. With the high potential for fog problems in the San Bernardino area, given its proximity to the Riverside and Pomona areas which have severe fog and dust problems, a fog plan would be beneficial even if fog is only an occasional problem. It would be better to have a written plan that can be referred to rather than no plan at all.

In addition, the CHP should extend its practice of monitoring the NWS or local or regional weather forecasting services regularly (every 4 to 6 hours or more frequently if appropriate) to obtain advance notification of weather changes that may seriously affect traffic movement and provide adequate leadtime for implementing contingency plans.

CONCLUSIONS

Findings

1. The design, construction, and maintenance of the highway did not contribute to this accident.

2. There was no evidence that the mechanical condition of the vehicles involved in the accident contributed to the accident.

3. The National Weather Service issued a forecast calling for "dense fog or low clouds" on the morning of November 10, which could have been monitored by the San Bernardino Office of the California Highway Patrol.

4. Although forecasts of general areas of fog are possible, consistent accurate forecasts of the density of fog for specific locations are not.

5. Neither the California Highway Patrol nor the California Department of Transportation had issued warnings because they were not aware of nor did they anticipate a dense fog problem at the accident site.

6. There were no permanent or portable advance fog warning or restrictive speed signs present.

7. Dense fog with a limited horizontal surface visibility of zero to 50 feet existed at the scene of the accident.

8. Half of the drivers were familiar with the roadway and the possibility of fog in the area.

9. The drivers anticipated a light fog condition and were not prepared for the sudden severely limited visibility conditions.

10. The estimated vehicle speed range was excessive considering the limited visibility due to the fog.

11. The collisions took place a short distance into the fogbank, reducing time for drivers to make emergency decisions and take evasive action.

12. The actions of the drivers demonstrated a need for improved driver education to provide guidance in determining safe speeds, driving methods, and postaccident procedures when approaching and entering fog conditions.

13. The difference in size and weight among the compact cars and the truck combinations was responsible for the severe damage to the compact cars.

14. The load shift of cargo contributed to the severity of the injuries to drivers of Vehicles 5 and 14.

15. Title 13 of the California Administrative Code establishes requirements for securing steel products in transportation but not for other metal products that seem to have comparable characteristics.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this multiple-vehicle accident was the failure of the drivers of many of the vehicles involved to reduce speed as necessary to be able to stop in distances compatible with visibility which was severely restricted by dense fog. The initial collision occurred when a tractor-trailer was rear-ended after its driver braked abruptly to avoid hitting an unidentified car which changed lanes immediately in front of the truck. Contributing to the severity of the consequences was the extremely varied sizes and weights of the vehicles in the collisions.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board reiterates the following recommendation made to the NHTSA as a result of an earlier fog accident investigation:

> Initiate (through an appropriate demonstration project) a program and procedures for minimizing the likelihood of catastrophic chain-reaction collisions on high-speed, multilaned highways in adverse weather or visibility conditions; such program to consider, among others, requirements to: (1) segregate heavy vehicles from light vehicles by assigned use of lanes whenever safe speed is below posted speed; (2) forbid overtaking and passing by heavy vehicles; (3) use of four-way flashers by all vehicles; (4) prohibit stopping on the traveled portion of highways (unless conditions will not permit otherwise); and (5) evacuate stopped vehicles under certain conditions. (Class II, Priority Action) (H-71-17)

This recommendation is in an "Open--Acceptable Action" status.

As a further result of its investigation, the National Transportation Safety Board also made these recommendations:

--to the National Highway Traffic Safety Administration:

Consider the circumstances of this and other similar limited-visibility accidents and develop a strategy such as that recommended in Safety Board Recommendation H-71-17 for inclusion in Highway Safety Program Standard No. 4, "Driver Education," to inform motorists faced with adverse, limited-visibility driving conditions about the safest actions to take to protect themselves from injury. (Class II, Priority Action) (H-81-26)

In developing the new standard related to Rear Underride Protection as proposed in NHTSA Docket No. 1-11, Notice 07, of January 8, 1981, incorporate the specification modifications submitted by Safety Board letter dated April 18, 1981, to the Docket. (Class I, Urgent Action) (H-81-27)

--to the State of California:

Encourage the California Highway Patrol to extend its communication facilities throughout the State and to monitor National Weather Service or local or regional weather forecasting services regularly to obtain advance warning of weather changes that may seriously affect traffic movement and to provide adequate leadtime for implementing contingency plans. (Class II, Priority Action) (H-81-28)

Identify areas throughout the State having a high potential for experiencing adverse weather conditions (fog, snow, sand, or dust storms, etc.) that may seriously affect major highway routes and/or traffic corridors. Develop contingency plans similar to the Riverside plan for those areas to warn and to guide traffic through affected areas, to redeploy personnel resources, and to notify other government agencies should weather conditions reach the plan implementation threshold. (Class II, Priority Action) (H-81-29)

Evaluate accidents involving vehicles transporting loads of aluminum and other metal products to determine if such accidents and any attendant injuries could be prevented or their severity reduced by requiring such products to be secured so as to meet the securement requirements for steel products contained in Title 13 of the California Administrative Code. (Class II, Priority Action) (H-81-30)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

JAMES B. KING, Chairman, and PATRICIA A. GOLDMAN, Member, did not participate.

