NATIONAL TRANSPORTATION SAFETY BOARD

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HIGHWAY ACCIDENT REPORT

PROPANE TRACTOR-SEMITRAILER OVERTURN AND FIRE
U.S. Route 501,
LYNCHBURG, VIRGINIA
March 9, 1972

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591
REPORT NUMBER: NTSB-HAR-73-3

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This report contains Highway Safety Recommendations H-73-20 through H-73-29.

16. Abstract

This report describes and analyzes the overturn of a tractor-semitrailer (tank) carrying liquid propane under pressure on U. S. Route 501 near Lynchburg, Va., on March 9, 1972. After overturning, the vehicle slid on its side and struck a rock embankment, which ruptured the tank shell and permitted the propane to escape. When the propane-air mixture ignited, two persons, including the truckdriver, were killed, and five others were injured.

The National Transportation Safety Board determines that the cause of the overturn was the driving of the tractor-semitrailer on the wrong side of the road, and a subsequent evasive steering action which exceeded the limited capability of the truck to resist overturn. Contributing factors included a misleading traffic-control sign, an inadequate road-marking system, and the high center of gravity of the truck. The causes of the burn fatalities and injuries were rupture of the tank at a point susceptible to rupture and the inadequacy of the required placards as a means of warning bystanders of the nature and range of the hazard.

The report contains recommendations to various Federal, State, and industry authorities intended to prevent the recurrence of this type of accident.

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FOREWORD

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

This report is based on facts obtained from an investigation conducted by the Safety Board and on information supplied by the Bureau of Motor Carrier Safety (Federal Highway Administration), the Office of Hazardous Materials, the Virginia State Police, and the Virginia Department of Highways.

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

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HIGHWAY ACCIDENT REPORT

Adopted: May 24, 1973

Propane Tractor-Semitrailer Overturn and Fire
U.S. Route 501,
Lynchburg, Virginia
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I. SYNOPSIS

At 2:30 p.m, on March 9, 1972, a tractor-semitrailer (tank) carrying liquid propane under pressure was traveling north on U.S. Route 501 at approximately 25 m.p.h. At a point 7.1 miles north of Lynchburg, Va., the truck, while changing lanes in a 48° curve to the left on a 6.9-percent downgrade, overturned onto the right shoulder of the road. The truck slid along the shoulder on its right side and struck a rock outcropping, which ruptured the tank and permitted the liquid propane to escape. On exposure to the atmosphere, the propane vaporized into a cloud, which spread rapidly throughout the area. Within 1 or 2 minutes a fire erupted in the propane-air mixture.

The truckdriver, apparently not injured in the rollover, fled on foot north from the overturned vehicle. When the propane-air mixture ignited, the truckdriver was enveloped in the fire and was killed. Two southbound motorists, who had stopped their cars north of the overturned truck, and a passenger of one of the motorists were severely burned when the vapor cloud ignited.

The occupants of a house located in a hollow below and west of the highway heard the crash and ran from the house, but were caught in the propane-air vapor flash and were severely burned. One of these victims died as a result of his burns. The house, outbuildings, and about 12 acres of woodland were destroyed in the ensuing fire.

The National Transportation Safety Board determines that the cause of the overturn was the driving of the tractor-semitrailer on the wrong side of the road, and a subsequent evasive steering action which exceeded the limited capability of the truck to resist overturn. Contributing factors included a misleading traffic-control sign, an inadequate road-marking system, and the high center of gravity of the truck. The causes of the burn fatalities and injuries were rupture of the tank at a point susceptible to rupture and the inadequacy of the required placards as a means of warning bystanders of the nature and range of the hazard.

II. FACTS

The Accident

At 2:30 p.m., on March 9, 1972, a tractor-semitrailer (tank)[1] was traveling north on U.S. Route 501, a winding two-lane mountain road, at a speed of approximately 25 m.p.h. At a point 7.1 miles north of Lynchburg, Va., as the truck was negotiating a 48° curve to the left (119.37-foot radius) on a 6.9-percent downgrade, the truckdriver crossed into the southbound lane. This action changed the projected path of the truck to a 31° curve with a radius of

[1]When used in this report, "truck" will indicate the tractor-semitrailer and "trailer" will indicate the semitrailer (tank).

about 184 feet. Seeing a southbound automobile approaching beyond the curve, the truckdriver steered back to the right in order to return to his own side of the road and then to the left in order to avoid hitting the embankment. As he steered left, the left-rear trailer tandem tires lifed off the road and the truck rolled onto its right side. (See Figures 1 and 2.)

The truck slid on its right side about 25 feet diagonally across the right shoulder of the road. The forward-mounted manway-cover assembly on the trailer struck a rock outcropping in the roadway embankment, and the truck ricocheted back onto the road. The vehicle came to rest heading north and lying diagonally across the right shoulder, the northbound lane, and about half of the southbound lane.

A postaccident examination of the road surface revealed two cresent-shaped gouge marks and two tire-scuff marks starting at a point 55 feet south of the point at which the truck struck the embankment. The gouge marks, which were four feet apart and 19 and 21 inches in length, were adjacent to the scuff marks and established the point where overturn was completed. The two tire-scuff marks started outside of the gouge marks and continued in the direction of the truck slide.

The trailer contained 9,208 gallons (38,854 pounds) of an odorized liquid petroleum gas (LPG), propane, under pressure.[2] The rollover impact buckled the front and rear hemispherical head material in the area of the head-to-shell circumferential weld on the right side of the trailer. The impact with the rock outcropping ruptured the tank head and shell material, and the propane escaped. (See Figure 3.) A vapor cloud containing a mixture of propane and air immediately began to form at the trailer and, following the downhill topography, spread rapidly throughout the area.

After the truck came to rest, the truckdriver exited the tractor through the left door. He waved at motorists approaching from the north and started to run downhill away from the truck. When he was about 270 feet north of the truck, the propane-air vapor cloud, which had continued to expand, ignited into a ball of flame with a radius of at least 400 feet. The truckdriver was killed instantly as a result of massive burns.

Witnesses. Two cars had been following the truck for at least 3 miles prior to the accident. The occupants of these cars stated that the truck had been traveling at a speed of between 20 and 30 m.p.h. as it descended the mountain road and that the truck had slowed on curves and at other points during the descent. When the truck overturned, the drivers of the two northbound cars stopped their vehicles. After they saw vapor escape from the trailer, the drivers backed their cars around the curve and out of the line of sight to the truck. As the vapor cloud ignited, they heard a muffled roar and saw an orange-red fireball. No concussion was felt. Neither driver was injured.

