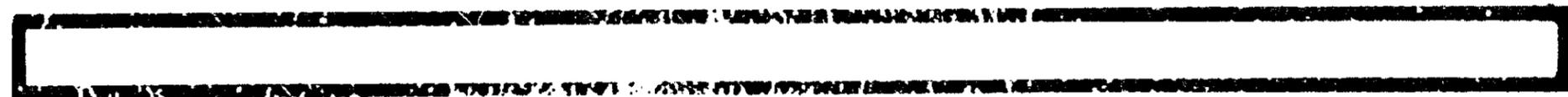


PB83-916204

Highway Accident Report - Multiple Vehicle
Collisions and Fires Under Limited Visibility
Conditions, Interstate Route 75 at
Ocala, Florida, February 28, 1983

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

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16. Abstract Between 1:30 p.m. and 1:55 p.m., e.s.t., on February 28, 1983, a grass fire of an undetermined origin was ignited in the gore area between the southbound exit ramp from Interstate Route 75 (I-75) to U.S. Route 27 and the southbound lanes of I-75. The fire burned rapidly, and a strong wind from the south-southwest fanned dense smoke across the southbound lanes of I-75. About 2 p.m., the smoke reduced visibility for a 200- to 300-foot stretch of the roadway from near zero to about 40 to 60 feet. Approaching drivers had a clear view of the smoke cloud for over 2 miles before entering the smoke, but they responded with diverse assumptions and drove into and through the smoke at a wide range of speeds. At least 22 vehicles, including three combination vehicles, all traveling south on I-75, entered the cloud of smoke and were involved in multiple vehicle collisions. Vehicle fuel tanks were breached and a gasoline fed fire erupted. Fourteen vehicles, including all three combination vehicles, were burned. In addition to extensive property damage being caused, 5 vehicle occupants were killed and 36 were injured. At least three rescuers suffered thermal injuries. The National Transportation Safety Board determines that the probable cause of this accident was the failure of most of the involved drivers to exercise proper judgment and due caution when confronted by a cloud of dense smoke blanketing the highway. Contributing to the accident was the extremely limited visibility within the smoke cloud and the widely varying speeds at which different vehicles entered and were being driven through the smoke cloud. Contributing to the severity of the accident was the breach of fuel system integrity in a number of vehicles and the resultant vehicle fires.			
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**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

HIGHWAY ACCIDENT REPORT

Adopted: October 18, 1983

**MULTIPLE-VEHICLE COLLISIONS AND FIRES
UNDER LIMITED VISIBILITY CONDITIONS,
INTERSTATE ROUTE 75 AT OCALA, FLORIDA
FEBRUARY 28, 1983**

SYNOPSIS

Between 1:30 p.m. and 1:55 p.m., e.s.t., on February 28, 1983, a grass fire of an undetermined origin was ignited in the gore area between the southbound exit ramp from Interstate Route 75 (I-75) to U.S. Route 27 and the southbound lanes of I-75. The fire burned rapidly, and a strong wind from the south-southwest fanned dense smoke across the southbound lanes of I-75. About 2 p.m., the smoke reduced visibility for a 200- to 300-foot stretch of the roadway from near zero to about 40 to 60 feet. Approaching drivers had a clear view of the smoke cloud for over 2 miles before entering the smoke, but they responded with diverse assumptions and drove into and through the smoke at a wide range of speeds. At least 22 vehicles, including three combination vehicles, and traveling south on I-75, entered the cloud of smoke and were involved in multiple vehicle collisions. Vehicle fuel tanks were breached and a gasoline fed fire erupted. Fourteen vehicles, including all three combination vehicles, were burned. In addition to extensive property damage being caused, 5 vehicle occupants were killed and 36 were injured. At least three rescuers suffered thermal injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of most of the involved drivers to exercise proper judgment and due caution when confronted by a cloud of dense smoke blanketing the highway. Contributing to the accident was the extremely limited visibility within the smoke cloud and the widely varying speeds at which different vehicles entered and were being driven through the smoke cloud. Contributing to the severity of the accident was the breach of fuel system integrity in a number of vehicles and the resultant vehicle fires.

INVESTIGATION

The Accident

Between 1:30 p.m. and 1:55 p.m. e.s.t. on February 28, 1983, a grass fire of undetermined origin was ignited immediately east of the exit ramp from southbound Interstate 75 (I-75) and about 280 to 320 feet north of U.S. Route 27 in Ocala, Florida. According to one witness, the fire spread rapidly until it was 100 to 150 feet wide and about 14 feet west of I-75's southbound lanes. Southbound traffic was not affected by the fire until the burning grass was fanned by a strong south-southwesterly wind which blew dense smoke across the southbound lanes of I-75.

According to witness statements and the police accident report, about 2 p.m., a series of collisions began which eventually involved at least 22 vehicles. ^{1/} (See figures 1 and 2.) A 1978 Oldsmobile Cutless Supreme (vehicle No. 2) traveling about 50 mph in the curb lane of I-75 slowed to about 45 mph after entering into the smoke. Seconds later, a 1978 Pontiac Grand Safari (vehicle No. 1), traveling about 50 mph in the curb lane, struck vehicle No. 2 in the rear. Vehicle No. 2 traveled into the median lane with vehicle No. 1 still in contact, disengaged when vehicle No. 1 stopped in the median lane, veered left into the median, and stopped facing south near the center of the median. Then a 1976 Buick LeSabre (vehicle No. 3) traveling in the median lane at a "slow rate" struck vehicle No. 1. Seconds later, a 1977 Chevrolet Scottsdale 10 pickup truck (vehicle No. 6) struck a 1982 Buick Park Avenue (vehicle No. 4) traveling in the median lane. Vehicle No. 4 then moved forward and partially into the curb lane and struck vehicle No. 3. Vehicle No. 3 departed the scene southbound on I-75, but was later identified. An unidentified vehicle (No. 5) struck the right side of vehicle No. 4 after vehicle No. 4 came to a rest. Vehicle No. 5 continued traveling southbound on I-75. At the same time, vehicle No. 6 had moved forward, had rotated about 50° clockwise, and had stopped crossways, blocking the median lane and part of the curb lane.

Next, a 1979 Ford F350 Ranger tow truck (vehicle No. 7), traveling about 15 to 20 mph in the median lane, entered the smoke. The driver of the vehicle saw vehicle No. 6 blocking the lane and stopped in the median lane behind it. A 1983 Buick Le Sabre (vehicle No. 8) stopped in the median lane behind vehicle No. 7 and was struck in the rear by a 1981 Oldsmobile Omega (vehicle No. 9), which partially overrode the rear of vehicle No. 8. (See figure 3.) A 1977 Mack 3-axle truck tractor (vehicle No. 10) then struck and overrode the rear of vehicle No. 8. Vehicle No. 8 was pushed forward, striking vehicle No. 7 which, in turn, moved forward and struck vehicle No. 6. After vehicle No. 10 came to rest, a 1980 Buick Estate station wagon (vehicle No. 11) struck the left rear of the semitrailer and stopped. A 1982 Dodge D-50 pickup truck (vehicle No. 12) then struck vehicle No. 11, rotated counterclockwise, struck vehicle No. 10, continued rotating, and came to rest facing east with its front end under the semitrailer's right side at about its longitudinal midpoint. Then a 1980 Delta 88 Oldsmobile (vehicle No. 13) struck the right rear of vehicle No. 10, rotated 70° to 90° counterclockwise, and stopped. A 1981 AMC Spirit (vehicle No. 14) then struck the left side of vehicle No. 13. Both occupants in vehicle No. 13 were killed.

Meanwhile, a short distance to the north, five vehicles were involved in chain reaction rear end collisions in the curb lane and on the paved shoulder. The driver of a 1974 Cadillac Sedan DeVille (vehicle No. 15) stopped about two to three carlengths behind a 1978 Ford LTD (vehicle No. 18) that was moving about 5 to 8 mph, and a 1979 Chevrolet Caprice Landau (vehicle No. 16) stopped behind vehicle No. 15. Seconds later, a 1980 Chevrolet Malibu (vehicle No. 17) struck vehicle No. 16 in the rear. Vehicle No. 16 moved forward, striking vehicle No. 15 in the rear, veered to the right onto the shoulder, struck and rebounded off the guardrail, struck vehicle No. 15 again, and stopped on the shoulder. Vehicle No. 15, in turn, struck vehicle No. 18 in the rear, and vehicle No. 18 moved forward and struck a 1978 Buick Estate station wagon (vehicle No. 19) in the rear.

Next, a 1982 Chevrolet C-30 1-ton pickup truck (vehicle No. 20), which was towing a fifth-wheel type of horse trailer, struck and completely overrode vehicle No. 17; both vehicles veered left and came to rest opposite the forepart of the semitrailer (vehicle

^{1/} Twenty vehicles remained at the scene. Driver's statements, witness statements and physical evidence indicated that at least three or four additional vehicles were involved in comparatively minor collisions and left the scene. Only one of those vehicles was later identified.

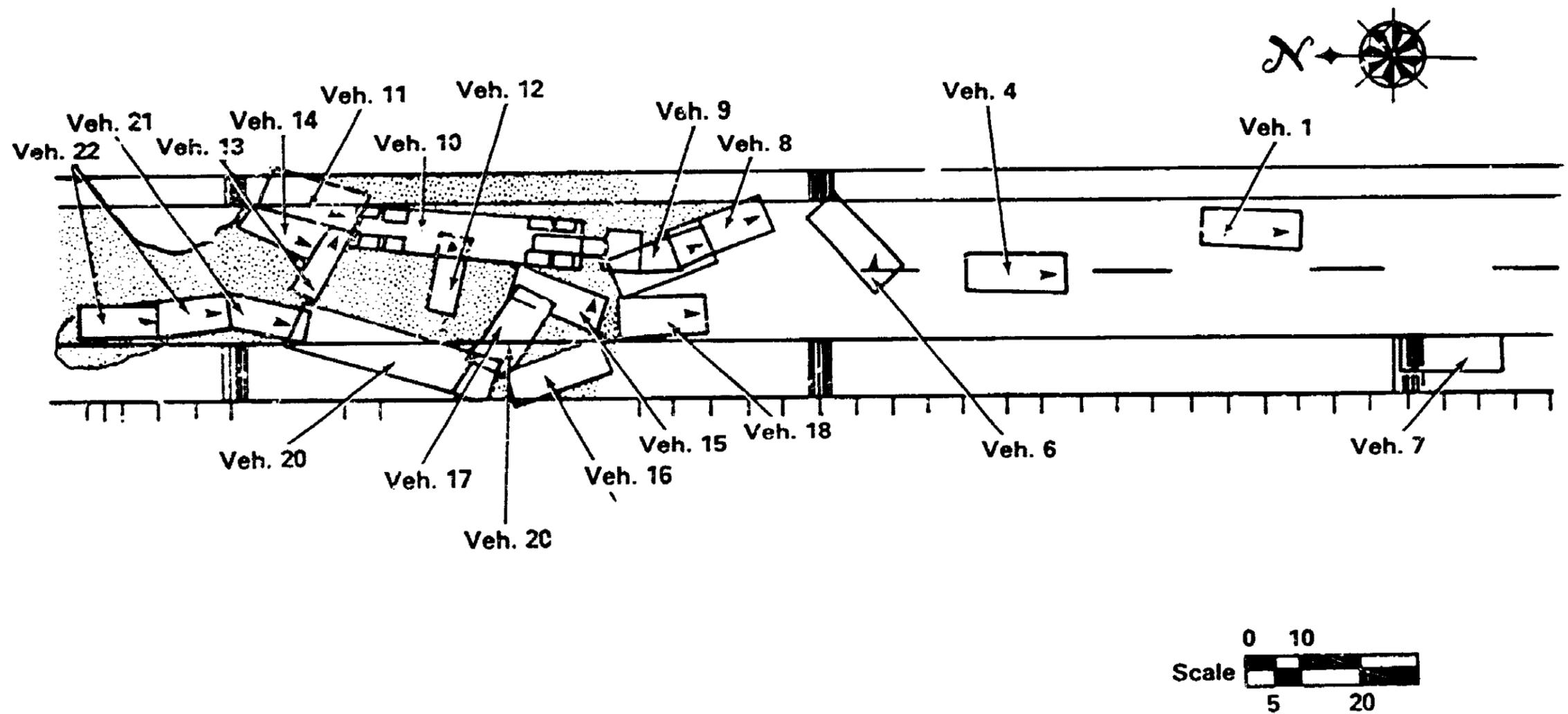


Figure 1.—Vehicles at final rest positions.