June 10, 1981

APPENDIX A

INVESTIGATION

1. Investigation

The National Transportation Safety Board was notified of the accident at 11 a.m. on November 10, 1980. Two highway accident investigators were dispatched from the Safety Board's Los Angeles field office. They arrived onscene at about 3 p.m. on November 10, 1980. An investigator-in-charge, a highway/environment engineer, and a weather specialist were dispatched to the scene from the Safety Board Headquarters in Washington, D.C. and arrived late that night. Representatives of the Multidisciplinary Accident Investigation Team and Motor Carrier Specialists of the California Highway Patrol; the California Department of Transportation; and the Bureau of Motor Carrier Safety of the Federal Highway Administration participated in the investigation.

2. Deposition/Hearing

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

APPENDIX B

CHRONOLOGY OF CRASH SEQUENCE

Vehicle 1 was a 1978 Freightliner, two-axle tractor, VIN No. CA212HL44259. It was towing a 1963 Utility one-axle, blow-off cement tank semitrailer, VIN 40247, and a 1963 Utility two-axle, blow-off cement tank full trailer, VIN UT 475. The combination was owned by Morosa Brothers Transportation of Bakersfield, California. It was southbound in lane No. 4 traveling at about 20 mph when the driver suddenly braked the vehicle to avoid a small, unidentified, white, late-model Dodge sedan which moved from lane No. 3, crossed in front of Vehicle 1, and exited the freeway at the Highland Avenue offramp. Vehicle 1 was struck from the rear by Vehicle 2 and later by Vehicle 3.

The full trailer sustained severe rear-end damage. The rear axle, structural supports, and the tank were damaged. The cargo of lime was spilled onto the highway. An ensuing fire destroyed the rear tires and all other flammable items.

Vehicle 2 was a 1977 GMC 1/2-ton pickup truck, VIN TCS 2472 506644. It had a gross vehicle weight rating of 8,200 pounds. It was owned by the driver. Vehicle 2 struck and underrode the rear of the full trailer of Vehicle 1.

The front of Vehicle 2 was deformed rearward and downward for a distance of 57 inches. The hood was crushed upward and to the rear, and the rear of the hood penetrated the windshield. (See figure 2.) The two persons in Vehicle 2 died in the collision.

Vehicle 2 was later struck from the rear by Vehicles 3 and 4. These rear-end collisions buckled Vehicle 2, displaced the rear axle forward 42 inches, twisted the frame to the right and upward, and displaced the left-rear springleaf forward. The leading end of the spring punctured the left fuel tank of Vehicle 2. Fire erupted and destroyed Vehicles 2 and 3, the rear of Vehicle 1's full trailer, and part of Vehicle 4.

Vehicle 3 was a 1972 Datsun sedan and was owned by the driver. The driver said that as he entered the fogbank, he slowed to about 30 mph. He saw a flashlight being waved from the shoulder of the road but before he could stop, Vehicle 3 struck the rear of Vehicle 2. As he got out of his vehicle, Vehicle 4 stopped 10 feet behind Vehicle 3.

Vehicle 3 underrode Vehicle 2 and sustained minor frontal underride damage. Later, Vehicle 5 struck Vehicle 4 which in turn struck Vehicle 3 from the rear and drove it into Vehicle 1. This second impact crushed Vehicle 3, and it was then completely engulfed in the fire from Vehicle 2. When Vehicle 3 was removed from the road, it broke in half at the "B" pillars.

Vehicle 4 was a 1980 GMC, three-axle, cab-over-engine tractor, VIN-TAV592069, towing a 1977 Kentucky two-axle van semitrailer, VIN 53011. The tractor was owned by Charles E. Barber of Palm Harbor, Florida, and leased to the North American Van Lines of Fort Wayne, Indiana, which also owned the trailer.

Vehicle 4 stopped within 10 feet of the rear end of Vehicle 3. Vehicle 4 was struck from the rear by Vehicle 23. Vehicle 4 was then struck by Vehicle 5 and driven into Vehicles 3 and 2. The tractor of Vehicle 4 was destroyed by fire transmitted from Vehicles 2 and 3. The front third of the trailer also sustained structural and fire damage.

Vehicle 5 was a 1973 Freightliner three-axle, cab-over-engine, flatbed truck, VIN CA413HP083153, towing a 1967 Fruehauf two-axle, flatbed trailer, VIN UVH407001. Both vehicles were owned by the Melhutt Leasing Company of Lodi, California. Both vehicles were loaded with railroad ties. When Vehicle 5 struck Vehicle 4, the railroad ties on the truck surged forward about 5 feet (see figure 5), deformed the headerboard, and crushed and penetrated the cab of Vehicle 5.

The headerboards on the tractor and trailer were both deformed forward and to the left. The front of the truck was deformed rearward, from left to right, a distance of 1 to 2 feet.