The southbound car which had caused the truckdriver to get back into the northbound lane stopped within 100 to 150 feet north of the overturned truck. The driver of that car had been rounding a curve to his left when he saw the truck approach, change lanes, and overturn. Because of the vapor escaping from the trailer, the driver tried to back his car around the curve, but another southbound car, which had stopped behind him, blocked his path.

The three occupants of these two cars got out of their vehicles and watched the truckdriver flee. They were standing downhill from and in line of sight with the truck. When the propane-air mixture ignited, all three were severely burned and the two cars were damaged. They later stated that they thought the ignition started at the truck.

Other casualties. A house and some outbuildings were located 200 feet west of and about 60 feet below the accident site. Three occupants of the house heard the crash and, being aware of the potential danger to themselves, fled from the house, but were enveloped in the burning vapor

[2]The characteristics of propane are described in Appendix A.

PROPANE TANK TRACTOR-SEMITRAILER OVERTURN AND FIRE ON U.S. 501 NEAR LYNCHBURG, VIRGINIA ON MARCH 9, 1972

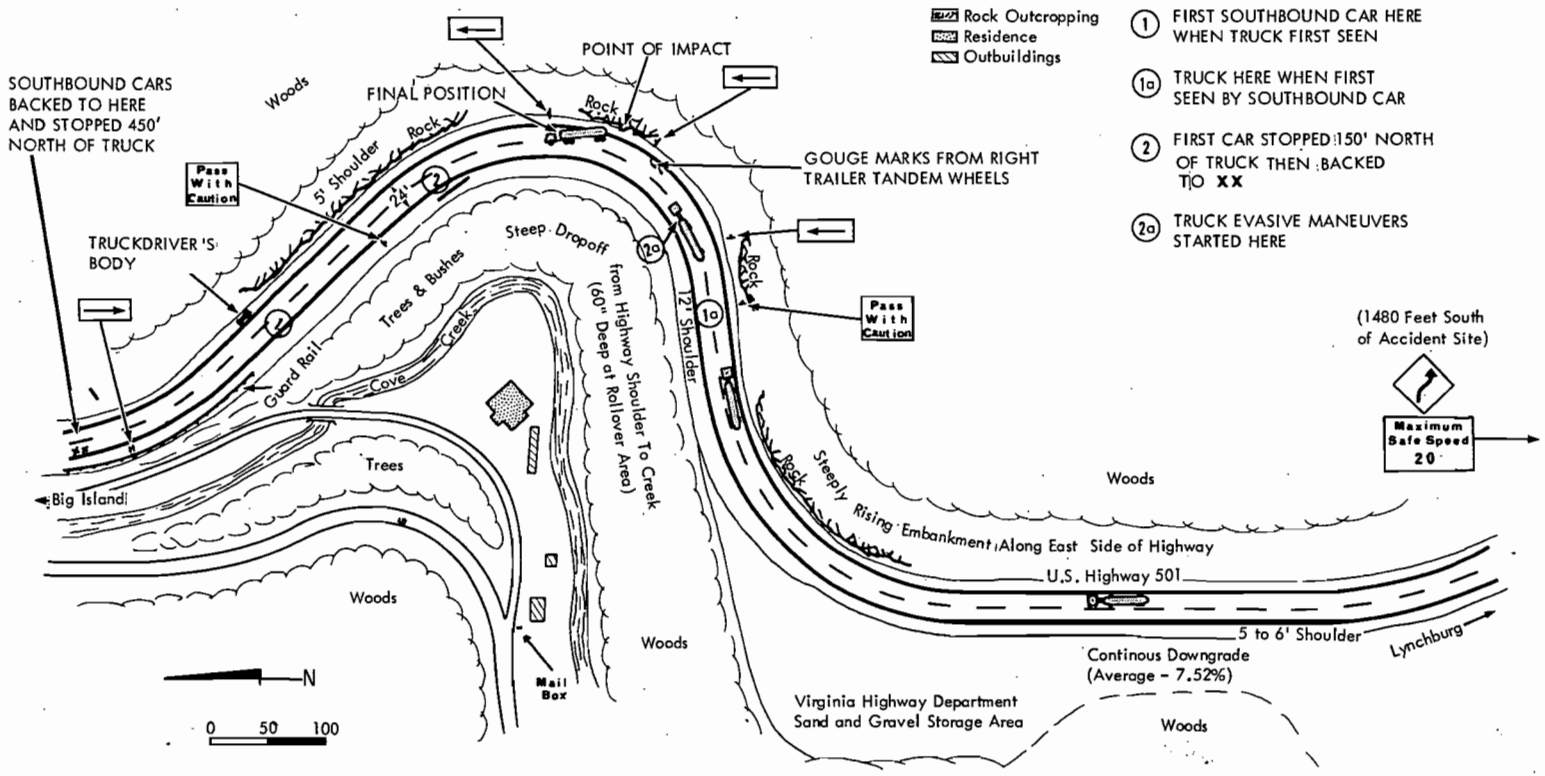

Figure 1. Accident site.