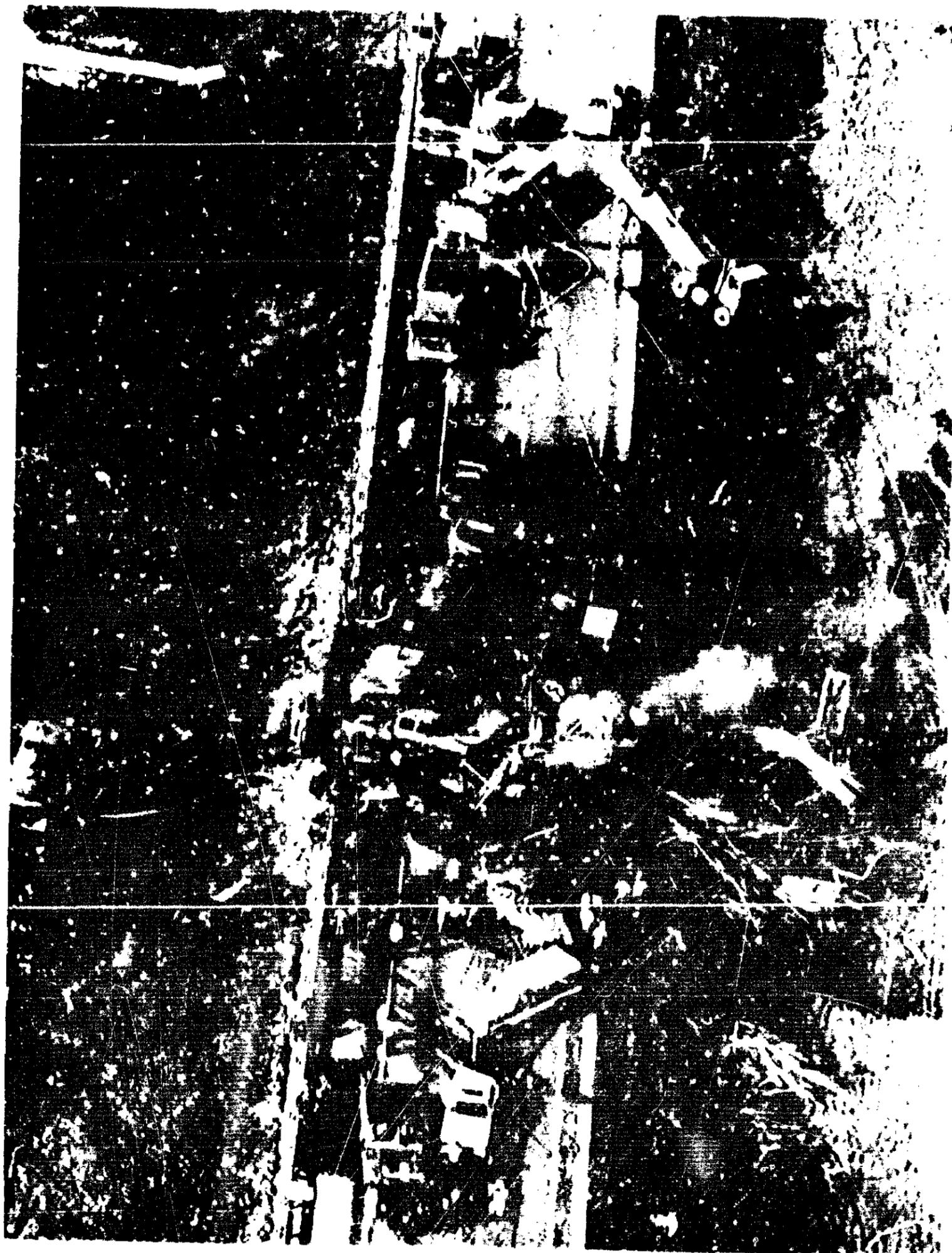


Figure 2.—Aerial photo of the accident site.

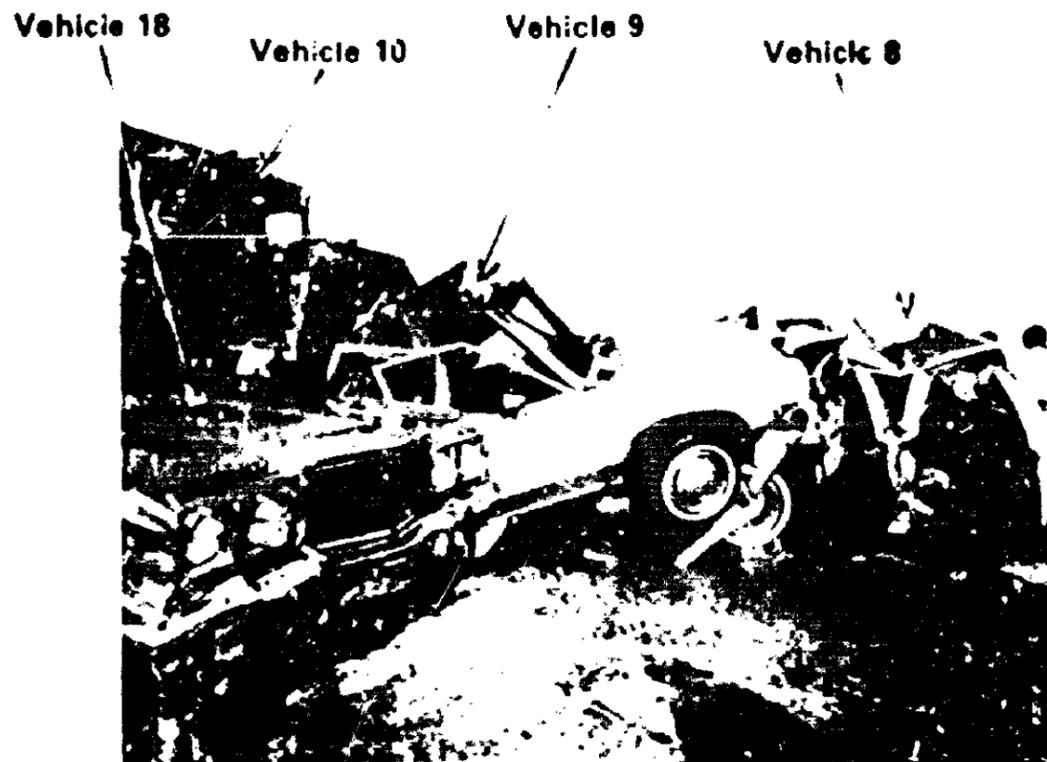


Figure 3.—Vehicles at rest in the median lane.

No. 10). (See figure 4.) At rest, vehicle No. 20 was mostly atop vehicle No. 17, but its right front wheel rested on the roof of vehicle No. 15. Then, a 1981 Ford Centurion van (vehicle No. 22), which was towing a 1981 Ford Bronco,^{2/} struck a 1975 Ford Elite (vehicle No. 21) in the rear. Both vehicles moved forward until vehicle No. 21 struck the rear of the horse trailer. The Bronco separated from the tow hitch and its front overrode the bed of vehicle No. 22. (See figure 5.)

Events After the Accident

Shortly after the accident, a vehicle fire was ignited. Witnesses placed the fire at the resting site of vehicles Nos. 17 and 20. (The fuel systems on both the pickup truck and the Chevrolet were breached.) The fire spread rapidly and eventually involved 14 of the vehicles in the accident area; 10 of these were totally burned. All combustible materials and materials with low melting points, except for some lumber on vehicle No. 10, including the 3 combination vehicles, were consumed by fire. Four other vehicles were partially burned. A grass fire, ignited by vehicle fires, burned across the median, bypassed the northbound traffic lanes, and continued to burn the grass east of the highway until it was interrupted by a fire break which had been constructed before the accident. (See figure 6.)

Substantial override/underride was a prevalent characteristic in nine of the vehicle collisions. Damage to vehicle doors and pillars hampered occupant escape from some of the vehicles. Nine drivers reported having difficulty exiting their vehicles. Escape from the vehicles was accomplished by forcing doors open, breaking and crawling out through side windows, exiting through open side windows, or using another door which was not jammed. Two occupants who were trapped in vehicle No. 17 died.

^{2/} Of the 21 identified vehicles involved, 5 each were registered in the State of Florida and Ontario Province, Canada, 2 each in the States of Ohio and Illinois, and 1 each in the States of Michigan, Pennsylvania, Georgia, Maine, New York, North Carolina, and Louisiana.

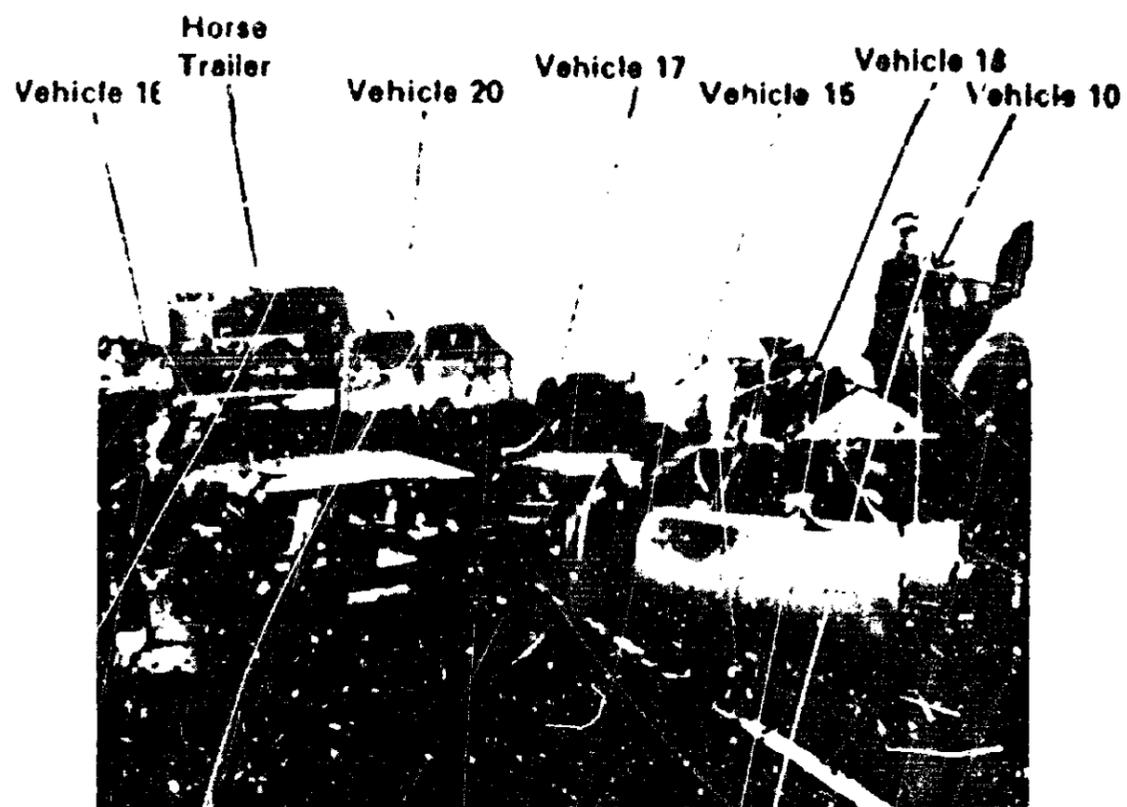


Figure 4.—Vehicles at rest in the curb lane and on the shoulder.

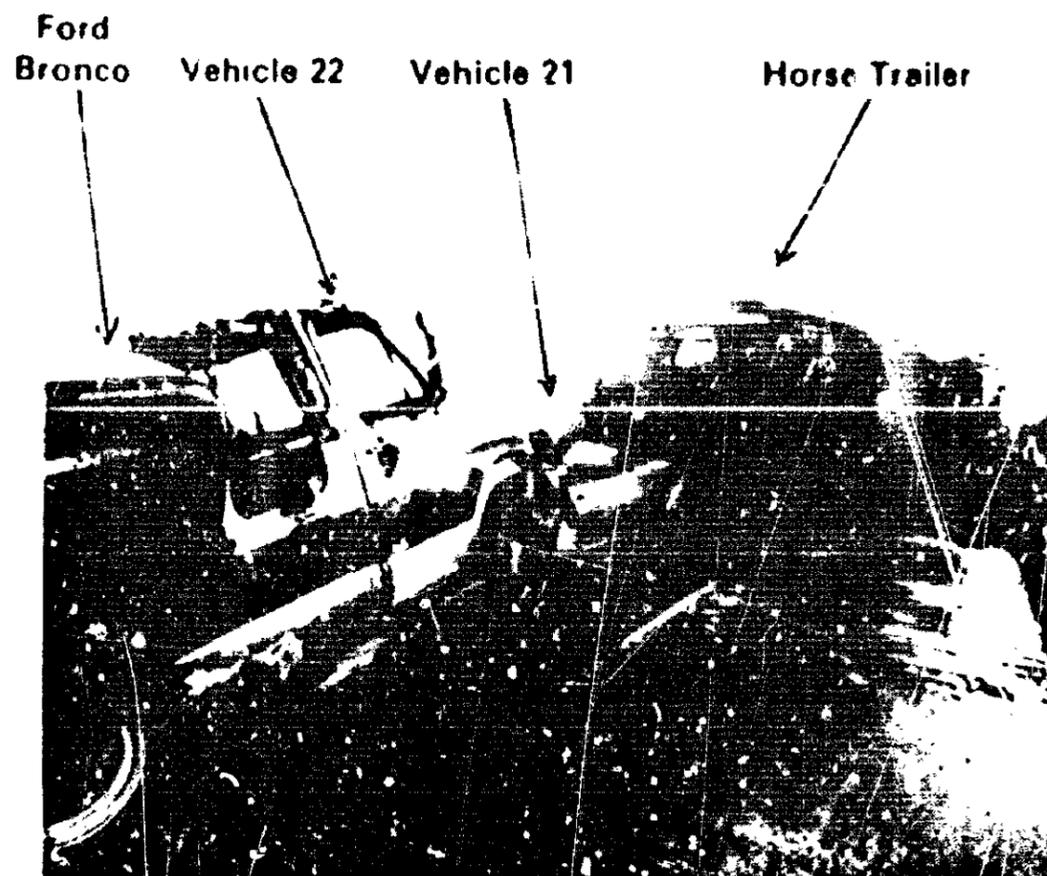


Figure 5.—Vehicles at rest in the curb lane.

Police, rescue personnel, and firefighting equipment responded to the accident scene about 10 minutes after the accident. All fires were extinguished within 2 hours. At least 49 vehicle occupants 3/ were involved in the accident; 4 persons died at the scene, 37 persons were injured, and 8 persons escaped injury. The injured persons were transported to three medical facilities in Ocala. Also, three rescuers, including an Ocala city police officer and two private citizens, were hospitalized with thermal burns received while attempting to extricate persons who were trapped in vehicles.