Vehicle 6 was a 1979 Freightliner three-axle, cab-over-engine tractor towing a 1979 Fruehauf one-axle semitrailer, a 1972 Jiffiox dolly, and a 1979 Fruehauf one-axle semitrailer. The combination of vehicles was owned by I.M.L. of Salt Lake City, Utah. Vehicle 6 stopped safely behind Vehicle 5. The rear semitrailer was struck by Vehicle 8. The semitrailer sustained structural damage to the rear components from the underride impact.

Vehicle 7 was a 1977 Kenworth two-axle tractor towing a 1970 Fruehauf one-axle, bottom-dump cargo-release semitrailer and a 1970 Fruehauf two-axle, bottom-dump cargo-release trailer. The combination of vehicles was owned by the Waroway Trucking Company of Apple Valley, California. The vehicle swerved to the left in an attempt to avoid vehicles ahead. The truckdriver sideswiped Vehicle 13 on his left and Vehicle 8 on his right causing minor damage to the left side of Vehicle 7 and moderate damage to the right side. Vehicle 7 came to rest occupying both lanes Nos. 3 and 4. Vehicle 7 was later struck by Vehicles 9 and 10, causing it to move forward and strike four pedestrians standing in front of Vehicle 7. Two of these pedestrians were killed and the other two were injured.

Vehicle 8 was a brown 1978 Ford Pinto stationwagon owned by Mary H. Young of Phelan, California. It struck the rear of Vehicle 6 at a speed that caused major damage to Vehicle 8 and fatal injuries to the driver. This damage and subsequent impacts by Vehicles 7, 9, and 10 destroyed Vehicle 8. (See figure 9.)

Vehicle 9 was a white 1979 Ford Fiesta. It followed Vehicle 11 at 45 to 50 mph into the fogbank. When the driver saw Vehicle 11 swerve to the right and its brake lights illuminate, he also swerved to the right and applied his brakes to reduce his speed to approximately 25 mph. Vehicle 9 sideswiped Vehicle 12, rotated, and came to rest impacting the rears of Vehicles 7 and 8. (See figure 3.) As the driver and passenger of Vehicle 9 exited their vehicle, it was struck by Vehicle 10. Vehicle 9 was destroyed. The entire right half was compressed inward from override by Vehicle 10. (See figure 10.)

Vehicle 10 was a 1979 Peterbilt three-axle tractor, VIN 12283N, towing a Timpte two-axle van-type semitrailer. The vehicle combination was owned by Harry Singh of Englewood, New Jersey. It was traveling in lane No. 4 at approximately 55 mph when it entered the fog. The truckdriver saw cars stopping ahead, applied the brakes, struck unknown cars, and stopped. Vehicle 10 was struck from the rear by Vehicle 14. Vehicle 10 was driven forward, struck Vehicle 11 and forced it onto the right shoulder, sideswiped Vehicle 12, pushed Vehicle 9 into Vehicles 8 and 7, and shoved Vehicle 7 forward, striking four pedestrians standing in front of Vehicle 7. Vehicle 10 was later struck by Vehicle 22.