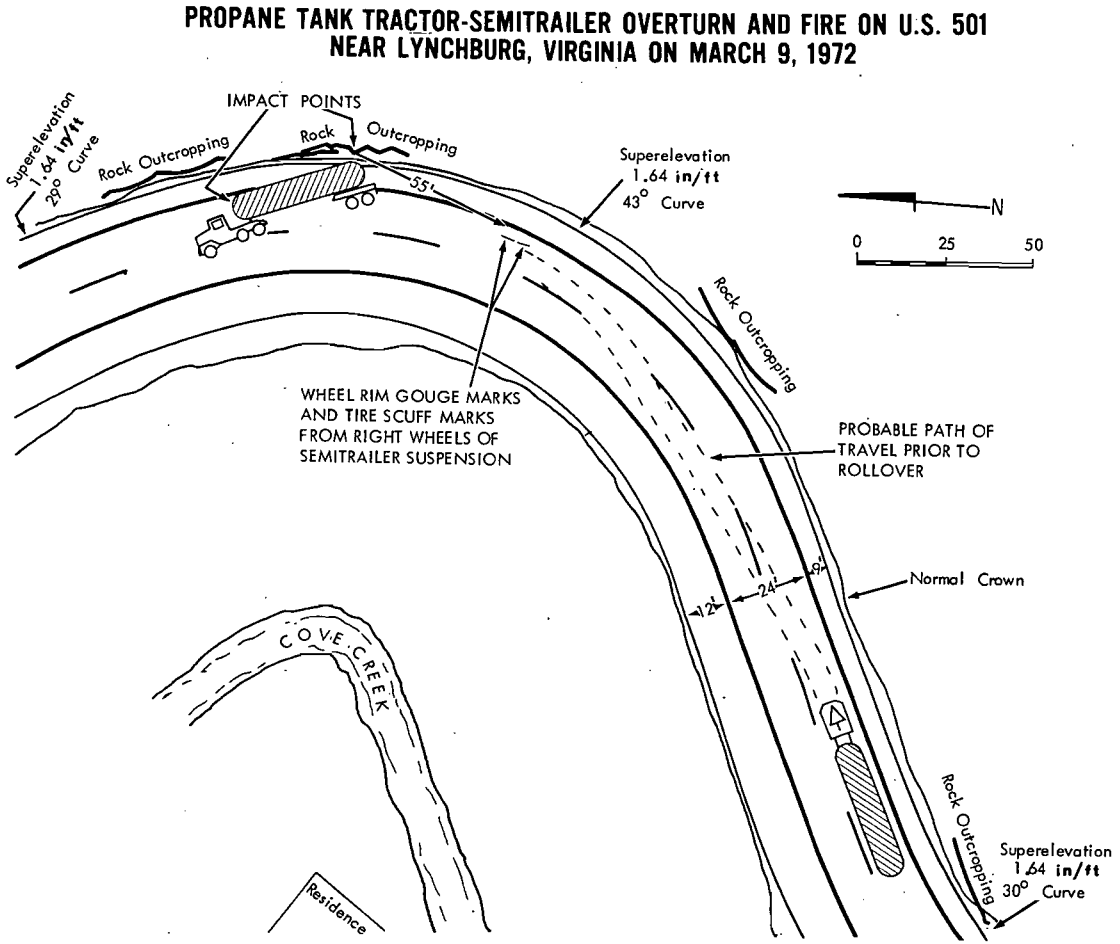

Figure 2. Details of accident site.

Figure 3. Final position of truck after rollover and impact with embankment. Propane-air mixture burning at tank rupture just to the rear of the manway cover.

before they could escape the danger zone. One of these victims later died as a result of his burns. The house and outbuildings and approximately 12 acres of woodland were destroyed in the ensuing fire. (See Figure 4.)

Total property damage as a result of the accident amounted to an estimated $70,000.

Accident Site

This accident occurred in hilly and heavily wooded terrain on the north slope of a mountain. From a point 2.1 miles north of the accident site to the point of impact, U.S. Route 501 passed through a series of curves on a 6- to 9-percent downgrade. The immediate northbound approach to the point of impact was through a 30° curve to the right on an 8-percent downgrade. The downgrade moderated to about 7 percent 217 feet into the curve and continued at that rate through the 48° curve on which the accident occurred. The superelevation of the road through this series of curves was 14 percent (1.6 inches per foot). The clear sight distance available to a northbound driver entering the 48° curve was approximately 225 feet.

The northbound and southbound lanes of the highway were separated by 4-inch-wide, broken, white lines, 18 feet long with 24-foot spacings. A 4-inch-wide solid, white, edge stripe was painted on the outer edges of the pavement.

At the point of impact, the embankment east of the highway rose steeply and contained a rock outcropping. The embankment west of the highway consisted of a steep dropoff on which stood a fringe growth of tall trees and underbrush. The trees and underbrush jutted above the level of the road and partially obscured a northbound driver's view around the curve. (See Figure 4.)

Several traffic-control signs pertinent to northbound traffic were located south of the scene of the accident. A mandatory speed-limit sign 2.88 miles south restricted the speed of cars to 55 m.p.h. and that of trucks to 45 m.p.h. About 1,480 feet south of the accident site were a reverse-turn sign which indicated that the road wound to the right and then to the left and an advisory safe speed sign which bore the legend, "MAXIMUM SAFE SPEED 20." About 200 feet south of the accident site was a sign with the legend, "PASS WITH CAUTION." Three signs, each showing a large arrow pointing left, were located 150, 65, and 0 feet south of the accident site.

The average-daily-vehicle volume (ADT) on U.S. 501 at the accident site for both northbound and southbound vehicles from 1967 through 1971 was as follows:

Year	*ADT*
1967	1,545
1968	1,545
1969	1,835
1970	1,820
1971	1,885

Data obtained from the Virginia Department of Highways indicate that from January 1, 1965 through March 9, 1972, there were 21 accidents (including this accident) in the 0.99 miles through the accident site. These accidents resulted in three fatalities, 13 personal injuries, and property damage amounting to $76,505.

The Truck

The truck consisted of a tractor and a pressure-tank semitrailer. Its combined unit and cargo weight was approximately 72,757 pounds.

Tractor. The tractor was a 1969 Autocar, Model A7564T, serial number 65040, equipped with a 250-horsepower diesel engine, a ten-speed transmission, tandem rear axles, and air brakes. The weight of the tractor with full diesel fuel tanks (110 gallons) and a 170-pound driver was approximately 14,123 pounds. No hazardous-material markings were displayed on the tractor, which was owned, operated, and maintained by Merritt Trucking Company, Inc., Greensboro, N.C., and was leased to O'Boyle Tank Lines, Inc., Washington, D.C.