Because the southbound lanes of I-75 were closed for 4 1/2 hours, a large backup of traffic resulted. Traffic was rerouted by police and no other accidents were reported. All emergency services, including police, rescue, ambulance, firefighting, and hospital personnel were praised by those persons who were involved and who commented on the subject.

Injuries to Persons

<u>Injuries</u>	<u>Drivers</u>	<u>Passengers</u>	<u>Rescuers/Others</u>	<u>Total</u>
Fatal	3*	2	0	5
Nonfatal	15	21	3	39
None	3	5	0	8
Total	<u>21</u>	<u>28</u>	<u>3</u>	<u>52</u>

* The driver of vehicle No. 21 died 50 days after the accident as a result of injuries and burns sustained in the accident.

Vehicle Damage Information

Of the 21 identified vehicles involved in the accident, three were combination vehicles consisting of a 1977 Mack tractor towing a flatbed semitrailer loaded with lumber, a 1982 Chevrolet 1-ton crew-cab pickup truck towing a 36-foot horse trailer loaded with five horses (nine-horse capacity), and a 1981 Ford Centurion towing a 1981 Ford Bronco. The remaining vehicles consisted of 1 tow truck, 2 pickup trucks (1 standard size and 1 compact size), 3 station wagons, and 12 sedans. (See appendix B for more detailed vehicle and vehicle damage information.)

The postcrash examinations of the 21 vehicles did not reveal any mechanical defects which may have contributed to the accident. None of the drivers reported any vehicle malfunctions.

The underride protection device installed on the rear of vehicle No. 10 (the semitrailer) was damaged. The lower 6 inches of the device was rotated about 60° to 80° forward; however, the device prevented serious underride by those vehicles which struck the rear of the semitrailer.

Postcrash vehicle examination revealed breaches of the fuel tank systems on 12 vehicles (including the Ford Bronco, which was in tow) involving 14 fuel tanks (the 1982 Chevrolet 1-ton pickup truck was equipped with 3 fuel tanks). The following data were noted:

3/ Unidentified vehicles were not included in the count. Of the 21 identified vehicles, 3 contained 5 occupants each, 3 contained 3 occupants each, 10 contained 2 occupants each, and 5 vehicles had the driver as the sole occupant.

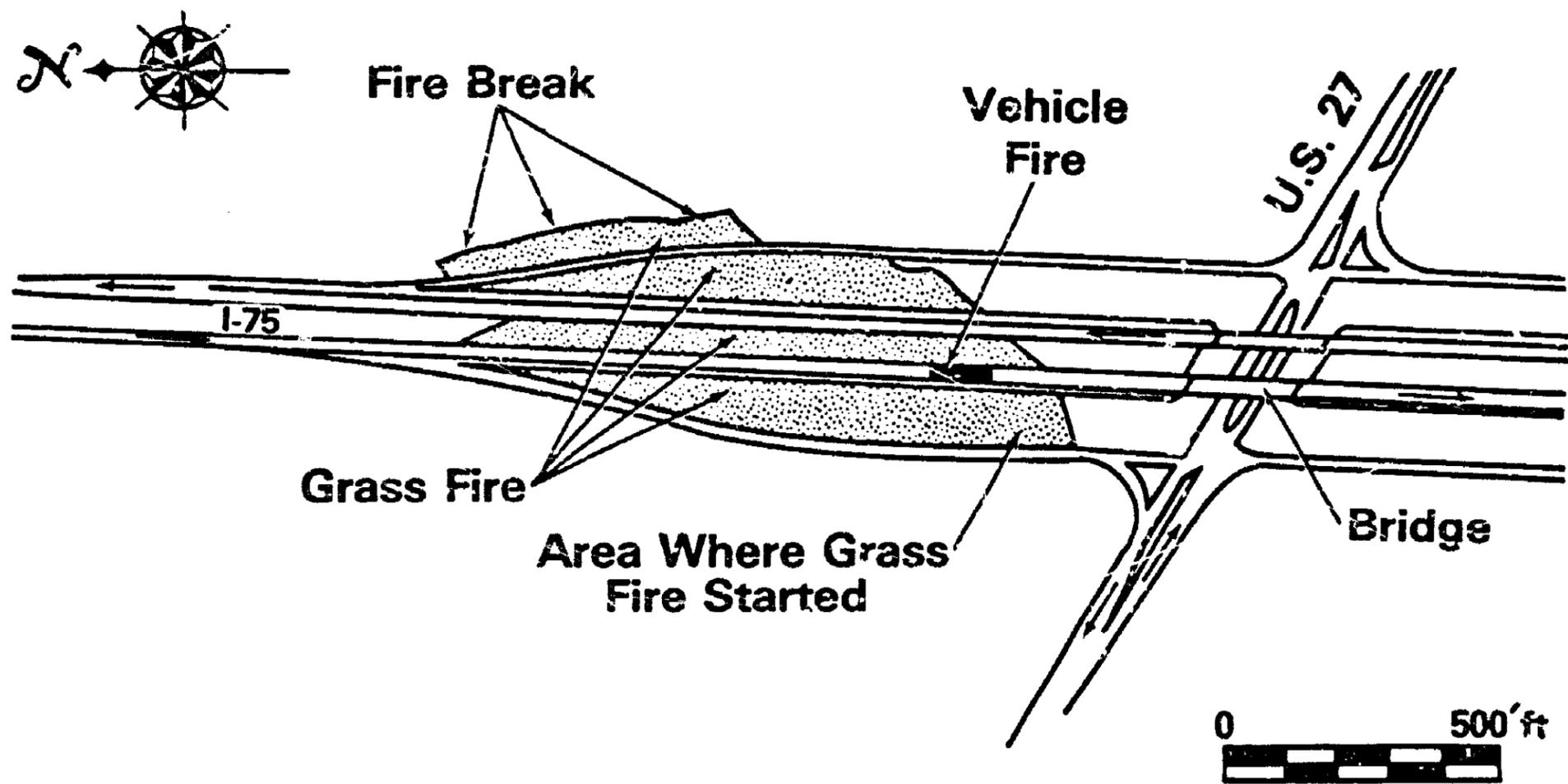


Figure 6.—Interchange and burn area.

<u>Mode of Breach</u>	<u>No. of Fuel Tanks Involved</u>
Hole in the fuel tank	1
Split in fuel tank system	1
Filler cap missing	4
Filler neck separated or loosened at tank	7
Rubber filler neck component burned away	3

*One tank had three different breaches.

All 14 fuel tanks were empty when inspected during the postcrash examination.

Driver Information

Ages of the 21 identified drivers ranged from 23 to 77 years of age. Most of the drivers were on vacation trips. Sixteen drivers were from out of State, and only one of the five Florida drivers resided in the Ocala area. Each driver held an operators or a chauffers license, which had been issued by the driver's respective home States/Province and were valid for the respective type of vehicle being driven. All holders of licenses with restrictions were in compliance with the restrictions. There was no indication of the involvement of alcohol or drugs in the accident.

The drivers had a clear view of the smoke cloud for over 2 miles before entering the smoke. Some drivers slowed to various speeds, while others entered the smoke at the highway posted speed limit (55 mph). The speed range at which drivers stated they entered the smoke is listed in the following tabulation:

<u>Speed Range (mph)</u>	<u>No. of Drivers 4/</u>
0 to 9	0
10 to 19	1
20 to 29	5
30 to 39	5
40 to 49	2
50 to 55	3
Unknown	5

Some drivers said that as they approached the smoke they were confused and did not know what to do but were concerned about stopping for fear of being struck from the rear. One driver stated that he changed from the curb to the median lane after he overheard a citizens band (CB) radio message warning of an accident in the curb lane at the south end of the smoke cloud. Other drivers stated that as they approached the smoke, it did not appear to be as dense as it actually was. Drivers estimated the range of visibility within the smoke cloud varied from two to three car-lengths to zero. Five drivers stated that, because of the dense smoke, they could not see what their respective vehicles struck. Four drivers saw stopped vehicles ahead and stopped short of a collision from the rear.

4/ Includes only the 21 identified drivers.

Highway Information

Interstate Route 75 is a divided, four-lane, north-south highway which is divided by a 55-foot-wide grass median. The accident occurred within a diamond interchange near milepost marker 353.6 about 0.5 mile south of the northern border of the city of Ocala, Florida. The impact zone ranged from 400 to 800 feet north of the U.S. 29 overpass. (See figure 7.)

The roadway at the accident site is on an embankment for the U.S. 29 overpass. Sideslopes on the hill are a 2:1 ratio. Commercial businesses border both sides of the highway right-of-way. The southbound roadway is constructed of asphalt pavement and consists of two 11.75-foot-wide travel lanes, a 4.5-foot-wide asphalt median shoulder, and a 9.83-foot-wide asphalt outside shoulder.

A 4-inch-high concrete curb borders the outside shoulder. A 28-inch-high steel W-beam guard rail, with 6.25-foot post spacing, is installed above the curb. Six 2-inch-wide rumble strips are located 675 feet before the overpass at intervals decreasing from 200 to 50 feet on the outside shoulder. The rumble strips extend from the edgeline to about 6 inches from the guardrail and are full width on the median shoulder. In the accident area, the southbound lanes ascended a 1.6 percent grade. The cross slope down toward the guardrail in the curb lane is 2.1 percent, and in the median lane is 0.65 percent.

Pavement markings consist of a solid yellow median edgeline and a solid white outside edgeline. Ten-foot dashed white lines located at 30-foot intervals separate the southbound lanes. Stimsonite Raised Reflective Markers are placed at 1-foot intervals from the end of each lane line. The last posted speed limit sign for southbound traffic before the accident site is located 3.4 miles north of the impact area; the sign bears the legend "SPEED LIMIT 55 MINIMUM 40." The average daily traffic (per 1981 count) is 29,000 vehicles per day, of which 14,520 is southbound.

Immediately south of U.S. 27, the grass on the west slope of the fill was dried and matted; when tufted up, it measured 12 to 13 inches long. A Florida Department of Transportation (FDOT) official stated that the grass in the accident area was last mowed in November 1982. He stated that it is the department's policy to mow grass at a 6-inch height to avoid hitting debris and that it is difficult to control mower height on the steep sideslopes of the fill.

The northbound roadway is parallel to and at the same grade as the southbound roadway. Its dimensions are similar to the southbound roadway. The collisions in the southbound lanes apparently did not materially affect the flow of the northbound traffic. The smoke being blown across the highway apparently diffused while crossing the southbound lanes and the median, and did not severely limit visibility for northbound drivers.

Accident history data furnished by the FDOT indicated that between 1977 and 1981, 57 accidents occurred within the 1.143-mile segment of I-75 which includes the interchange (including the exit and entrance ramps) and extends for about 0.25 mile north and south of the interchange. Of the 57 accidents, 21 resulted in injuries; however, there were no fatalities. None of these accidents occurred in smoke or fog.

Exit Ramp to US 29

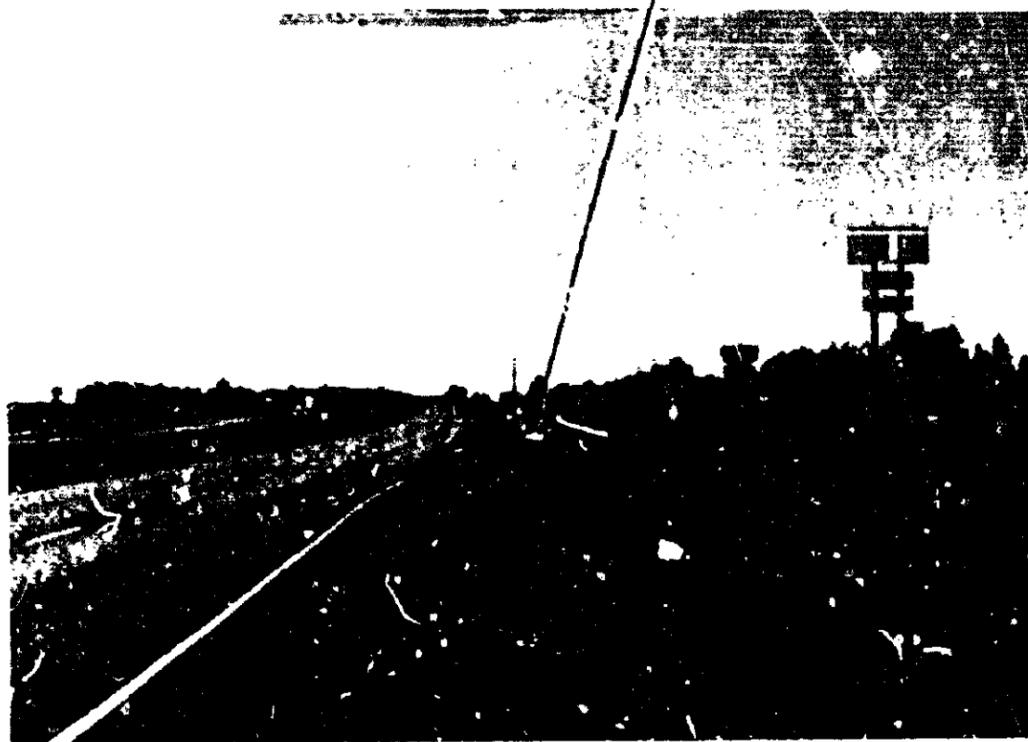


Figure 7.—Looking south on I-75 toward the overpass.

A postaccident inspection revealed that the highways appeared to be well maintained. Signs and markings were in good condition and clearly visible and, along with pavement skid resistance and highway appurtenances, conformed to the Manual on Uniform Traffic Control Devices (MUTCD) and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Gouges, tire marks, paint transfers, and burnt material were found on the guardrail extending intermittently from 416 to 781 feet north of the overpass. Tire marks and pavement chops/gouges were found on the outside shoulder over an area extending from 452 to 819 feet north of the overpass. The vehicle fire burn area on the southbound lanes pavement extended from 398 to 500 feet north of the overpass. All 14 burned vehicles came to rest within that area; the other vehicles which remained at the scene were stopped between the burn area and the overpass.