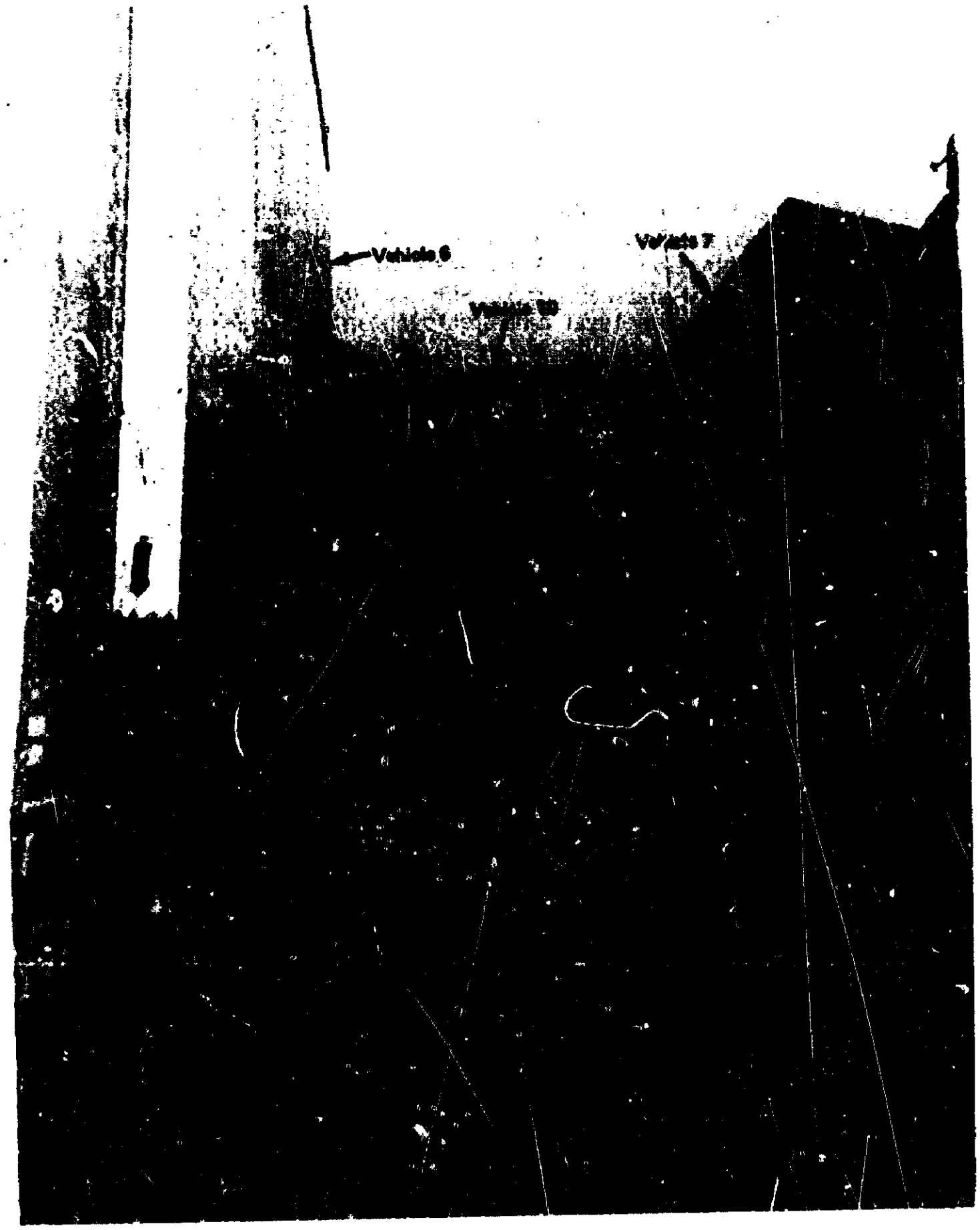

Figure 9.--Postimpact positions of Vehicles 6, 7, 8, and 10.

Figure 10.--Postimpact positions of Vehicles 6, 7, 9, and 10.

The tractor cab was compressed 2 feet to the rear. All frontal components received major damage. The front axle assembly was forced about 1 foot to the rear. The trailer sustained minor structural damage.

Vehicle 11 was a white 1980 Ford Courier, with a wood frame camper attached, owned by the CSC Management Company of Fullerton, California. The driver said he entered the fog area at approximately 55 mph but reduced speed to 30 to 40 mph because he could see only about 20 feet ahead. He swerved to miss a vehicle stopped in lane No. 2, continued to the right, and stopped behind Vehicle 9 in lane No. 4. Vehicle 11 was then struck from the rear by Vehicle 10.

The camper shell was destroyed. The front was crushed 1 foot. The rear bumper, rear frame, and rear-end components were damaged.

Vehicle 12 was a brown 1976 Ford Pinto stationwagon owned by the driver. It stopped in lanes Nos. 3 and 4 after impacting Vehicle 15. Vehicles 9 and 10 struck Vehicle 12 in passing. Paint transfers indicated impact by at least one more vehicle.

Vehicle 12 sustained massive, total damage. (See figure 11.) It was so demolished that it was difficult to determine the source of all of the damage. The right front-seat passenger was fatally injured.

Vehicle 13 was a 1977 Kenworth three-axle, cab-over-engine tractor, VIN 2518YOK, towing a 1978 Trailmobile two-axle, van-type semitrailer. It was owned by the Interstate Contract Carrier Corporation of Ardmore, Oklahoma. It was traveling in lane No. 3 at a driver-stated speed of 20 mph. The truckdriver was unable to see once in the fog. Vehicle 13 struck the rear of Vehicle 24 and drove it forward. Both vehicles came to rest in lane No. 3. Vehicle 13 was later sideswiped by Vehicle 7 and struck in the rear by Vehicles 18 and 15.

The tractor frame was severely distorted forward of the fifth wheel. There was minor damage across the front, and the right front of the tractor cab received minor impact damage. The trailer sustained minor rear-end damage and penetration on the right side.

Vehicle 14 was a 1979 Peterbilt three-axle tractor towing a 1979 Alloy two-axle, flatbed semitrailer leased by Tiger Transportation of Billings, Montana. The trailer was loaded with sheet aluminum and was following closely behind Vehicle 10 as the vehicles entered the fog. The driver stated that the vehicles entered the fogbank at about 55 mph. Just as he realized the fog was very dense, he heard a call on the CB radio to "shut it down." At the same time, he saw the brake lights illuminate on Vehicle 10 ahead, and he locked up the brakes on Vehicle 14. Vehicle 14 struck Vehicle 22 and moved it to the right shoulder and then continued ahead to strike the rear of Vehicle 10. The cargo of sheet aluminum slid forward, deflecting the headerboards, and crushed the cab, injuring the driver. He was able to exit his cab, crawl under his trailer, and move to the right shoulder until the series of collisions stopped.