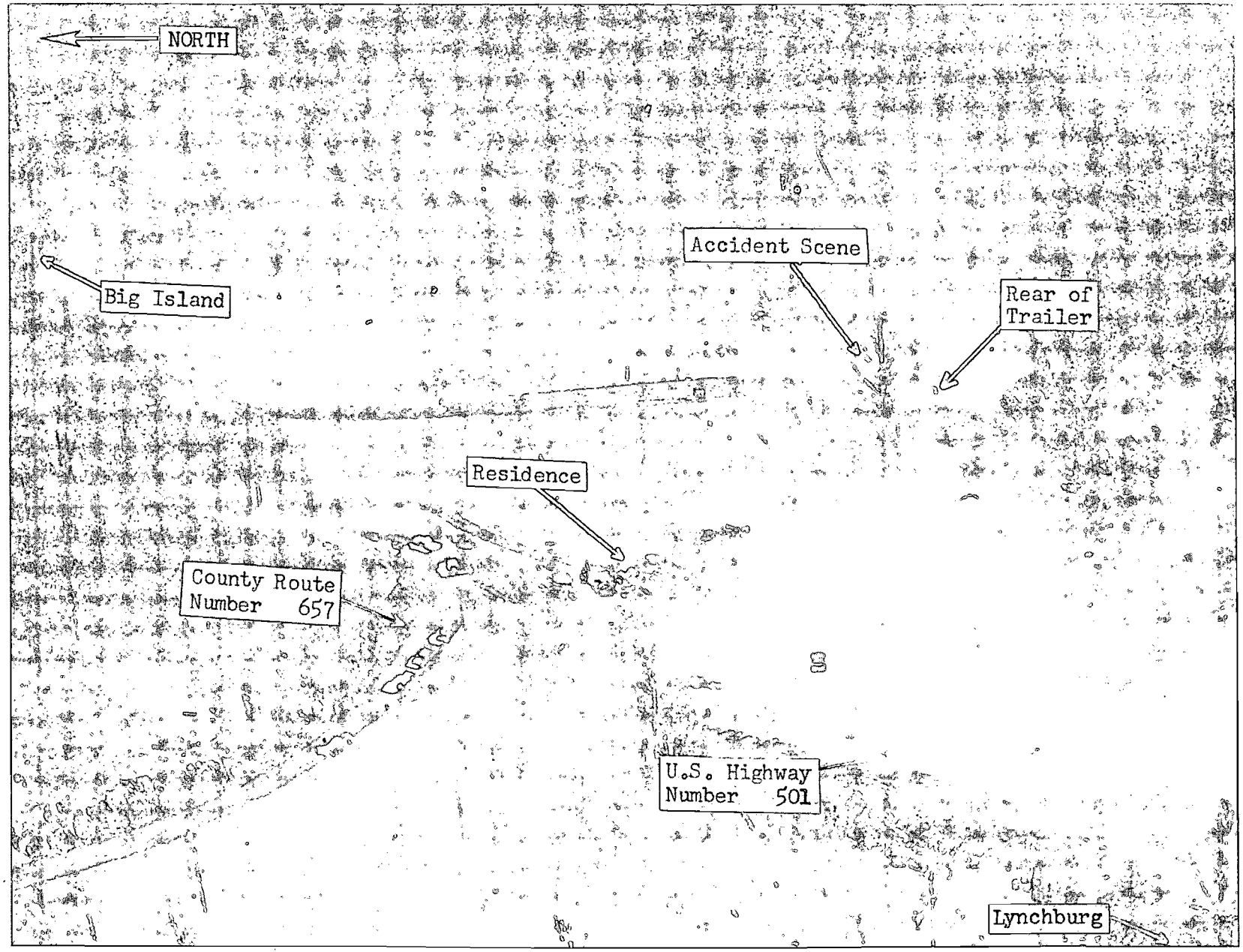

Figure 4. U.S. Highway 501, 7 miles north of Lynchburg, Virginia. Truck was traveling north.

Trailer. The trailer was a 1969 Lubbock, MC 331 pressure cargo tank, serial number 57178, equipped with a Reynolds Manufacturing Company (Reyco) tandem axle suspension and air brakes. The empty weight of the trailer was approximately 19,780 pounds. Painted on both ends and each side of the trailer was the legend, "Flammable Compressed Gas Propane." These markings conformed with applicable Federal regulations.[3] The trailer was owned by O'Boyle Tank Lines, Inc. The pressure cargo vessel had been fabricated and tested in compliance with applicable Federal regulations.[4]

The single-compartment pressure vessel had a cylindrical body with hemispherical heads and was equipped with three equally spaced transverse baffles. The 0.387-inch-thick shell material was fabricated in sections and welded together. The 0.250-inch-thick hemispherical head material was fabricated in "orange peel" fashion of formed plates welded together. The trailer was equipped with a single 15.25-inch-diameter manway opening mounted in the upper top quadrant of the front hemispherical head. (See Figure 5.) The manway opening was reinforced with a 20-inch-diameter, 1.5-inch-thick steel ring welded into the head material. This ring was drilled and tapped to receive twenty-four 0.625-inch-diameter studs to secure the 20-inch-diameter, 1.125-inch-thick manway cover and seal.

The physical characteristics of the trailer were as follows:

Volumetric capacity - 10,600 gallons
Length (overall) - 453.5" (37'9.5")
Tank length - 444" (37')
Outside diameter - 87.52" (7'3.516")
Overall height - 156" (13')
Design working pressure - 250 p.s.i.
Tank material - Quenched and tempered high-strength steel, Case 1298-5 (115,000-p.s.i. tensile)

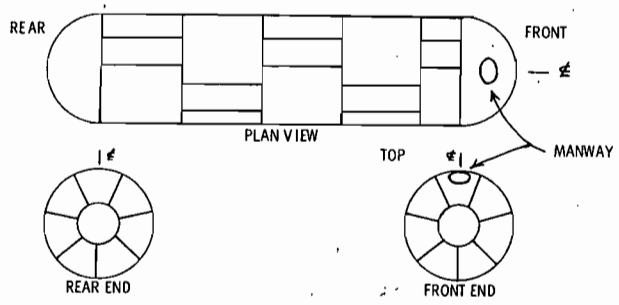

Figure 5. Schematic diagram of MC 331 pressure vessel, serial number 57178, showing relative location of tank sheets and manway.

The trailer suspension, a Model 21-B tandem axle, was manufactured by Reyco and assembled by Lubbock Manufacturing Company. The suspension consisted of four multiple-leaf springs, two per axle. Midway between the tandem axles, two load equalizer assemblies, one on each side, retained the rear end of the front spring and the front end of the rear spring. At each side, the axles were positioned by radius rods. The rear end of the rear spring supported the trailer through a wear plate in the rear-spring hanger. The rear-spring hanger incorporated a transverse bolt, under the spring, to retain the spring when it rebounds.

The top surface of the liquid cargo (9,208 gallons) was 16.83 inches below the top of the tank. The center of gravity of the partially loaded trailer was 84 inches above the ground. The center of gravity of the truck was 76.6 inches above the ground. (These dimensions assume a level road surface.)

Truck Damage

The damage resulting from the overturn and the impact with the rock outcropping was repairable. With the exception of the failure and damage described below, the cargo vessel appeared to have survived the overturn and impact in good condition, from a product-retention standpoint. However, the tractor and trailer were damaged beyond economically feasible repair and the cargo was destroyed in the fire which followed ignition of the vapor cloud.

[3] 49 CFR 177.823 (5)(b)(1) and (3), January 1, 1972.
[4] 49 CFR 178.337-16(b)(2), January 1, 1972

Tractor. The impact of the right side of the tractor with the road damaged the bumper, radiator, fender, air cleaner, cab, exhaust pipe, and fuel tank. The radiator, hood, and cab had been forced leftward and rearward. The lower coupler plate of the fifth-wheel assembly was deformed upward in the area of the fifth-wheel kingpin lock. Other than physical damage resulting from the general distortion of the right side, the left side of the tractor was free from impact damage. There appeared to have been no impact between the tractor and the rock outcropping.

Trailer. A multiple-herringbone scratch pattern extended along the entire right side and slightly above the horizontal axis of the tank shell. A vertical buckle about 2 inches deep and approximately 3.5 feet long was found in the right side of the head material, at both ends of the tank, adjacent to the forward and rear head-to-shell circumferential welds. There was no material or weld failure in the area of these buckles. (See Figure 6.)