Photographs of the accident scene taken shortly after the accident showed several sets of skidmarks in the travel lanes which were not visible when the highway was inspected the next day. The combination of firefighting operations, cleanup operations, and postaccident traffic apparently eradicated those skidmarks. Final rest positions of the vehicles were marked by Florida Highway Patrol officers by using metal tags and nails which were driven into the pavement.

Meteorological information

The following weather observations were observed in the area on the day of the accident:

Weather observations recorded at 1:52 p.m. at the Ocala Municipal Airport, about 3.6 miles southwest of the accident site, reported the weather as mostly cloudy with 7 miles visibility, temperature 62° F, dewpoint 55° F, and wind out of the south southwest (200°) at 17 mph gusting to 28 mph. In the 12:48 p.m. observation, light rain had been reported.

The Gainesville airport, 34 miles north of the accident site, reported intermittent light rain beginning at 6:50 a.m. and ending at 1:06 p.m. The Orlando airport, 73 miles southeast of the accident site reported intermittent light rain between 7:50 a.m. and 1:35 p.m.

The Ocala Water Treatment Plant, located 5.4 miles east of the accident site, recorded a maximum temperature of 75° F and a minimum temperature of 59° F. At 5:00 p.m. the temperature was recorded at 69° F. The Water Treatment Plant reported precipitation as follows:

<u>Date</u>	<u>Precipitation (inches)</u>
2-16-83	0.23
2-17-83	0.21
2-22-83	0.12
2-23-83	0.01
2-27-83	Trace
2-28-83	0.08

Weather observations recorded at the Florida Division of Forestry station, located 5 miles east of the accident site, show the 3 p.m. temperature at 75° F and the relative humidity at 55 percent. The Division of Forestry reported that instruments used in recording temperatures and relative humidity at the Ocala Municipal Airport were malfunctioning. The Division of Forestry readings were more compatible with other readings in the area. The wind direction and velocity reported by the Ocala Airport appeared to be accurate and agreed with readings of the Forest Service and observations by witnesses.

Medical and Pathological Information

There were no reports or indications of any pathological disorders which might have adversely affected the driving ability of any of the involved drivers.

Four of the five fatalities died at the accident scene. The coroner's reports indicated that three persons died from impact trauma and that one person died from thermal burns. The fifth fatality died 50 days after the accident from complications secondary to thermal burns received in the accident. (See appendix C for injury details).

Survival Aspects

According to available evidence, all 21 identified vehicles were equipped with occupants restraints. However, only 13 (26.5 percent) occupants were determined to have been wearing occupant restraints at the times of the collisions. Fire damage precluded positive determination of restraint usage for two fatalities.

Two persons in vehicle No. 17 were killed when their vehicle was overridden by vehicle No. 21 and both vehicles burned. Two persons were killed in vehicle No. 13 which received a severe penetrating impact into the driver's door and burned.

Most of the involved persons either exited their vehicles unassisted; some were assisted from their respective vehicles by other vehicle occupants or by passersby who stopped to assist. (See appendix D.) Occupants then moved out of the smoke cloud and into the median or off to the west side of the highway away from the grass fire. Some occupants went to the north end of the smoke to warn other vehicles. Police and rescue personnel at the scene assisted in treating the more seriously injured occupants and attempted to rescue those occupants trapped in vehicles.

Other Information

Federal Standards.--Federal Motor Vehicle Safety Standard (FMVSS) 301, Fuel System Integrity, was initially promulgated in January 1968 by the National Highway Traffic Safety Administration (NHTSA). The purpose of the standard was to reduce the number of deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes. The original standard applied only to passenger cars produced after January 1968 and addressed fuel spillage as a result of impacts from a frontal direction only. Test criteria prescribed a 30-mph impact velocity and no fuel loss in excess of 1 ounce per minute.

An upgraded version of the standard, FMVSS 301-75, effective September 1975, expanded vehicle coverage to include light trucks, light multipurpose vehicles, light buses, and schoolbuses, in addition to all passenger cars. Impact coverage was extended to include rollover, rear end, side, and frontal impacts. Test criteria prescribed a 30-mph impact velocity for frontal, oblique, and rear impacts, and a 20-mph impact velocity for lateral (side) impacts, all with static rollover. Fluid loss was not to exceed 5 ounces of fuel in 5 minutes.

In 1979, the NHTSA began an experimental crash test program (New Car Assessment Program) to determine which passenger cars could exceed the 30-mph standard. The passenger cars were crashed into a concrete barrier at 35 mph, which is similar to two identical passenger cars crashing head-on, each traveling at 35 mph. At 35 mph, a crash is 36 percent more severe than the same crash conducted at 30 mph.

Preliminary results on the NHTSA experimental crash program indicate that, although there are significant differences in the ability of passenger cars to protect their occupants, most new passenger cars can meet the requirements of FMVSS 301-75 at 35 mph. In 1983, the program was expanded to include limited testing of multipurpose vehicles, such as vans and light trucks. Currently, no data is available on large commercial vehicles, such as trucks and buses over 10,000 GVWR.

Investigation of Grass Fire.--An investigator from the Florida Division of Forestry conducted a postaccident investigation into the origin and cause of the grass fire at the accident scene. Weather factors which were considered included the relative humidity (55 percent), temperature (75° F), and wind speed/direction (17 mph gusting to 28 mph from 200°). The investigation determined that the major fuel source for the grass fire was dead Bahia Grass. Some accumulation of dead grass due to mowing was found on the ground, with the highest accumulation being on the 2:1 slope next to the southbound lanes of I-75. The dead grass next to the soil normally would be higher in moisture content than the dead grass on top.

Based on the conditions that were present at the time of the fire, a spread index 5/ of 25 (very high) was calculated using wind speed and relative humidity. A build-up index 6/ of 30 (moderate) was calculated using the relative humidity and the recent history of precipitation in the area.

The Florida Division of Forestry investigator determined that the fire probably started within 40 feet east of the southbound exit ramp to U.S. 27 and between 280 and 320 feet north of U.S. 27, that the fire spread rapidly in the north-northeast direction, and that the high wind and steep side slope contributed to the rapidity with which the fire spread. Generally, the faster a fire spreads, the more incompletely the fuel is consumed. Incomplete fuel consumption produced in this case a greater amount of particulate matter which, in turn, contributed to increased smoke density and reduced visibility. The dead grass with a higher moisture content also contributed to the generation of the smoke. The wind then carried the dense smoke across the southbound lanes of I-75.

Several possible causes of the grass fire, including a smoldering cigarette, a lighted match thrown from a vehicle, a glowing ember from open burning in the area, fireworks, burning carbon particles from a vehicle exhaust system, catalytic converters, low hanging or dragging exhaust system components, chains or metal object dragging from a moving vehicle and generating sparks, a vehicle running on a flat tire, and an incendiary set, were considered. Existing weather related conditions, the short, sparse condition of the grass adjacent to the exit ramp, and other considerations set most of the possible causes at a low probability. The Florida Division of Forestry investigator stated that "under the particular conditions the day of the fire, one of the most likely sources of sufficient heat to ignite the dead Bahia grass was burning carbon particles from the exhaust system of a vehicle." Carbon particles accumulate in the exhaust system and are forcibly expelled when a vehicle is being geared down or accelerated rapidly. Studies 7/ have shown that carbon particles can be emitted from an exhaust system at 1000° F to 1200° F and are often well above the ignition temperature of dry grass, leaves, or pine needles (500° F to 700° F) when they reach ground level. The investigation, however, could not definitely establish the cause of the grass fires.

The grass fires, which burned in the highway median and on the east side of I-75, resulted from the vehicle fires in the southbound lanes.

ANALYSIS

The Accident

The facts developed in the accident investigation showed that a fire ignited by an undetermined source began in the gore area on the west side of I-75 and produced thick smoke which was blown across the southbound lanes of I-75. The smoke variably reduced visibility for a 200- to 300-foot stretch of highway from near zero to about 40 to 60 feet. Approaching drivers had a clear view of the smoke cloud for over 2 miles before entering the smoke, but they responded with different reactions and drove into and through the cloud in a wide range of speeds. The wide speed differentials combined with the severely

5/ A measurement of how easily fires will start and how rapidly they will spread.

6/ A measure of dryness (or wetness) of fuel other than the fine, flashy fuels.

7/ Industrial Operations Fire Prevention Field Guide, California Department of Forestry, United States Forest Service, United States Bureau of Land Management, 1980.

restricted visibility and the existing traffic volume made it likely that collisions would occur. These factors have been at the heart of virtually all restricted visibility, chain reaction accidents occurring on high speed highways that have been investigated by the Safety Board.

During the sequence of collisions which followed, 9 of the 22 involved vehicles were subjected to underride/override. This collision characteristic contributed to jamming of vehicle doors and to a breach in 14 vehicle fuel tanks. Jammed doors increased the difficulty of, and delayed, escape from nine of the involved vehicles. At least seven fuel tanks were breached as a result of collision forces. Fire damage also caused some fuel system failures. Fuel released from breached fuel systems was instantaneously ignited and a massive fire ensued. Thermal burns caused two fatalities, injury to one vehicle occupant, and injuries to at least three rescuers.

Highway and Weather Role

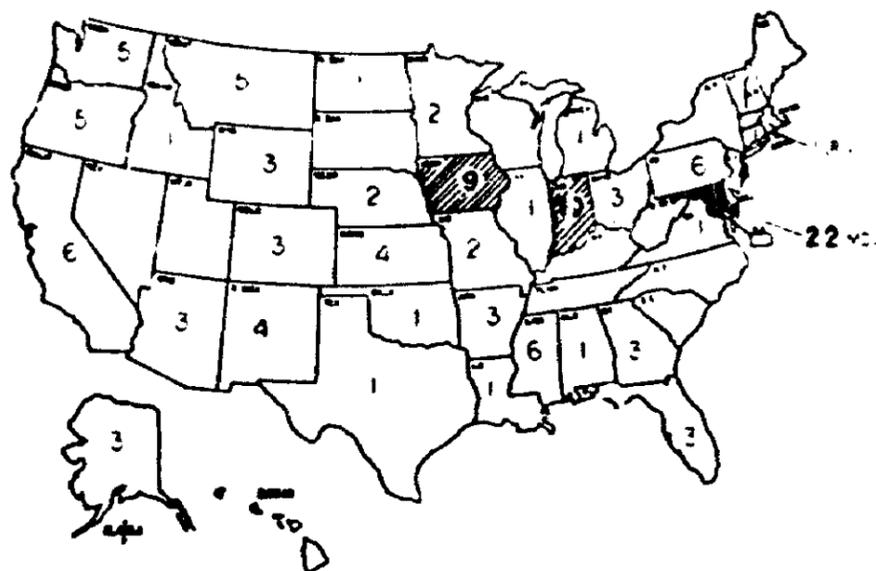
The roadway surface, barriers, signing, and delineation were maintained properly and were in good condition before the accident. Although these items were not factors in the accident, the presence of the guardrail restricted the distance that vehicles could be driven off the road to the right. However, due to the slope of the fill embankment, the guardrail was warranted. The shoulder was wide enough to allow vehicles to stop off the travel lanes. None of the involved drivers mentioned driving onto the shoulder, but physical evidence found on the shoulder pavement and the guardrail indicated that some collisions occurred while vehicles were fully on the shoulder. Apparently, some drivers drove onto the shoulder without realizing they had done so.

The grass fire, which was ignited by an undetermined source, was fueled by dead Bahia grass. The conditions of the weather, terrain, and grass, as indicated by the Florida Division of Forestry investigation, were conducive to a rapid spread of the fire and heavy persistent smoke. After the grass fire was ignited, it was fanned by high winds (17 mph gusting to 28 mph) and spread to the base of the 2:1 fill slope. Most of the dead, mowed grass was on the slope and the uphill slope contributed to the rate at which the fire spread. A Fire Staff Officer from the Alabama Forestry Commission calculated that once the grass fire began to burn up the slope, the rate of spread likely increased to about 0.98 to 2.4 miles per hour (1.4 to 3.5 feet per second). Incomplete burning grass, which generated smoke rapidly and increased amounts of particulate matter which increased smoke density, limited visibility as the smoke was blown across the southbound lanes of I-75.

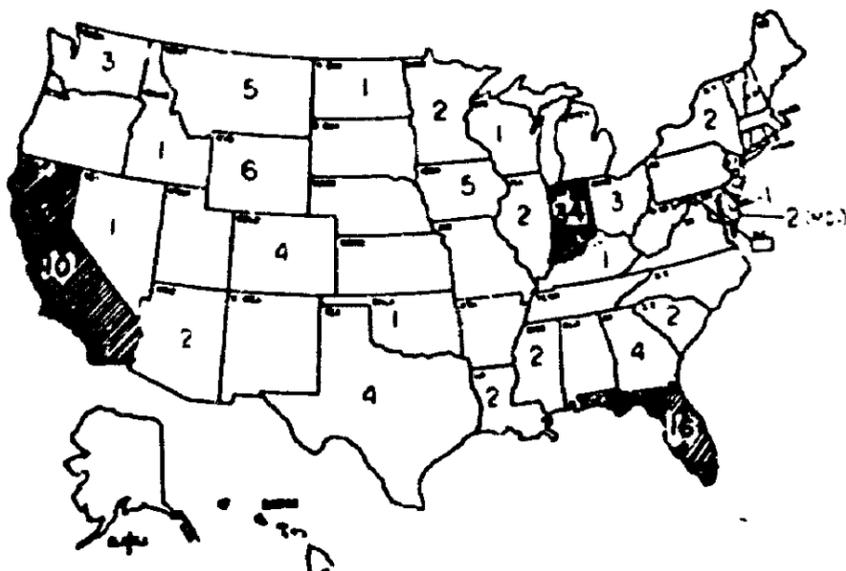
In many locations throughout the United States where reduced visibility conditions (due to smoke, fog, blowing snow, or dust) can be anticipated, such countermeasures as fixed and variable warning signs and high visibility pavement markings have been installed. However, such countermeasures are not warranted at the accident site. There was no recent history of smoke-related accidents in the accident area, and thus, there was no reason to anticipate a traffic problem caused by grass fires. Other alternatives, such as killing the grass and covering the area with gravel or pavement, probably would not be economically feasible or environmentally acceptable.