Both the headerboard on the tractor and the headerboard on the semitrailer were deformed forward and downward by the palletized aluminum sheets which surged foward on impact. The front of the cab was deformed rearward about 2 feet on impact and the rear of the cab was crushed foward about 4 feet when the cargo shifted forward. (See figure 6.)

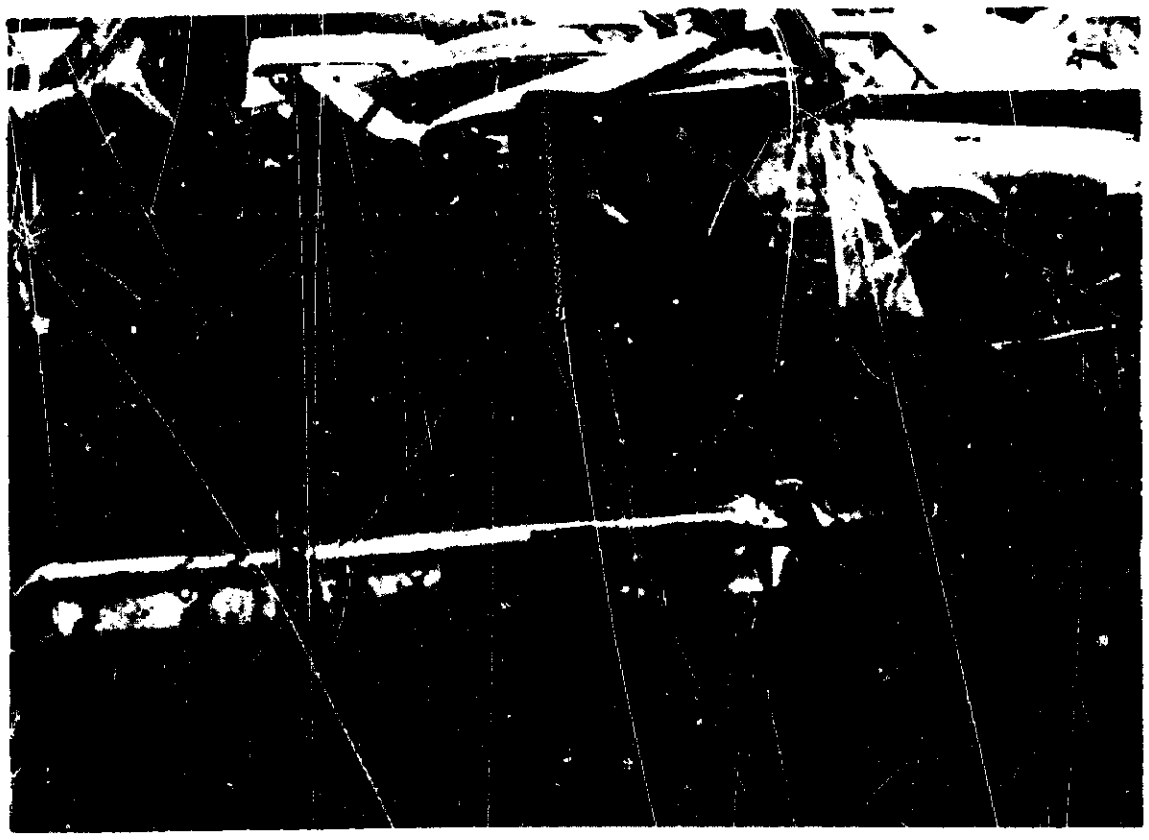

Figure 11.--Frontal damage to Vehicle 12.

Vehicle 15 was a bright yellow 1975 Honda sedan and was owned by the driver. It underrode the rear of Vehicle 13 and was destroyed. (See figure 4.) Vehicle 15 was struck from the rear by Vehicle 16. (See figure 12.) Several other vehicles, including Vehicle 12, showed transfers of paint similar to the paint of Vehicle 15. These transfers could have occurred from collisions before Vehicle 15 struck the rear of Vehicle 13. The driver of Vehicle 15 received fatal injuries.

Vehicle 16 was a tan 1980 Chevrolet 1/2-ton pickup truck owned by its driver. It was southbound in lane No. 3 at 55 mph. The driver stated he slowed to 40 mph as he entered the fog. He noticed Vehicle 15 at the rear of Vehicle 13 and swerved to the left to avoid them. Vehicle 16 hit Vehicle 15, however, and then bounced off and hit Vehicle 17.

There was evidence of minor impact damage to the right and left front of Vehicle 16 and sideswipe damage to the left side and right rear. There were three different color paint transfers on Vehicle 16.

Vehicle 17 was a red 1978 Honda sedan owned by its driver. It was traveling in lane No. 3 at 50 mph. The driver stated he started to slow and then saw crashed vehicles ahead of him. He attempted to avoid them by steering and braking but bounced off of another car and rotated 180°. Vehicle 17 was then struck by Vehicles 16 and 20.

Vehicle 17 received major damage to both the left and right sides along the full length of the vehicle. The middle portion of the body was narrowed by one-half of its original width.