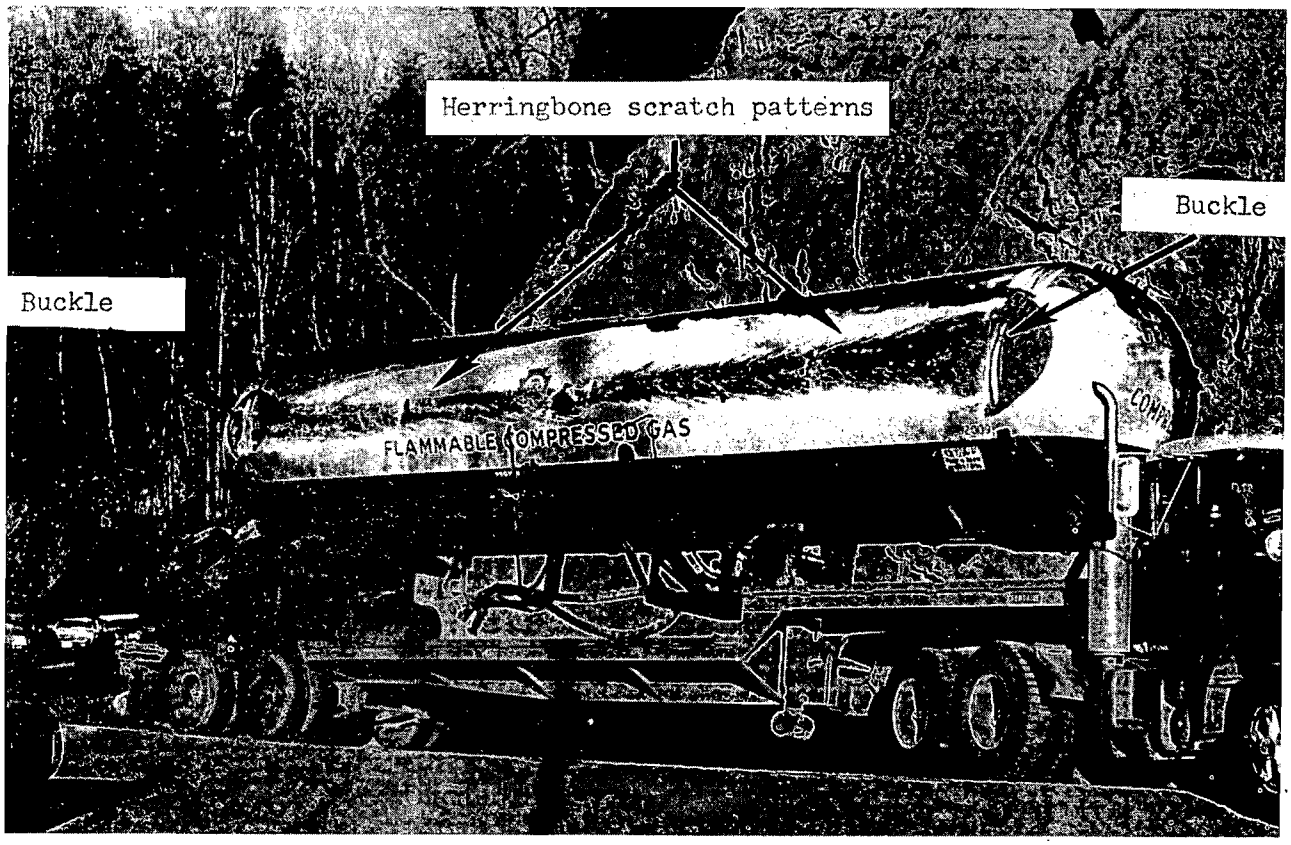

Figure 6. Right side of trailer after rollover.

The forward-mounted manway cover assembly was pushed inward and rearward. The adjacent head and shell material was buckled inward and rearward. (See Figure 7.) The manway cover had a longitudinal scratch pattern in the upper left quadrant which appeared to have been the point of initial impact with the rock outcropping. Six of the 24 manway cover studs were sheared off at the top surface of the manway cover. (See Figures 8 and 9.)

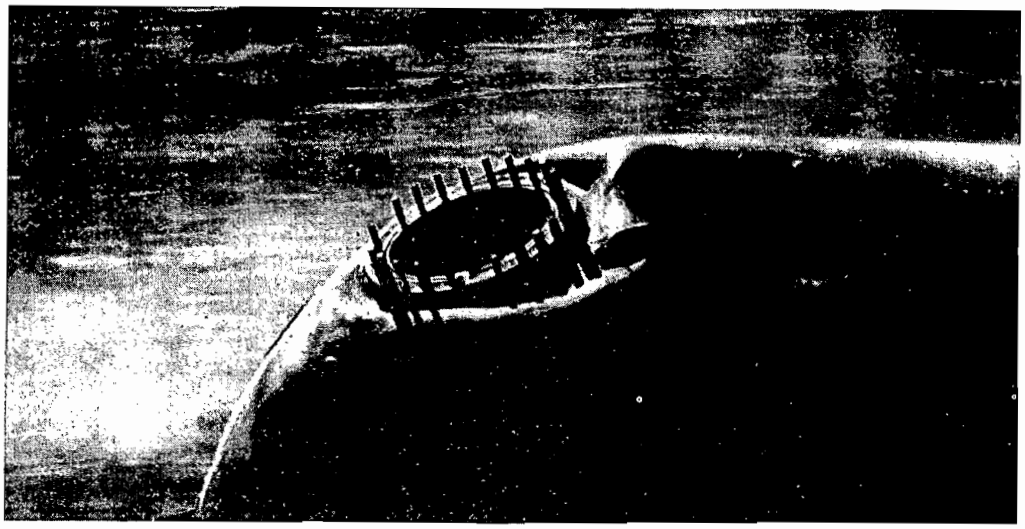

Figure 7. Forward-mounted manway. Note inward deformation and buckling of head and shell material.

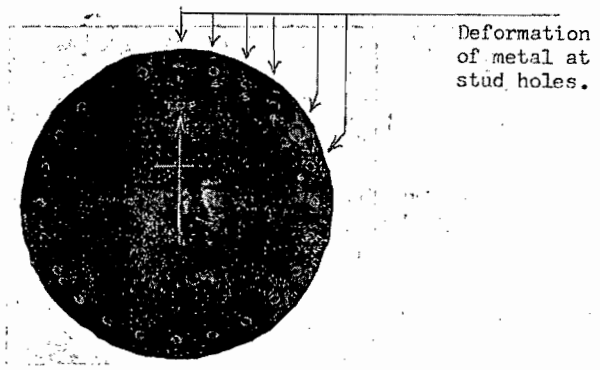

Figure 8. Scratch pattern and deformation around the six stud holes in upper left quadrant of manway cover.