Limited Visibility—Operation and Education

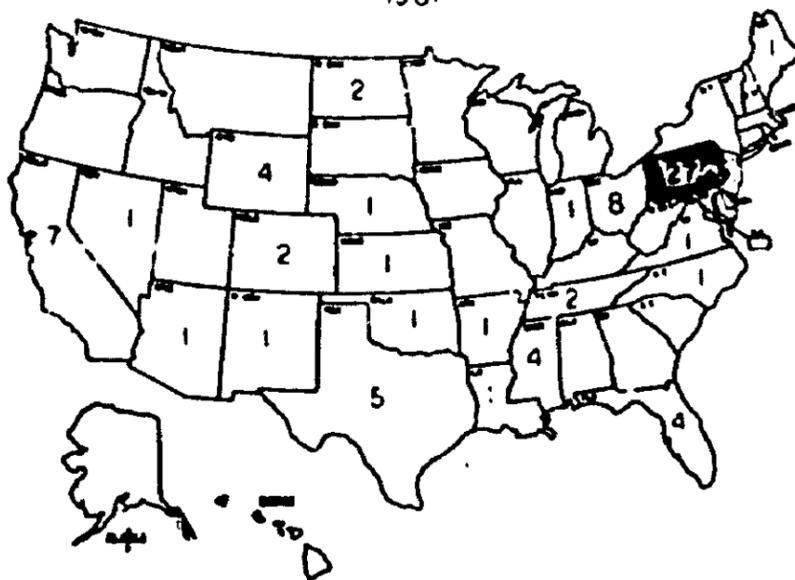
According to Fatal Accident Reporting System (FARS) data, fatal accidents involving weather conditions coded as smog, smoke, blowing sand, or dust result in about 145 fatalities each year. (See figure 8.) FARS data indicate that between 1 and 2 percent



1960



1981



1982-NOT COMPLETE

Figure 8.--Fatal accidents involving weather conditions coded as smog, smoke, blowing sand or dust.

of all fatal accidents occur because drivers encounter limited visibility driving situations. No data are available with regard to nonfatal accidents. While the problem of reduced visibility is not statistically as great as other highway safety problems, during the last 16 years, the Safety Board has investigated 10 such accidents which involved over 220 vehicles and resulted in 44 fatalities and injuries to 251 persons. (See appendix E.)

Cost and technical problems make it impractical to design and install highway features on a very extensive basis which could protect motorists from involvement in accidents in reduced visibility driving conditions. The wide variety of assumptions and decisions and actions taken by drivers confronted by the smoke in the February 28, 1983, accident demonstrate that the problem is largely one of driver education. Motorists should be aware that fire can spread rapidly and produce smoke of varying density. An awareness of the hazards could encourage more defensive driving practices and a more uniform response from drivers approaching conditions, such as smoke, which limit visibility.

The Safety Board reviewed the most recent driver manuals of 18 States and 3 of the most commonly used textbooks in school driver education programs. Little information was available in the publications about proper actions drivers should take when confronted with smoke conditions on the roadway. The information, or lack of information, presented in the publications fell within the following categories:

- (1) No mention of driving in limited visibility conditions.
- (2) Only limited mention of driving in limited visibility, the need for using low beam headlights, and speed reduction below the speed limit when conditions warrant.
- (3) An extensive treatment of driving in limited visibility conditions caused by smog, fog, heavy rain, sleet, or snow. Motorists are encouraged to slow down and pull off the road. Conditions are severely restrictive. Florida includes "Smoke" in the title of the subject area, but does not discuss the issue.

South Carolina's Driver's Guide states under its "What to Do If?" section that:

Smoke: You notice that just ahead of you the road is obscured by heavy smoke. If you are not sure how dense the smoke is, reduce your speed immediately, drive as far as possible to the right and stop off the roadway. Then determine if it is safe to continue.

Certain types of smoke if inhaled can irritate your lungs and eyes. Inhaling smoke from chemical fires can be fatal.

If you suddenly enter smoke and it is very heavy immediately turn on your low beam headlights, signal for a right turn and get as far off the traveled portion of the roadway as you can. Then turn on your emergency flashers.

On a freeway, you may need to get onto the grassy portion of the shoulder and stop. If this is the case, after you have stopped get yourself and all passengers out of the vehicle and move back in the direction from which you were traveling so that you can warn other drivers of the impending danger.

If possible, notify the Highway Patrol or other responsible police agency. Never stop on the traveled portion of the freeway or roadway or abandon your car. This could cause other drivers to crash into your vehicle.

With the exception of South Carolina's driver manual, it appears that State driver manuals and driver education textbooks materials typically have not discussed what actions motorists should take when smoke is encountered. The Safety Board believes that there is a need to educate the motoring public concerning the properties and density characteristics of smoke as stated in the South Carolina Driver's Guide above, and to recommend actions to be taken when a motor vehicle driver encounters smoke.

Survivability — Escape from Vehicles

Autopsy reports of the four fatalities at the accident scene indicated that three fatalities resulted from trauma and that one fatality resulted from thermal burns. It could not be determined whether or not the thermal burn victim had attempted to exit the vehicle or was incapacitated by trauma. Witnesses and rescuers reported that the fifth fatality, who died 50 days after the accident, had exited his vehicle but was then overtaken by flaming gasoline which was flowing downgrade along the south edge of the southbound lanes.

Nine vehicles were subjected to doors jamming, which increased the difficulty of escape and delayed the egress of the vehicle occupants. However, in most cases, the vehicle occupants escaped before the vehicles caught fire. Some of the occupants sustained minor cuts from glass while climbing out through windows. However, there is no indication the door jamming materially contributed to injury severity in this accident.

Thirteen (26.5 percent) of the 49 identified vehicle occupants were using restraints at the time of the accident. A review of injury data showed that 10 of those 13 persons sustained minor (AIS-1) or moderate (AIS-2) injuries. (See appendix C.) Three persons were not injured. The 9 vehicles in which the 13 restrained occupants were riding were subjected to multiple and, in some instances, severe impacts. The Safety Board believes that the use of restraints probably reduced the severity of injuries sustained by those 13 occupants.

Twenty-three occupants were unrestrained and suffered no injuries or moderate injuries (AIS 0 to AIS 2). Two occupants suffered severe injuries (AIS 3).

Fuel System Integrity

The Safety Board has promulgated a number of recommendations to improve motor vehicle fuel system integrity. In April 1971, the Safety Board recommended that the National Highway Traffic Safety Administration (NHTSA) and the Automobile Manufacturers Association (now the Motor Vehicle Manufacturers Association (MVMA)) initiate programs leading to the development of automotive fuel tank systems which will minimize the escape of fuel in collisions (Safety Recommendation H-71-20). In August

1972, the Safety Board recommended that the NHTSA extend its proposed rulemaking on FMVSS to include standards for the fuel retention integrity of all components of the fuel system which are subject to damage and subsequent spillage of fuel (Safety Recommendation H-72-19).

As a result of Safety Recommendations H-71-20 and H-72-19, test criteria prescribing the maximum rates of fuel loss were included in FMVSS 301-75. In January 1983, the NHTSA released a technical report ^{8/} which estimated that FMVSS 301-75 resulted in annual savings, or benefits of: (1) 400 fewer fatalities, (2) 520 fewer serious injuries, (3) 110 fewer moderate injuries, and (4) 6,500 fewer passenger car crash fires. The report included a cost-benefit ratio and found that 47 fatalities, 61 serious injuries, 13 moderate injuries, and 762 crash fires were avoided for each \$10 million expended to comply with the standard. It was further noted in the report that:

Although significantly lower crash fire rates have been found for poststandard vehicles, there is some indication that the fire rate may be increasing slightly in newer vehicles. This is a preliminary finding and reasons for it are not clear. It does suggest, however, that the agency continue to monitor the phenomenon of motor vehicle crash fires.

The FARS data do not indicate a significant decrease in fatalities resulting from accidents involving fire. In 1980, fire was present in 1,720 (2.71 percent) of the 63,485 vehicles involved in fatal accidents; in 1981, fire was present in 1,809 (2.89 percent) of the 62,666 vehicles involved in fatal accidents; and in 1982, fire was present in 1,521 (2.7 percent) of the 56,190 vehicles involved in fatal accidents.

The American Medical Association (AMA) also has expressed its concern about fuel fire in motor vehicles. In June 1982 at the AMA's Annual Meeting, the House of Delegates adopted a new policy on the use of technology to prevent explosions in the following resolutions:

RESOLVED, That the American Medical Association endorse the use of available technology to reduce the number of volatile liquid and gas container explosions which occur, and thereby reduce the amount of pain and suffering due to burns caused by these explosions; and be it further

RESOLVED, That the AMA encourage manufacturers of automobiles, boats and other vehicles, as well as makers of containers of volatile liquids and gases, to incorporate appropriate safety technology into the development of their products.

Seven of the twelve vehicles on which fuel systems were breached during impact in the February 28, 1983, accident ranged from 1975 to 1982 year models (1975 Ford Elite, 1978 Ford LTD, 1979 Chevrolet Caprice, 1980 Chevrolet Malibu, 1981 AMC Spirit, 1981 Oldsmobile Omega, and 1982 Chevrolet C-30 crew cab pickup truck), all manufactured after the effective date of FMVSS 301-75. Four of these seven vehicles had been struck from the rear by vehicles traveling in excess of 30 mph (30, 50, 50, 45, 25, 25, and

^{8/} Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars, U.S. Department of Transportation, National Highway Traffic Safety Administration, DOT HS-806-335, January 1983.

45 mph). These four were overridden by the striking vehicles. Postcrash examination of the vehicles suffering severe fire damage revealed that twelve had empty fuel tanks; that fuel filler pipe caps were missing; and that whatever fuel had been in the tanks before the accident had either leaked out or had evaporated because of the heat from the fire. These conditions do not reflect the test requirements of FMVSS 301.75, which require that vehicles be crashed either forward or rearward into a flat barrier at 30 mph.

Based on its accident investigation experience, the Safety Board believes that a vehicle fuel system's ability to withstand 30-mph collisions with minimal fuel spillage provides only a limited margin of safety, especially since many collision speed differentials in the "real-world" exceed 30 mph. In this accident, the speeds of the vehicles entering the dense smoke area ranged from 5 to 55 mph, and in many of the collisions, speed differentials probably exceeded the 30-mph performance requirement specified in FMVSS 301-75.

Although the Safety Board acknowledges the benefits derived from FMVSS 301-75, it believes that further improvements might be achieved by upgrading the performance requirements of FMVSS 301-75. Therefore, the Safety Board will continue to investigate this safety issue in future accidents. In the interim, the Safety Board believes that the MVMA should encourage motor vehicle manufacturers to develop and apply better technology in the design, engineering, placement in the vehicle, and protection of fuel system components to prevent, to the extent practical, their being damaged during collisions involving higher speed differentials and thereby prevent substantial fuel spillage.

CONCLUSIONS

Findings

1. The design, construction, and maintenance of the highway did not contribute to this accident.
2. The mechanical condition of the vehicles involved in the accident did not contribute to the accident.
3. A fire, ignited by an undetermined source, began in the gore area between the southbound lanes of I-75 and the southbound exit ramp to U.S. 29. Dead Bahia grass and an accumulation of dead, mowed grass fueled the fire.
4. Weather conditions days before the accident increased the moisture content of the grass. Grass conditions were conducive to rapid spread of fire and the production of heavy persistent smoke.
5. High winds blew the smoke across the southbound lanes of I-75, reducing visibility within a 200- to 300-foot section of the highway. Visibility within the smoke ranged from zero to about 60 feet.
6. The smoke was clearly visible for over 2 miles, and approaching drivers had adequate forewarning of its presence.
7. Because there was no recent history of smoke in the area and no reason to expect a grass fire, protective countermeasures for limited visibility conditions were not warranted.

8. Involved drivers responded with diverse assumptions, decisions, and reactions as they approached the smoke.
9. Vehicles were driven into and through the smoke at speeds ranging between 5 and 55 mph.
10. During the collision sequence, nine vehicles were subjected to underride/overside impact dynamics.
11. Doors were jammed on nine vehicles, but, because alternate means of escape were affected, door jamming did not materially increase the injury severity of the accident.
12. Fourteen vehicle fuel tanks were breached during the accident. At least seven fuel tanks were breached as a result of vehicle impacts.
13. Vehicle fires resulting from fuel spillage caused two fatalities, serious injuries to three persons, minor injury to one person, and substantial loss of property.
14. The use of occupant restraints by 13 (26.5 percent) of the 49 vehicle occupants probably reduced the severity of their injuries.
15. Little information is contained in driver education textbooks, State driver manuals, or defensive driving course materials to instruct drivers the proper action when confronted by smoke.
16. Motorist need more education on the variable properties of smoke and defensive driving strategy when encountering smoke on the highway.
17. FMVSS 301-75 has produced significant benefits in preventing the loss of life, injuries, and property loss, but the incidence of vehicle fires is increasing and should be given more attention.
18. Technology which would improve vehicle fuel system integrity exists and should be employed in the design, engineering, positioning, and protection of motor vehicle fuel systems.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of most of the involved drivers to exercise proper judgment and due caution when confronted by a cloud of dense smoke blanketing the highway. Contributing to the accident was the extremely limited visibility within the smoke cloud and the widely varying speeds at which different vehicles entered and were being driven through the smoke cloud. Contributing to the severity of the accident was the breach of fuel system integrity in a number of vehicles and the resultant vehicle fires.