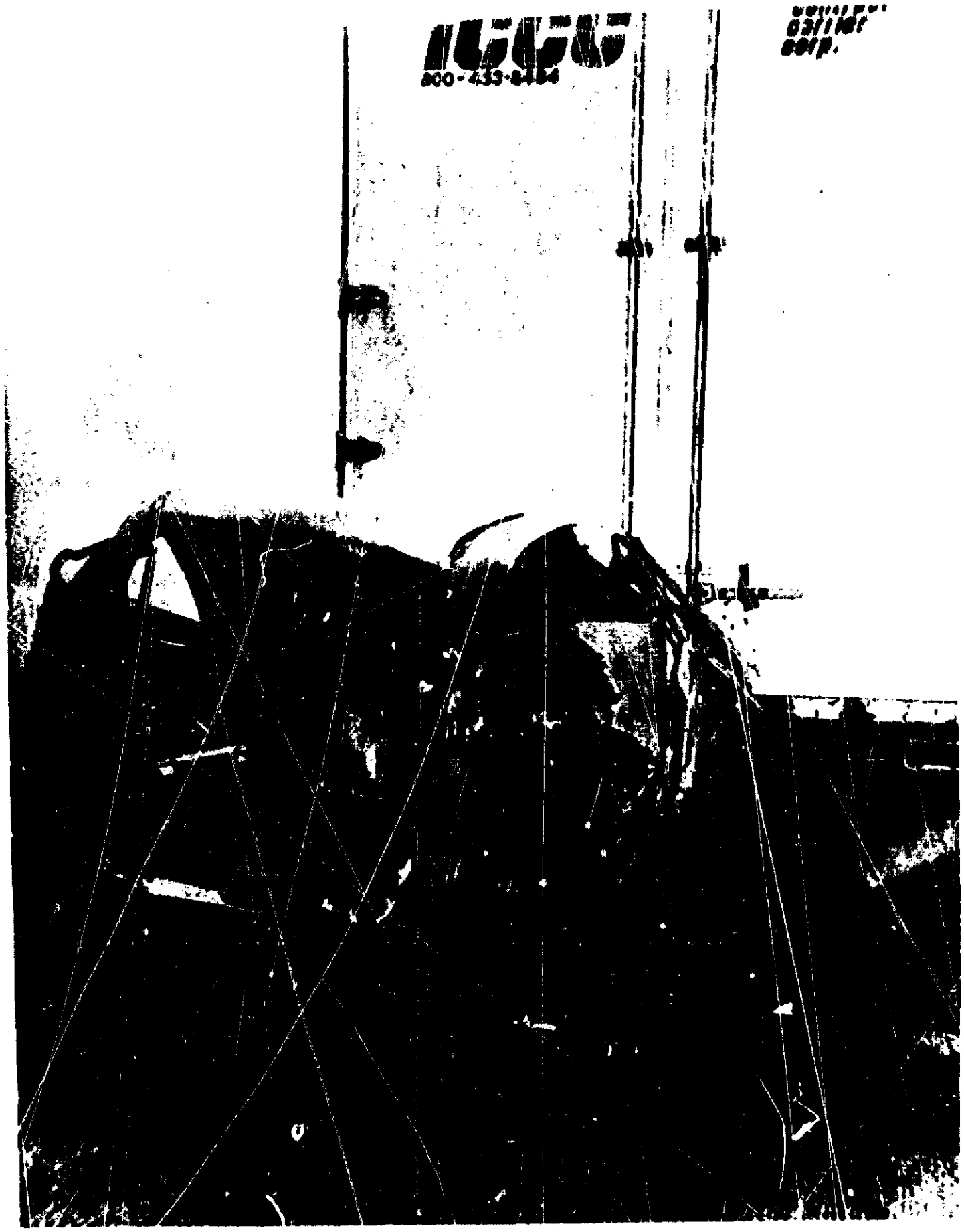

Figure 12.--Postimpact positions of Vehicle 15, foreground, and Vehicle 13, background.

Vehicle 18 was a gold 1974 Dodge Colt stationwagon owned by its driver. It was traveling in lane No. 3 at an unknown speed. The driver stated she slowed in the fog but was unable to avoid striking the left rear of Vehicle 13 and rotating 180°. The driver exited her vehicle and walked to the median. After coming to rest, Vehicle 18 was later struck by Vehicles 21, 19, 20.

Vehicle 18 sustained major damage across its front and minor damage at the right rear. There was a bright yellow paint transfer in the frontal damage area.

Vehicle 19 was a blue 1979 Datsun stationwagon owned by its driver. It was traveling in lane No. 1 at 50 mph. It slowed as it entered the fog, but struck Vehicle 21 and then struck Vehicle 18 head-on. Vehicle 19 then rotated nearly 90° and came to rest. It was later struck by Vehicle 20.

Vehicle 19 received moderate damage across its front with 10 inches of crush at the right front fender area. The windshield was damaged and evidenced two visible "web" impact points from within.

Vehicle 20 was a white 1977 Toyota pickup truck owned by Doreen M. Kennedy of Hesperia, California. It was traveling in lane No. 2 at 40 mph. The driver could not remember the details as Vehicle 20 struck Vehicles 17, 18, and 19.