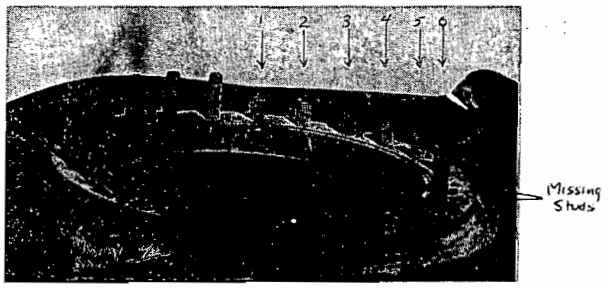

Figure 9. Sheared studs at manway opening. Top of manway is at stud number 1. (Missing studs were removed at time cover was taken off to flood tank.)

The head and shell parent material had ruptured 32 inches longitudinally, with the forward end of the rupture 9.75 inches behind the rear edge of the manway cover. The rupture crossed the head-to-shell circumferential weld, then roughly paralleled a longitudinal shell weld. The rearmost 9 inches of the rupture was located in the heat-affected zone of the longitudinal shell weld. The head and shell material also showed a longitudinal scratch pattern which started just to the rear of the manway assembly and approximately paralleled the rupture. (See Figure 10.)

The two trailer suspension axles were not parallel. The rear end of the right rear spring was outside of and below the transverse rebound bolt in the right rear-spring hanger. This dislocation permitted the left end of the rear axle to move forward 3 inches. Both the right and left springs on the rear axle had been installed backward.

The upper coupler plate on the fifth-wheel assembly was deformed downward in the area surrounding the kingpin. The ladder at the right-side rotary gauge had torn loose from its tank-shell mounting pads.

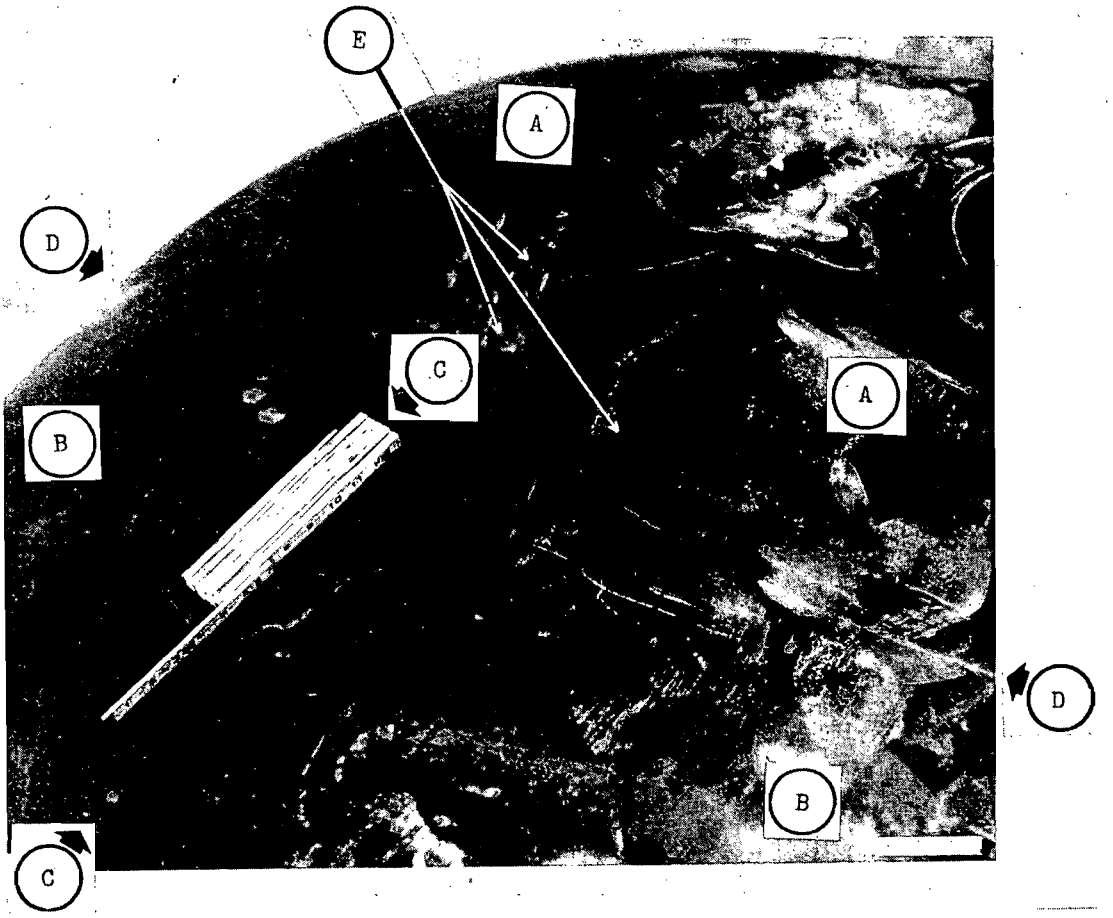

Figure 10. Rupture in head material (A), and shell material (B), to left and rear of manway. Circumferential head-to-shell weld area (C), and longitudinal shell weld area (D). Longditudinal scratch pattern (E).

The Truckdriver

Employment. The truckdriver was a 28-year-old male. He had been employed by Merritt Trucking Company, Inc., as a driver-mechanic at the O'Boyle Tank Lines terminal in Chesapeake, Va., from July 10 to October 31, 1969, at which time he resigned. He was again employed by Merritt as a truckdriver on October 31, 1971, at the O'Boyle terminal in Apex, N.C.

The truckdriver's application for employment as a truckdriver with Merritt, dated October 31, 1971, showed that he held a New York chauffer's license, that this license had been suspended or revoked and that he had two traffic convictions and two accidents. The application, written examination, employment checks, road tests, and road test certification were administered and signed by the assistant terminal manager, the truckdriver's brother.

Final approval of any truckdriver hired by Merritt Trucking Co., Inc., to drive a tractor leased from Merritt by O'Boyle Tank Lines, Inc., hauling an O'Boyle-owned semitrailer, rested entirely with O'Boyle, after review of the employment application and records. This driver had been so approved.

Licensing. At the time of the accident, the truckdriver held a valid North Carolina chauffeur's license, issued December 15, 1971, in addition to his New York license. He had previously held Florida and Virginia driver's licenses. The New York license required the

truckdriver to wear corrective lenses; the North Caroline license did not.