RECOMMENDATIONS

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

—to the National Safety Council:

Develop and include in the Safety Council's driver training textbooks and defensive driving training programs advice, such as appears in the South Carolina Driver's Guide, as to the hazards presented by highways blanketed with smoke and what actions the motorists should take if they are suddenly confronted with such a situation. (Class II, Priority Action) (H-84-01)

—to the American Association of Motor Vehicle Administrators:

Urge its members to develop and include in their own State Driver Manuals advice, such as appears in South Carolina State Driver's Guide, concerning the hazards presented by highways blanketed with smoke and what actions the motorists should take if they are suddenly confronted with such a situation. (Class II, Priority Action) (H-84-02)

—to the Motor Vehicle Manufacturers Association:

Review current state-of-the-art technology related to motor vehicle fuel systems and determine which elements of that technology might be used in the design, engineering, placement in the vehicle, and protection of fuel system components to reduce breaches of the fuel system and to minimize fuel spillage if the fuel system is breached. Consider high-speed impacts and underride/override impact dynamics in selecting effective countermeasures. (Class II, Priority Action) (H-84-03)

After selecting the technology to enhance fuel system integrity, strongly encourage all Association members to employ that technology in the manufacture of motor vehicles. (Class II, Priority Action) (H-84-04)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ G. H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

GOLDMAN, Vice Chairman, and McADAMS, Member, did not participate.

October 18, 1983

APPENDIXES

APPENDIX A

INVESTIGATION

1. Investigation

The National Transportation Safety Board was notified of the accident at 8 a.m. on March 1, 1983. The investigator-in-charge from Safety Board headquarters was dispatched to the scene and arrived at 11:50 p.m. the same day. On March 6, 1983, a highway/environment engineer from the Safety Board's headquarters joined the on-scene investigation. Representatives from the Florida Highway Patrol, the Florida Department of Transportation, and the Florida Division of Forestry participated in the investigation. The Motor Vehicle Manufacturers Association was a party to the investigation.

2. Deposition/Hearing

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

APPENDIX B

VEHICLE AND DAMAGE DESCRIPTIONS

Vehicle No. 1, a brown 1978 Pontiac Grand Safari 4-door station wagon, VIN 2N35X8X150416, was registered in Michigan. The odometer read 73,807 miles. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. Vehicle No. 1 was being driven in the curb lane at a driver estimated speed of 45 mph. The driver said she could not see what she hit. The front of vehicle 1 impacted the rear of vehicle No. 2 when it was near the south end of the smoke cloud. Vehicle No. 1 then moved into the median lane, stopped, and was struck in the right rear by vehicle No. 3.

Frontal crush to vehicle No. 1 was about 5 inches. The front bumper was skewed and rotated downward, the grill was broken out and the headlight gates were deformed. The windshield cracked as a result of two headstrikes. The leading edge of both front doors were buckled as the result of being forced open. The right rear bumper sustained minor damage with induced damage going into the quarter panel. There was no burn damage, and the fuel system maintained its integrity.

Vehicle No. 2, a brown 1978 Oldsmobile Cutlass Supreme 2-door sedan, VIN 3R47F82403043, was registered in Pennsylvania. The odometer read 28,573 miles. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. Vehicle No. 2 was traveling in the curb lane at a driver estimated speed of 50 mph. The driver said she slowed to about 45 mph after entering the smoke. Vehicle No. 2 was struck from the rear by vehicle No. 1 while in the curb lane, traveled into the median lane with vehicle 1 still in contact, disengaged when vehicle No. 1 stopped, veered left into the median, and stopped facing south near the center of the median.

Rear crush to the vehicle was about 6 inches at the rear bumper and about 17 inches into the deck lid. Both quarter panels were buckled to the respective C-pillars and the right door was jammed shut. There was no burn damage and, although the filler neck was bent, it was intact. The fuel system maintained its integrity.

Vehicle No. 3, a yellow 1976 Buick LeSabre 2-door sedan, VIN 4P37Y7H433473, was registered in Ontario Province, Canada. The odometer read 49,454 miles. The vehicle was equipped with an automatic transmission, power assisted steering and power assisted front-disc, rear-drum brakes. The driver of vehicle No. 3 said that he was traveling through the smoke at "a slow rate." Vehicle No. 3 was in the median lane when its front struck the right rear of vehicle No. 1 which was stopped in that lane. Vehicle No. 3 then stopped in the median lane and was struck from the rear by vehicle No. 4. Vehicle No. 3 was driven from the scene southbound on I-75, but was later identified.

The front bumper rotated downward, the grill broke, and the windshield cracked on the passenger side. A small dent was found in the right center rear bumper, and the right rear bumper was displaced forward. There was no burn damage and the fuel system maintained its integrity.

Vehicle No. 4, a white 1982 Buick Park Avenue 4-door sedan, VIN 1G4AW694XCH471473, was registered in Ohio. The odometer read 16,049 miles. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. Vehicle No. 4, which was traveling in the median

lane, was struck in the left rear by vehicle No. 6. Vehicle No. 4 moved forward and partially into the curb lane, and its left front struck the rear of vehicle No. 3. Vehicle No. 5 struck (sideswiped) the right side of vehicle No. 4 after it had come to rest.

About 9 1/2 inches forward crush was found at the left rear corner with about 19 inches lateral contact. Minor scraping damage was found along the right side extending from about the midpoint of the right rear wheelwell forward to and including the wraparound portion of the front bumper. Blue paint transfers were found around the right front wheelwell. Minor damage was found in the left headlight area. There was no burn damage and the fuel system maintained its integrity.

Vehicle No. 5 was an unidentified, hit-and-run vehicle. After sideswiping vehicle No. 4, the vehicle continued southbound on I-75.

Vehicle No. 6, a green and white 1977 Chevrolet, Scottsdale 10, pickup truck, VIN CCU147B134593, was registered in Georgia. The odometer read 15,110 miles. The truck was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear drum brakes. The driver said he saw the smoke and slowed to about 30 to 35 mph as he entered the smoke. Vehicle No. 6 was traveling in the median lane when its right front struck vehicle No. 4. The truck moved forward, rotated about 50° clockwise, and stopped, blocking the median lane and part of the curb lane. It was later struck in its forward right side by vehicle No. 7.

Contact damage extended 17 1/2 inches left from the right front corner. About 11 inches rearward crush was found at the corner. The right front fender was buckled and induced damage extended into the right door. Cracks were found in the upper right and center windshield from occupant head strikes. There was no burn damage and the fuel system maintained its integrity.

Vehicle No. 7, a red and white 1979 Ford F350 Ranger tow truck, VIN F37SCDF2293, was registered in Florida. The odometer read 73,366 miles. The truck was equipped with a 4-speed manual transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The tow truck was traveling southbound in the median lane and entered the smoke at a driver stated speed of 15 to 20 mph. The driver saw vehicle No. 6 crossways in the lane and stopped. Vehicle No. 8 stopped behind vehicle No. 7, but was struck from the rear by vehicle 9 and pushed into the rear of the tow truck. The tow truck moved forward and to the right and its left front corner contacted vehicle No. 6.

The tow truck had minor damage to the rear and to the left front bumper. There was no burn damage and the fuel system maintained its integrity.

Vehicle No. 8, a gray 1983 Buick LeSabre Limited 4-door sedan, VIN 1G4AP69Y4DX401467, was registered in Florida. The odometer read 7,149 miles. The vehicle was equipped with an automatic transmission, power assisted steering and power assisted front-disc, rear-drum brakes. Vehicle No. 8 followed vehicle No. 7 into the smoke at a driver estimated speed of 25 mph. The driver saw the stopped tow truck and stopped his vehicle about 2 feet behind the tow truck. Vehicle No. 8 was struck from the rear by vehicle No. 9 and pushed forward into vehicle No. 7. Vehicle No. 10 then struck the rear of vehicle No. 9, forcing that vehicle to override the rear of vehicle No. 8. Vehicle No. 8 came to rest in the median lane with the front of vehicle No. 9 resting on the trunk area of the Buick.

Minor impact damage was found on the right front with a towing hitch ball imprint and a puncture in the front bumper. Rear contact damage extended 45 inches left from the right rear corner and held blue paint transfers. Contact override damage extended to the right C-pillar with induced damage to the left C-pillar. The roof was buckled and induced damage displaced the right A-pillar. Stress cracking was found on the windshield. Burn damage involved only the left quarter panel, left rear wheel, left C-pillar, rear edge of the left rear door, and left side of the deck lid. The fuel system maintained its integrity. (See figure 9.)

Vehicle No. 9, a blue 1981 Oldsmobile Omega 4-door sedan, VIN 1G3AE6958BW134892, was registered in Massachusetts. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the curb lane when the driver heard a CB report of an accident in that lane just south of the smoke. He moved into the median lane and entered the smoke in "the 30 mph range." The driver stated that he could see the smoke from about 0.75 mile away. The driver estimated that about 1 to 2 seconds after entering the smoke, his vehicle struck something (vehicle No. 8) that he could not see. As the occupants were trying to exit the vehicle, vehicle No. 10 struck and overrode the rear of vehicle No. 9, causing it to override the rear of vehicle 8.

Damage was found across the entire front with about 5 inches crush. Rear override penetration extended to and displaced both C-pillars forward. The roof was severely buckled and the right B-pillar was bent forward. Burn damage extended from the rear to the C-pillar on the right side, across the rear end and nearly all of the left side; the interior was burned. The fuel filler neck was separated at the tank. (See figure 10.)

Vehicle No. 10, a white 1977 Mack 3-axle truck tractor, VIN R685ST65827, was registered in Florida. The odometer was unreadable. The tractor was equipped with a 5-speed manual transmission, power assisted steering, and air mechanical brakes. The tractor was towing a 1970 Brown P1H2S 40-foot flatbed semitrailer laden with 1 x 2 inch and 1 x 4 inch lumber. The truck was in the median lane, and the truckdriver estimated the nearest car was about 0.25 mile ahead. He saw the smoke and slowed to an estimated 20 mph as he entered the smoke. He said he heard a crash to his right, glanced in that direction and when he redirected his attention forward, the truck "crashed into another car." The truck overrode the rear of vehicle No. 9 and stopped (vehicles Nos. 10, 9, and 8 were all in contact). Within seconds, there were multiple impacts to the rear of the semitrailer.

The front bumper was buckled and the leading ends of the chassis rails were skewed to the left. All glass was missing. The rear plate on the semitrailer was buckled and the lower 8 inches of the underride protection device (from the braces downward) was rotated 60° to 80° forward. The right side rail of the semitrailer was bowed downward. The cargo apparently remained secured throughout the crash sequence and was removed from the semitrailer into the highway median to facilitate firefighting efforts. The tractor and semitrailer were both destroyed by fire. The tractor's fuel tanks maintained their integrity. Fuel lines in the engine compartment were either damaged or destroyed by fire. (See figure 11.)

Vehicle No. 11, a 1980 Buick Estate 4-door station wagon, VIN 4R35XAX135114, was registered in Ontario, Canada. The odometer was unreadable. The vehicle was equipped with automatic transmission, power assisted steering, and power assisted front-disc, rear drum brakes. Vehicle No. 11 was traveling in the median lane when the driver saw the smoke and said he "debated about stopping," but was concerned about cars behind him. He said he slowed and entered the smoke with his foot on the brake. He then "saw something, but too late." The right front of the vehicle struck and partially underrode



Figure 9.—Vehicle No. 8. (Note rear override damage.)



Figure 10.—The rear of vehicle No. 9 was overrode by vehicle No. 10.

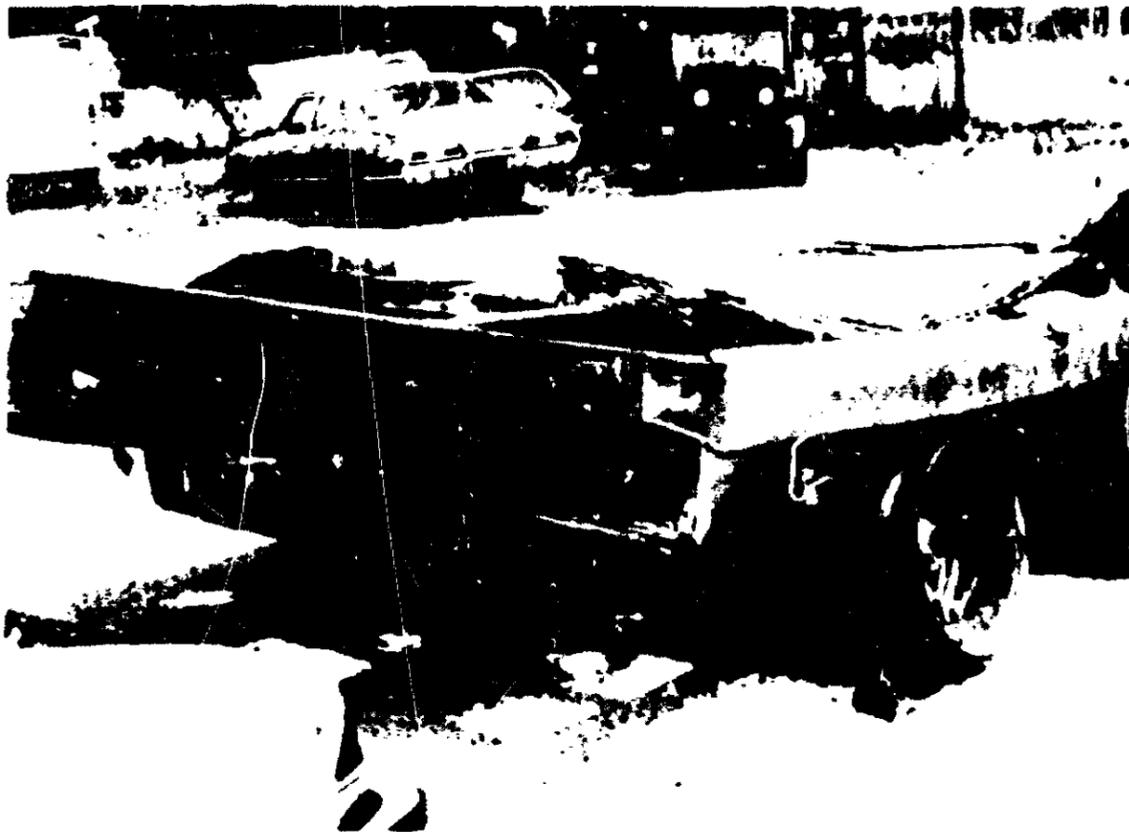


Figure 11.--Rear of semitrailer (vehicle No. 10).
(Note damage to the rear underride protection device.)

the left rear of the semitrailer (vehicle No. 10). Within seconds vehicle No. 11 was struck at least twice in the rear.