The vehicle sustained major impact damage to the right door and front end, and minor damage to the rear bumper and tailgate.

Vehicle 21 was a yellow 1979 Triumph TR7 owned by the driver. She stated that she was traveling in lane No. 2 at approximately 40 mph when her car struck Vehicle 18. Vehicle 21 was then struck by Vehicle 19 and pushed into lane No. 1.

The vehicle was damaged in the right front and left rear. The hood was folded back but stopped short of the windshield. The left rear was crushed inward approximately 1 foot. (See figure 13.)

Vehicle 22 was a white 1979 Datsun pickup truck and was owned by its driver. It was slowing from a speed of 50 to 55 mph after entering the fog. The driver saw brakelights illuminate ahead of him and applied the brakes and steered to the right. Vehicle 22 struck the right rear of Vehicle 10 and was struck from the rear by Vehicle 14 and pushed onto the right shoulder.

The left front between the fender and door was compressed inward about 6 inches. This distorted the hood, bumper, and grill. The windshield was damaged on the driver's side, suggesting impact from within.

Vehicle 23 was a silver 1978 Datsun 280Z. It was traveling in lane No. 4 at approximately 50 mph. Early in the series of collisions, Vehicle 23 struck the left rear of Vehicle 4, moved to the left out of control across the median and the four northbound lanes of Interstate Route 15, and struck the east perimeter fence at the road edge.

The vehicle exhibited underride damage involving the hood, windshield, and the front of the top. There was an 8-inch to 10-inch penetration of the right door.

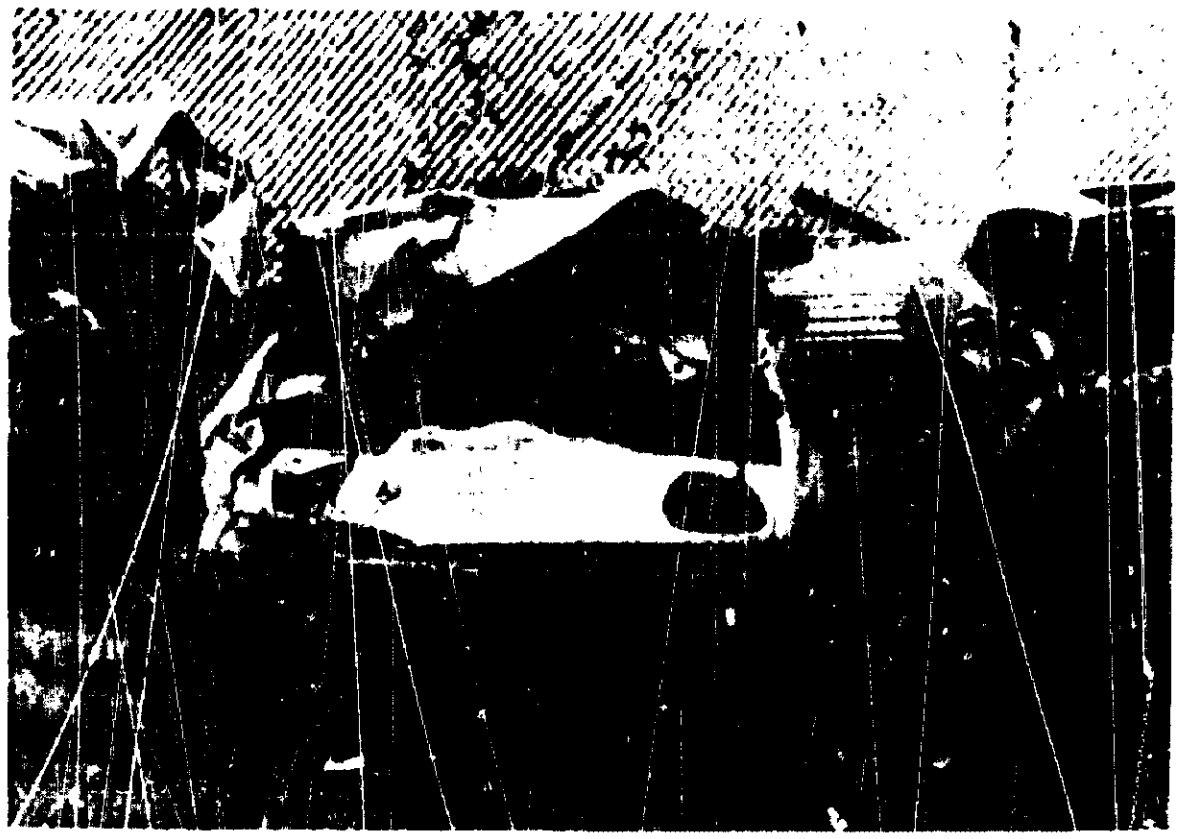

Figure 13.--Damage to rear of Vehicle 15.