In obtaining the Florida, North Carolina, and New York licenses, the truckdriver had falsified each application by stating that his driving privilege had not been suspended or revoked by any other State and that he had neither been involved in a motor-vehicle accident nor had been convicted of a traffic violation. The motor-vehicle laws of each of these States invalidate the license of or otherwise penalize any driver who falsifies his license application.

The motor-vehicle administrations in New York, Florida, and North Carolina do not check all driver-license applicants with the National Driver Register to determine whether the applicant's license to operate a motor vehicle is under suspension or revocation in another State. Nor do they, as standard procedure, check the applicant's driving record in States which, to their knowledge, had previously issued him licenses.

A summary of the truckdriver's licensing and driving history is contained in Appendix B.

Activities on the day of the accident. On March 9, the truckdriver reported on duty at 10:00 a.m., arrived at the Dixie Pipeline Company terminal, Apex, N.C., at 10:20, and departed at 10:50, enroute to Goshen, Va., a distance of approximately 207 miles. The truckdriver received verbal directions from the Apex terminal manager and two senior drivers concerning which routes to follow, since this was his first trip to Goshen. It is not known whether the driver wrote down the directions, but he apparently followed the routing as far as the junction of U.S. Route 501 with U.S. Route 29. Then, instead of taking U.S. Route 29, the bypass north to Virginia Route 130, he continued through Lynchburg on U.S. Route 501. The reason for his not following the directed route is not known.

Emergency response

The Big Island Volunteer Fire Department received a report of a truck fire at 2:35 p.m. and sent all five of its units. Four units arrived at the scene at 2:43 p.m., and the fifth unit arrived shortly thereafter. Two units from the Boonsboro, Va., Volunteer Fire Department arrived at 3:00 p.m. Water was used exclusively to fight the truck and woods fires. The main objectives were to keep the fires "knocked" down as much as possible and to keep the tractor and trailer as cool as possible. The trailer cargo fire was topped out at 12:30 a.m. on March 10. The trailer was then filled to the rupture opening with water.

The Big Island Emergency Crews, Inc., received a report of the accident at 2:33 p.m. and dispatched two ambulances and a light-duty crash truck. Emergency units from Campbell County and Lynchburg also assisted.

The burn victims were taken by ambulance to the Lynchburg General Hospital, approximately 14 miles south of the accident scene. One severely burned victim was transferred to the Burn Center at the Medical College of Virginia at Richmond.

Applicable Standards and Regulations

The "MAXIMUM SAFE SPEED 20" legend does not appear on the advisory-speed plate in the manual on traffic-control devices published by the Federal Highway Administration (FHWA).[5] The legend, which indicates a maximum safe speed of 20 m.p.h., does appear, however, in a similar manual published by the Commonwealth of Virginia.[6] Likewise, the "PASS WITH CAUTION" sign is not in the FHWA manual but is in the Virginia manual.

The policy of the Virginia Department of Highways is to use "PASS WITH CAUTION" signs and broken centerlines on roads in mountainous areas. "NO PASSING" signs and pavement barrier stripes (solid centerlines) are not used on such roads where the signs and stripes

[5] Federal Highway Administration, *Manual on Uniform Traffic Control Devices for Streets and Highways,* p. 81.

[6] *Commonwealth of Virginia Manual on Uniform Traffic Control Devices for Streets and Highways,* p. 630.

would create long no-passing zones. Under certain circumstances, automobiles can safely pass slow-moving vehicles on uphill grades with limited clear-sight distances, and this opportunity would be denied if "NO PASSING" signs and solid centerlies were present.

The FHWA manual calls for the establishment of no-passing zones and installing pavement barrier stripes at horizontal curves on roads where the clear-sight distance is inadequate. Based on the criteria set forth in the FHWA manual[7] or on those established by the American Association of State Highway Officials (AASHO),[8] the curve on which this accident occurred did not have adequate clear-sight distance for passing.

Virginia law requires drivers to drive on the right side of the road at all times except when passing or turning. The Driver's Manual of Virginia, however, does not discuss the "PASS WITH CAUTION" sign or the State policy concerning passing on sharp curves and steep grades on mountainous roads.

Federal regulations which are pertinent to this accident include 49 CFR 177.823(5)(b)(1) and (2), which concern the labeling of trucks carrying hazardous materials; 49 CFR 178.337-16(b)(2), which concerns tank-weld testing and inspection; and 49 CFR 397.9, which concerns the routing of trucks carrying hazardous materials.

III. ANALYSIS

Vehicle Dynamics

As it approached the accident site, the tractor-semitrailer made a 30° turn to the right, straightened, and made a 31° turn to the left, which carried the vehicle into the southbound lane on the 48° curve in the highway. The truck turned back to the right, i.e., toward the northbound lane, and then made the sharp left turn which immediately preceded overturn.

At the moment of overturn, two factors were present to reduce the stability of the truck. The first factor was the misalignment of the tractor and the trailer caused by the final left-turn movement. This misalignment reduced the angle between the fifth-wheel crossshaft and the longitudinal axis of the trailer from 90° (perfect alingment) to an angle commensurate with the turn. This change in the angular relationship between the crossshaft and longitudinal axis reduced stability at the front of the trailer.

The loss of maximum resistance to overturn due to tractor-trailer misalignment was compounded by the already high center of gravity, which was made even higher at the front of the trailer by the downgrade of the road. When the truck entered the 48° curve, the 6.9-percent downgrade raised the level of the liquid cargo to about 5 inches below the top of the tank at the front of the trailer and reduced it to about 29 inches below at the rear (effects of surge and superelevation not included). This change in the cargo height effectively raised the trailer's center of gravity above the nominal 84 inches at the front of the trailer and reduced it below 84 inches at the rear. In the final left turn, the center of gravity at the rear of the trailer, which was 76.6 inches above the road, shifted an estimated 2.0 inches to the right as a result of spring deflection. The trailer's center of gravity had also moved forward as a result of the downgrade.

On a level road, with no cargo surge and no superelevation, the tractor-semitrailer would have had a calculated stability factor of .546.[9] From this factor, it can be estimated that the vehicle could have resisted a steady, lateral turning acceleration of between .5 and .6 g, if no surge were present.

If the truckdriver had followed the 119-foot radius of the 48° curve engineered into the road, at the estimated speed of 25 m.p.h., the turck would have experienced about .35 lateral g, and

[7] FHWA, *op. cit.*, p. 186-190.

[8] AASHO, *A Policy on Geometric Design of Rural Highways - 1965*, p. 140-151.