The front bumper was rotated upward. Underride crush to the front extended from the right front corner about 39 inches to the left. The hood was displaced about 14 1/2 inches rearward and buckled. (See figure 12.) All glass was missing. Impact damage with 18 1/2 to 20 inches forward crush was found at the center rear. Induced buckling was found along both sides of the station wagon. The vehicle was destroyed by fire. The fuel tank had been pushed into the differential housing and dented, but was intact. The fuel cap was missing and the filler neck was displaced, but intact. The fuel tank was empty when it was inspected.

Vehicle No. 12, a blue 1982 Dodge D-50 pickup truck, VIN 7FP44XCY404174, was registered in Florida. The odometer was unreadable. The truck was equipped with a 4-speed manual transmission, nonpower assisted steering, and power assisted front-disc, rear-drum brakes. The pickup was traveling in the median lane when the driver saw the smoke and "slowed to 50 mph upon entering." He said visibility was extremely limited and he could not see the car ahead "until its brake lights came on." He applied brakes, but could not avoid the impact. The vehicle struck the rear of vehicle No. 11, rotated counterclockwise, probably was struck by the horse trailer (vehicle No. 20) in the curb lane, struck the semitrailer (vehicle No. 10), continued its rotation, and came to rest facing east. At rest, the front of the pickup truck was under the right side of the semitrailer, about the semitrailer's longitudinal midpoint.



Figure 12.--Vehicle 11. (Note underride control due to protection on the rear of the semitrailer.)

There was severe frontal crush, and the front of the vehicle was skewed 16 to 18 inches to the right. The right rear showed override damage; the tailgate was buckled forward, and the right side board was folded outward (to the right). About 14 to 15 inches impact crush was found into the right door. All glass was missing and both doors were jammed shut. The hood was severely buckled. The truck was destroyed by fire. A filler neck component (possibly rubber) which extended from the metal spout at the cap end of the filler neck to the tank had been burned away. The fuel tank was intact but was empty when inspected.

Vehicle No. 13, a brown 1980 Oldsmobile Delta 88 2-door sedan, VIN 3Y37YAM259967, was registered in Ontario, Canada. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear drum brakes. The vehicle was traveling in the median lane when its left front struck the right rear of the semitrailer (vehicle No. 10). The vehicle rotated 75° to 90° counterclockwise. Its right rear may have contacted the horse trailer (vehicle No. 20), and it probably was struck in the left rear corner by vehicle No. 21. Vehicle No. 13 was struck in the driver's door area by vehicle No. 14.

The front bumper was missing. There was moderate underride crush damage to the front. The hood was buckled and engine components were damaged. The rear end was elevated to 43 inches above ground level. Impact damage was found at the right rear corner with buckling extending to the right C-pillar. The rear bumper was rotated upward and minor impact damage was found at the left rear corner. The left side was severely crushed with about 32 to 35 inches penetration at the driver's door. (See figure 13.) The vehicle was destroyed by fire. The fuel cap was partially burned off, but the filler neck and tank were intact. The tank was empty when inspected.

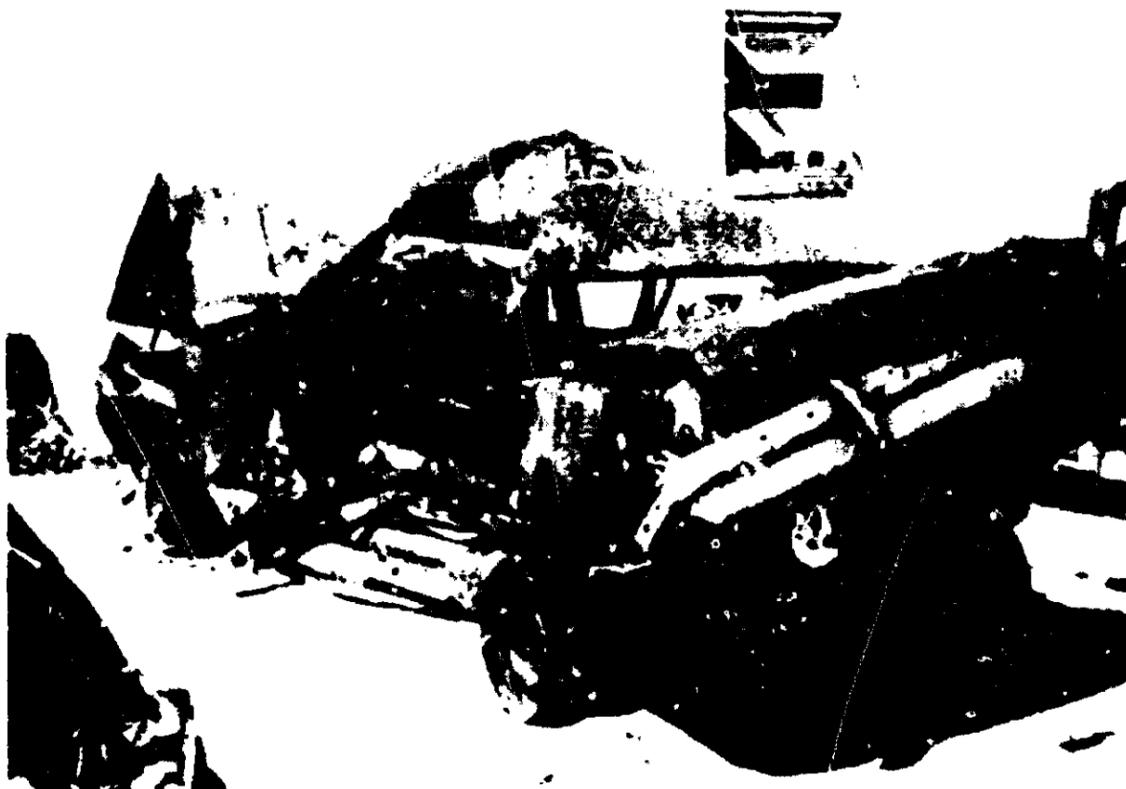


Figure 13.—Vehicle No. 13 showing left side damage from impact by vehicle No. 14. The two occupants were fatally injured.

Vehicle No. 14, a blue 1981 AMC Spirit 3-door hatchback, VIN 1AMCA4356BK232158, was registered in Ontario, Canada. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the median lane traveling at a driver estimated speed of 55 mph. The driver said he saw the smoke but thought he would "be in and out of it in a second or two," so he did not slow down. He stated that after entering the smoke he "could not see a thing" so he "braked hard and then hit another vehicle." The front of vehicle No. 14 struck the left side of vehicle No. 13. The vehicle rotated clockwise and struck the right rear corner of vehicle No. 11.

The front bumper was missing and severe crush damage was found across the entire front. Rearward crush was more severe on the right side. There was impact damage to the left quarter panel from the B-pillar to the left rear wheel well. The vehicle was destroyed by fire. The rubber filler neck component was charred, but intact. The filler neck was still attached to the tank, but was loose and could be moved freely. The fuel tank was intact, but empty, when inspected.

Vehicle No. 15, a brown 1974 Cadillac Sedan DeVille, 4-door sedan, VIN 6D49R4Q101187, was registered in Illinois. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear drum brakes. The vehicle was traveling in the curb lane at a driver estimated speed of 55 mph when he saw a car ahead stopped, so he stopped about two to three carlengths behind the car ahead (vehicle No. 18). Vehicle No. 15 was struck in the rear by vehicle No. 16. Vehicle No. 15 was pushed into vehicle No. 18 and stopped in the curb lane still in contact with vehicle No. 18.

The vehicle had moderate impact crush to both the front and rear. There was impact crush to the right quarter panel extending from the right rear door to the right rear corner. The roof and deck lid were crushed downward and contained burned debris. The vehicle was burned except for a small area at the right front corner. The fuel tank was distorted on its bottom side, but the tank and filler neck appeared intact.

Vehicle No. 16, a white over blue 1979 Chevrolet Caprice Landau 2-door sedan, VIN 1N4769J217505, was registered in Ohio. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering and power assisted front-disc, rear-drum brakes. The driver had just filled the fuel tank and was southbound in the curb lane at an estimated 45 mph. The driver said that she saw a car ahead stop (vehicle No. 15) and stopped her vehicle before entering the smoke cloud. The vehicle could have been partially on the shoulder. Vehicle No. 16 was then struck in the rear by vehicle No. 17 and pushed forward striking vehicle No. 15. Vehicle No. 16 veered to the right onto the shoulder and struck the guardrail, rebounded off the guardrail, struck vehicle No. 15 a second time, and stopped on the shoulder.

Impact damage was found across the entire front with about 7 inches rearward crush at the right front. A guard rail imprint was in the right side of the vehicle. There was impact damage to the left side extending from the left front wheel well to just forward of the left rear wheel well with about 12 1/2 inches crush into the left door. Rear contact damage extended from the left rear corner to the right about 31 inches with about 18 inches forward crush. The deck lid and left quarter panel were buckled and the left door was jammed shut. The vehicle was burned except the right door and right front fender area. A 3 1/2-inch (horizontal) by 3-inch (vertical) hole was found in the rear of the fuel tank centered 5 1/2 inches right of the tanks left end. The filler neck was intact.

Vehicle No. 17, a gray 1980 Chevrolet Malibu 2-door sedan, VIN 1T27KA1479655, was registered in New York. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the curb lane when it struck the rear of vehicle No. 16. Vehicle No. 20 then struck the rear of and completely overrode vehicle No. 17. With the pickup truck on it, the vehicle moved forward and to the left while rotating counterclockwise. Its front struck the right side of vehicle No. 15 and the vehicle stopped facing east.

Impact and fire damage rendered the vehicle unrecognizable. (See figure 14.) The total vehicle length was 9 feet 9 inches measured along the right side (original length about 16 feet 3 inches). The right wheel base was reduced by 36 inches. There was severe crush to the front and rear. The top, deck lid, right door, and right quarter panel were missing. The rear bumper was buckled and skewed to the right about 24 to 27 inches. The vehicle was destroyed by fire. The fuel cap was missing; the filler neck was intact, but loose in the tank. A split seam was found in the left side of the fuel tank. The tank, which had been pushed forward into the differential housing, was empty.

Vehicle No. 18, a white over blue 1978 Ford LTD 2-door sedan, VIN 8B62H133081, was registered in Illinois. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the curb lane at 55 mph when the driver saw the smoke and reduced his speed to about 25 to 30 mph and followed a brown station wagon (vehicle No. 19) into the smoke. Once in the smoke, the driver further reduced her speed to about 5 to 8 mph. The vehicle was struck from the rear by vehicle No. 15, then



Figure 14.--Vehicle No. 17 was overrode by vehicle No. 20.
The two occupants were fatally injured.

moved forward and struck vehicle No. 19. Vehicle 15 may have separated, then struck the rear of vehicle No. 18 a second time partially overriding into the trunk area. Vehicle No. 18 stopped in the curb lane facing south.

Impact damage was found at both front corners. The rear bumper was rotated upward and the deck lid severely buckled, exposing the trunk. Induced buckling was found on both sides of the vehicle. Burn damage extended from the A-pillar rearward on the left side and from the B-pillar rearward (excluding the right rear corner) on the right side. The interior was destroyed by fire. The fuel filler neck was loose at the tank and could easily be slid in and out. No other fuel system breaches were noted, but the loose filler neck could have permitted loss of fuel.

Vehicle No. 19, a brown 1978 Buick Estate Wagon 4-door station wagon. VIN 4R35X8X132859, was registered in Ontario, Canada. The odometer read 29,866 miles. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the curb lane at an estimated speed between 50 to 55 mph. The driver said he saw the smoke and reduced his speed to about 30 mph. When he entered into the dense smoke, he actuated his 4-way flashers and further reduced his speed to 5 mph. He said he was traveling at that speed when vehicle No. 18 struck the station wagon from the rear.

Damage was found on the rear bumper and rear tailgate with about 5 inches crush. The rear window was broken. Induced buckling was found on the left quarter panel, and the vehicle's rear section was skewed downward. The vehicle was not burned and the fuel system maintained its integrity.