Vehicle 24 was a 1979 Kenworth three-axle tractor towing a 1974 Trailmobile two-axle semitrailer. The vehicle combination was owned by Truck Plaza of Commerce City, Colorado. It was traveling in lane No. 4 and entering the dense fog when the driver heard a warning on his CB radio to avoid lane No. 4. He moved to lane No. 3 and had slowed to 5 to 10 mph when he was struck from the rear by Vehicle 13. Vehicle 24 was forced forward away from Vehicle 13. Both vehicles came to rest in lane No. 3.

The trailer received moderate rear-end damage.

APPENDIX C

DETAILS OF INJURIES

Vehicle	Driver Age	Driver Sex	Passenger Age	Passenger Sex	Description of injuries
Vehicle 1	41	M			None AIS 0 1/
Vehicle 2	83	M			Fatal (trauma then burned) AIS 6
			--	M	Fatal (trauma then burned) AIS 6
Vehicle 3	50	M			None AIS 0
Vehicle 4	54	M			Complained of pain in right side AIS 1
			--	F	None AIS 0
Vehicle 5	35	M			Fractured pelvis and legs and internal injuries; visible lacerations to head AIS 4
Vehicle 6	53	M			None AIS 0
Vehicle 7	38	M			None as a vehicle driver; suffered fatal injuries as a pedestrian later during events AIS 6
Vehicle 8	54	F			Fatal AIS 6

1/ Abbreviated Injury Scale (AIS):

0--No Injury
1--Minor - No loss of consciousness
2--Moderate - Unconsciousness less than 15 minutes
3--Severe - Not life-threatening
4--Serious - Life-threatening but survival probable
5--Critical - Survival uncertain
6--Maximum - Fatal

Vehicle	Driver Age	Driver Sex	Passenger Age	Passenger Sex	Description of injuries
Vehicle 9	41	M			Minor laceration to right eye AIS 1
			26	M	Minor unknown injuries AIS 1
Vehicle 10	28	M			Head lacerations; lacerations and abrasions to both legs AIS 1
Vehicle 11	44	M			None AIS 0
Vehicle 12	37	M			Concussion, major laceration to rear of head, abrasion and laceration AIS 3
			--	F	Fatal AIS 6
Vehicle 13	24	M			None AIS 0
Vehicle 14	27	M			Lacerations to right knee and contusions AIS 1
Vehicle 15	46	M			Fatal AIS 6
Vehicle 16	52	M			None AIS 0
Vehicle 17	29	M			Complained of pain AIS 1
Vehicle 18	23	F			Forehead lacerations, vertebra injury to neck; pain to right leg AIS 2
Vehicle 19	50	M			Laceration to left arm; lacerations and abrasions to facial area; complained of pain to chest and legs AIS 1
			32	F	Lacerations and abrasions to the right side of head and facial area; complained of pain to lower back AIS 1

Vehicle	Driver Age	Driver Sex	Passenger Age	Passenger Sex	Description of injuries
Vehicle 20	21	M			Lacerations; complained of pain to back AIS 1
Vehicle 21	42	F			Whiplash injuries AIS 1
Vehicle 22	29	M			Laceration to face; dislodged teeth; broken jaw; complained of pain to right lower leg AIS 2
Vehicle 23	43	M			Lacerations to the head; complained of pain in left arm AIS 1
Vehicle 24	23	M			None in collision; As pedestrian later in events, fractured left leg, facial lacerations, numerous body abrasions AIS 2
Pedestrian from unknown vehicle	--	M			Fatal AIS 6
Pedestrian from unknown vehicle	--	M			Fractured left leg; facial lacerations; abrasions AIS 2

APPENDIX D

CHRONOLOGY OF EMERGENCY SERVICES EVENTS

November 10, 1980

0725	(approximate time of collision as reported by one of the victims)
0734	Victorville CHP unit came upon scene and radioed that there was an accident and that I-15 was blocked
0735	First San Bernardino CHP unit dispatched
0736	First southbound CHP Sergeant dispatched
0736	Coroner, tow trucks, and ambulances requested
0737	Coroner notified
	Five tow trucks and numerous ambulances dispatched
0737	Second southbound CHP unit dispatched
0737	Fire department dispatch confirmed
0739	Third southbound CHP unit dispatched
0739	Caltrans notified of the road condition
0742	"Jaws of life" equipment requested"
0746	First southbound CHP unit onscene
0750	Second and third southbound CHP unit onscene; fire department expedited
0752	Request made to close freeway
0752	Code-20 called
0758-0800	Fourth and fifth southbound CHP units dispatched
0758	Lieutenant and Multidisciplinary Accident Investigation Team (MAIT) requested
0802	More tow trucks requested
0803	Command post established
0805	Four/five more ambulances requested

0807	Sixth CHP unit dispatched
	MAIT team responding
0817	Caltrans supervisor requested at scene
0820	Part of freeway access closed off
0828	Seventh CHP unit dispatched
0836	Sergeant advised no hazardous materials involved
0844	MAIT participation advised; two motor carrier officers dispatched
0901	All northbound and southbound traffic on Interstate Route 15 stopped and rerouted
0929	Sergeant at scene reported 150- to 200-foot visibility
1109	MAIT on scene
1132	NTSB advised participation, enroute
1338	Roadway open

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