Vehicle No. 20, a tan 1982 Chevrolet C-30 1-ton, crew cab (4-door) pickup truck, VIN 1GCHC33WZCS 123870, was registered in North Carolina. The odometer was unreadable. The vehicle was equipped with a 4-speed manual transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. There were two fuel tanks mounted underneath the pickup; mounted between the rocker panel and chassis rail on

either side of the vehicle and extending from just forward of the rear wheel wells forward. The third tank was mounted in the pickup bed just behind the cab. The pickup was towing a green 1978 Phillips 36-foot fifth-wheel type, nine-horse capacity horse trailer (five horses were in the trailer). The horse trailer was equipped with tandem axles (single wheels on each side) and electric brakes to each wheel. The fifth wheel tow bar was mounted in the pickup's bed directly over its rear axle. The vehicle was traveling in the curb lane at a driver estimated speed of 45 mph. The driver said he saw the smoke and slowed to about 25 mph. He said he thought about stopping but "the smoke then seemed to blow to me." He further stated: "Once inside it turned very black. I then heard a loud noise and the next thing I know the truck turned left and went up." The pickup had struck and overrode vehicle No. 17. The pickup came to rest predominantly atop vehicle No. 17 but its right front wheel was on the top of vehicle No. 15.

There was minor crush to the front bumper and hood; the grill and headlight assemblies were broken out. The front section was skewed downward and there was extensive undercarriage damage. Both right doors showed induced buckling. The truck was destroyed by fire. The fuel filler necks were separated at each of the two undercarriage fuel tanks. Both tanks were buckled on the bottom side, but intact, and empty when inspected. The cap was missing from the tank in the bed and it too was empty. It was not determined if the tank held gasoline precrash, but the driver estimated he had 35 gallons of gasoline in the tanks. The horse trailer's rear doors were displaced forward 33 inches. The rear of the bed was buckled and the left rear corner pillar was separated from the bed. Components from vehicle No. 21 remained on the rear bed. The left rear, left side, front, forward right side, and forward roof of the horse trailer was burned.

Vehicle No. 21, a silver 1975 Ford Elite 2-door sedan, VIN 5G21H134053, was registered in Florida. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering, and power assisted front-disc, rear-drum brakes. The vehicle was traveling in the curb lane behind the horse trailer when it was struck from the rear by vehicle No. 22 and pushed into the horse trailer. Vehicle No. 21 came to rest with its front penetrating the rear of the horse trailer and the front of vehicle No. 22 atop its trunk area.

Severe override rear crush extended to the right C-pillar. The deck lid was displaced and both quarter panels were severely buckled. The roof was also buckled. The front bumper was rotated downward, as were the forepart of both front fenders. The grill was missing and the hood was buckled. Vehicle No. 21 was burned except the right side panels and the extreme center and right front. The interior was burned. The fuel filler neck was separated from the tank and was missing when the vehicle was inspected; the tank was empty.

Vehicle No. 22, a white 1981 Ford F350 Centurion Van (2-door), VIN 1FDKE30L8BHA44611, was registered in Louisiana. The odometer was unreadable. The vehicle was equipped with an automatic transmission, power assisted steering and power assisted front-disc, rear drum brakes. The van was towing a black 1981 Ford Bronco 2-door, VIN 1FMDU15E4BLA61798. The Bronco was being towed by a Reese tow hitch. The vehicle was traveling in the curb lane at a driver estimate speed of 45 mph. The driver said the smoke "did not look as bad as it was" and he entered the smoke at his travel speed. The driver said he did not see any vehicles, but did see taillights "just before hitting." Vehicle No. 22 struck the rear of vehicle No. 21 and both vehicles moved forward until vehicle No. 21 struck the horse trailer. Vehicle No. 22 then overrode the

trunk area on vehicle No. 21 and stopped. The Bronco broke the tow hitch and overrode the rear bed of the vehicle No. 22. The Bronco came to rest with its front end near the front of the Centurion's bed.

The Centurion had moderate front bumper distortion with 7 to 8 inches rearward crush. Both front fenders were buckled. The rear bumper was buckled at its center and the rear of the steel bed was buckled. The right sideboard of the bed was folded outward (right). The vehicle was burned except the right side from the C-pillar forward. The fuel tank was intact, but the rubber filler neck component was burned away. The tank was empty. The Bronco had minor damage to the front bumper and the left grill/headlight assembly. Both front fenders had minor buckling. The vehicle was totally burned. The fuel tank was intact, but an 8- to 9-inch rubber filler neck hose was crumbling from burn damage. The tank was empty when it was inspected.

APPENDIX C

DETAILS OF INJURIES

<u>Vehicle No.</u>	<u>Driver</u>		<u>Passenger(s)</u>		<u>Description of Injuries</u>
	<u>Age</u>	<u>Sex</u>	<u>Age</u>	<u>Sex</u>	
1	39	F			Fractured nose, fractured ribs, multiple contusions AIS 2 ^{1/}
			9	M	Contusions to nose, both knees, laceration to finger AIS 1
			60	F	Facial abrasion and lacerations Contusion to neck AIS 1
			9	M	None AIS 0
			71	F	Complaint of neck pain, smoke inhalation AIS 1
2	49	F			Knee abrasion. Complaint of neck pain. AIS 1
			53	M	Complaint of neck pain AIS 1
			16	F	Scalp laceration. Neck strain AIS 2
3	69	M			Abrasion to forehead AIS 1
			63	F	Complaint of head pain AIS 1

1/ Abbreviated Injury Scale (AIS)

- 0—No Injury
- 1—Minor
- 2—Moderate
- 3—Severe--not life-threatening
- 4—Serious--life-threatening, but survival probable
- 5—Critical--survival uncertain
- 6—Maximum--fatal

APPENDIX C

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<u>Vehicle No.</u>	<u>Driver</u>		<u>Passenger(s)</u>		<u>Description of Injuries</u>
	<u>Age</u>	<u>Sex</u>	<u>Age</u>	<u>Sex</u>	
4	77	F			Abrasions to both shins. Cervical strain. Complaint of back and chest pain. AIS 1
5	No information - Hit and Run Vehicle				
6	33	M			Abrasions and contusions to arms and legs. Mouth laceration AIS 2
			27	M	Abrasion to forehead AIS 1
			17	M	Contusion to forehead - Complaint of back pain. AIS 1
7	28	M			None AIS 0
8	41	M			None AIS 0
			2	M	None AIS 0
			31	F	None AIS 0
			6	F	None AIS 0
			70	F	Abrasions to face, hand, knee. Complaint of chest pain. AIS 1
9	58	M			Scalp laceration, neck contusion, strain. AIS 1
			55	F	Lacerations to hands, feet, scalp, neck. Contusions and abrasions to arms, legs, chest, abdomen. Complaint neck pain. AIS 2

<u>Vehicle No.</u>	<u>Driver</u>		<u>Passenger(s)</u>		<u>Description of Injuries</u>
	<u>Age</u>	<u>Sex</u>	<u>Age</u>	<u>Sex</u>	
10	25	M			Complaint of back pain AIS 1
11	60	M			Facial contus. n. Mouth injury. Chest abrasions. Hand lacerations AIS 1
			57	F	Fractured clavicle. Hand lacerations. Chest abrasions. Sprained ankle AIS 2
12	23	M			Laceration to face, back, hands, arms, legs, feet, knee abrasions AIS 2
13	70	M			Fatal (trauma, then burned) AIS 6
			66	F	Fatal (thermal burns) AIS 6
14	56	M			Lacerations to face, hand. Fractured nose. Knee abrasion. Complaint of pain in neck and chest. AIS 2
			51	F	Fractured femur. Facial lacerations. Chest contusions. Complaint of abdominal pain. AIS 3
15	67	M			None AIS 0
			61	F	Contusions, abrasions to legs, feet. Complaint of neck and abdominal pain. AIS 1
			59	F	Contusions, abrasions to arm, leg, foot. Complaint of neck and back pain. AIS 1
16	67	F			Lacerations to scalp, elbow Contusions to face, shoulder, leg. Complaint of neck pain. AIS 2

APPENDIX C

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<u>Vehicle No.</u>	<u>Driver</u>		<u>Passenger(s)</u>		<u>Description of Injuries</u>
	<u>Age</u>	<u>Sex</u>	<u>Age</u>	<u>Sex</u>	
16			77	F	Compression fracture of two vertebrae. Contusions to chest, abdomen. AIS 2
17	67	M			Fatal (trauma, then burned) AIS 6
			64	F	Fatal (trauma, then burned) AIS 5
18	38	F			Mouth laceration. Knee abrasion AIS 1
			15	M	Complaint of neck pain. AIS 1
			18	F	Complaint of neck, back pain. Knee contusion. Wrist laceration. AIS 1
			10	F	Wrist abrasion. Scratches. AIS 1
			42	M	Mouth laceration. Abrasions to arm, ankle. Contusions to forehead, back AIS 1
19	47	M			Complaint of neck pain AIS 1
			45	F	None AIS 0
20	28	M			Burn to elbow AIS 1
21	57	M			Burns (second and third degree) to 80 percent of body. AIS 5
			55	F	Fractured ribs. Lacerated chin. Fractured metatarsal bones (foot). Abrasions to hands. Contusions to face, chest. Back pain. Concussion AIS 3

<u>Vehicle No.</u>	<u>Driver</u>		<u>Passenger(s)</u>		<u>Description of injuries</u>
	<u>Age</u>	<u>Sex</u>	<u>Age</u>	<u>Sex</u>	
22	42	M			Avulsion of teeth and tongue. Facial lacerations. Neck contusion. AIS 2
			40	M	Fractured ribs. Arm laceration. Contusions, abrasions to face, chest. AIS 2

APPENDIX D

ESCAPE FROM VEHICLES

<u>Vehicle No.</u>	<u>Number of Occupants</u>	<u>Description of Escape</u>
1	5	One occupant (right rear passenger) was using restraints. The driver and center front passenger forced the driver's door open then exited and went around the car to help the right rear passengers. The driver of vehicle No. 19 assisted in getting the occupants out of vehicle No. 1. Some occupants also assisted the right front passenger.
2	3	None of the occupants were using restraints. The right door would not open. All three occupants exited through the driver's door unassisted.
3	2	Neither occupant was restrained. The driver exited through the driver's door and assisted the passenger out through the same door. They went into the median.
4	1	No restraint was used. There is no information as to how the driver exited her vehicle.
5	Unknown	The vehicle did not stop at the accident scene.
6	3	Only the driver was restrained. All three occupants exited the pickup unassisted and without difficulty.
7	1	No restraints were used. The driver exited unassisted through the right door of the tow truck.
8	5	Restraints used by the driver and right front passenger. All occupants except the right rear passenger exited unassisted through the right front door. The right rear passenger was reportedly pinned in. The driver moved the electric front seat forward, jerked the left rear door open and was able to extricate the passenger through that door.
9	2	Both occupants were restrained. The left front door could not be opened. The driver used his feet to force the right front door open. He pushed his passenger out through the right front door and followed her out.
10	1	The driver was restrained. He exited the tractor's cab unassisted through the left door.

<u>Vehicle No.</u>	<u>Number of Occupants</u>	<u>Description of Escape</u>
11	2	Both occupants were restrained. The driver was unable to open the vehicle's doors, so he used an object to break the glass from the left front door. He crawled through the window area, then turned and assisted his passenger out through the same area.
12	1	The driver was not restrained. The pickup's doors were jammed closed. The driver exited through the right door window area unassisted and crawled under the semitrailer into the highway median.
13	2	It could not be determined whether or not restraints were used. Neither occupant got out of the vehicle.
14	2	No restraints were used. The left door was jammed closed, so the driver opened the right door, exited the vehicle and pulled his injured passenger out.
15	3	No restraints were used. The driver's door was jammed shut and there were flames by the right side of the vehicle. The driver opened the powered window in the driver's door, crawled through the window, then assisted his two passengers out through the same window.
16	2	The right front passenger was restrained. The driver was unconscious and the right door was jammed closed. Two men (passersby) pulled both occupants out through the right door window and carried them to a safe area.
17	2	No restraints were used. The occupants were pinned in the vehicle.
18	5	The right front passenger was restrained. All occupants exited unassisted through the vehicle's front doors.
19	2	Both occupants were restrained. Both occupants exited the vehicle unassisted and went to the aid of the occupants in vehicle No. 1.
20	1	The driver was not restrained. He climbed into the rear seat, opened the right rear door and jumped to the road surface.

<u>Vehicle No.</u>	<u>Number of Occupants</u>	<u>Description of Escape</u>
21	2	No restraints were used. The driver reportedly exited the vehicle unassisted, but was burned by flaming gasoline which was flowing down the shoulder. The passenger was, reportedly, pulled from the vehicle by rescuers. Two rescuers were burned while getting her out.
22	2	No restraints were used. The driver exited the vehicle unassisted, he removed the unconscious passenger through the vehicle's right door.

APPENDIX B

NTSB INVESTIGATED ACCIDENTS
LIMITED VISIBILITY ACCIDENTS

<u>Location</u>	<u>Date</u>	<u>No. of Injuries</u>	<u>No. of Fatals</u>	<u>Report No.</u>
Joilet, Illinois	8-12-67	24	5	NTSB-SS-H-1
Petersburg, Indiana	11-24-69	28	1	NTSB-HAR-71-4
New Jersey Turnpike	11-29-69	18	6	NTSB-HAR-71-3
New Jersey Turnpike	10-23-73	39	9	NTSB-HAR-75-2
Corona, California	2-28-75	23	0	NTSB-HAR-75-7
McAlester, Oklahoma	7-14-77	6	8	NTSB-HAR-78-2
Charlestown, Tennessee	11-5-78	46	-	Field Report
Charlestown, Tennessee	4-15-79	14	3	Field Report
San Bernadino, California	11-10-80	17	7	NTSB-HAR-81-2
Ocala Florida	2-28-83	36	5	NTSB/HAR-83/04
Totals		251	44	