[9] This is a relatively low overturn-stability factor; typical American passenger cars have a stability-factor range of between 1.0 and 1.4.

the accident would not have occurred. The 184-foot radius made possible when the truck crossed into the southbound lane would have reduced this lateral g by about 35 percent, if the turn had been completed on the longest radius. In order to overturn (surge discounted), the truck would have had to reduce its turning to a radius 76 feet or less, which is a very sharp turn for a vehicle of this type.

The truckdriver, however, did not stay on the 184-foot radius. Instead, he turned back to the right to avoid the oncoming vehicle and then turned sharply to the left to avoid the rock embankment. These evasive maneuvers resulted in a centrifugal force which combined with a second force, lateral surge of the liquid cargo, to contribute to the overturn of the vehicle.

As the truck passed through the series of curves south of the accident site, excitation of the liquid cargo resulted in lateral surge of unknown magnitude. Because of the difference in the level of the cargo at the front and rear of the tank, the pattern of surge is difficult to analyze. In general, lateral surge of a partially loaded tank displays a pendulum-like characteristics and has a natural frequency at which lateral excitations can produce a resonant build-up. In this accident, such a pendulum-like surge could have aided overturn, or could have had little effect, depending on the timing of the swings in relation to the turn. Surge seldom opposes overturn enough to prevent it.

Thus, the instability of the truck at the moment of overturn, and the centrifugal force and lateral surge produced by the sequence of evasive maneuvers were sufficient to overturn the vehicle. Whether the truckdriver knew with any degree of accuracy the circumstances which would cause his vehicle to overturn is unlikely. It is not practical for a driver to test the overturn characteristics of his vehicle, and the essential parameters by which an estimate could be reached are not available in the state of the art. The Safety Board has previously recommended that stability factors be analyzed and made known to drivers,[10] but at present a truckdriver must rely on his own experience and judgment. The calculated overturn stability of a vehicle when loaded is not required to be determined as an engineering design factor in the manufacture of the vehicle.

In this accident, the relative contribution of each of the overturn forces and factors is difficult to determine because of the present lack of understanding of liquid surge loadings. The Safety Board is aware of an existing National Highway Traffic Safety Administration (NHTSA) contract which will study the performance parameters necessary to evaluate road worthiness of trucks and to compile data on predicted behavior during vehicle operations. The Board believes that the proposed program, as outlined in NHTSA's Statement of Work, will not adequately resolve the liquid-surge problem described both in this report and in the Moscow, Pa., report. Any such program should study not only various volumetric loadings, but should also study variables such as specific gravity, viscosity, tank cross section, and tank fore-and-aft attitudes, as well as the relationship of surge to center-of-gravity height. Such variables should be resolved both for straight tank-truck and for articulated tank-trailer operation. In the Moscow, Pa., report, the Safety Board recommended (H-72-45) that the Bureau of Motor Carrier Safety (FHWA) cooperate with affected industries in an investigation of the surge problem.

Through demonstration tests, the Board determined that the right rear spring dislocation had no bearing on the accident. Since the gouge marks in the roadway at the accident scene matched the spacing between centers of the hubs of the dual wheels of the rear axles, the

[10] National Transportation Safety Board, *Tank-Truck Combination Overturn onto Volkswagen Microbus, Followed by Fire: U.S. Route 611, Moscow, Pa., September 5, 1971*, NTSB-HAR-72-6; and *Multiple-Vehicle Collisions under Fog Conditions, Followed by Fires, New Jersey Turnpike, North of Gate 2, November 29, 1969*, NTSB-HAR-71-3.

axles were not displaced before the truck overturned. As the trailer began to overturn, the right-side trailer wheel rims were temporarily embedded in the road surface. As lateral forces pulled the truck outward, the wheel rims were held by the pavement, the axles were pulled away from the trailer, and the right rear spring dislocation occurred at the rear-spring hanger.

The Cargo

If the cargo had not been a hazardous material, the fatalities would not have occurred. Because it is heavier than air, propane tends to diperse toward elevations below a spill. When the trailer came to rest on its side, the internal pressure from the cargo propelled the propane at a high velocity through the fracture in the tank wall. Once the trailer tank wall was breached, the progressive enlargement of the danger zone was inevitable. The escaping liquid vaporized apidly upon exposure to the atmosphere; the velocity of the escaping propane accelerated the mixing and dispersion of the propane vapors in the air. It is estimated that about 4,000 gallons of liquified propane was discharged before the level of the liquid gas dropped below the level of the rupture, and the flow of liquid stopped.

It is likely that this large flow and vaporization of propane resulted in a concentration of propane-in-air in excess of the upper flammable limit as the vapor enveloped the tractor. Thus, the ignition of the propane-air mixture was apparently delayed until the flow rate declined and the concentration of propane-in-air fell within the flammable range.

The visible vapor cloud cannot be relied upon to delineate the danger zone in a spill of this nature. When the vapor cloud ignited, it was expanding around the truck, but had not reached the motorists approximately 450 feet downhill. Similarly, when the cloud ignited, the occupants of the residence were about 420 feet from the truck. The vapor cloud had almost obscured the house from their view as it flowed into the hollow, but the cloud had not reached them.

Since the motorists and residents were outside of the vapor cloud, the burns they received were caused by thermal radiation, rather than contact with the propane. Nevertheless, the location of the victims at the time of the ignition helps to establish the danger zone associated with propane spill in this type of accident. The 12 acres of forest that burned after the ignition suggest additional boundaries of the danger zone. Because the fire damage from the initial ignition of the propane cannot be reliably separated from the resultant fire, the entire fire-damage area constituted the danger zone associated with the propane spill.

From the observations of witnesses, it appears that the propane-air mixture ignited in the area of the truck. The engine had been heard racing after the overturn of the truck. The racing was probably caused by the intake of the propane-air mixture. Sources which could have ignited the vapor cloud might have been the hot engine, a damaged truck battery, or broken electrical circuits.

Vehicle Operation

The truckdriver, who had not driven this route before, did not follow the route he had been orally told to take. The recommended route had fewer sharp curves and steep grades than the route he followed.

The sequence of events in this accident demonstrates the desirability of careful route analysis and selection to avoid sharp curves, long steep grades, and other environmental hazards. Route analysis must also assess the risk to those who live, work, and travel along the roads to be taken. The Motor Carrier Safety Regulation (MCSR) contained in 49 CFR 397.9 (Routes) requires route selection but limits the criteria for route analysis to "heavy populated areas, places where crowds are gathered, tunnels, narrow streets, or alleys." This accident demonstrates the need for other criteria.

It is not known whether the truckdriver did not understand or forgot the route instructions or whether he missed a turn. If the instructions had been in writing, the truckdriver would have had a basis for compliance and checking. Written route direction is required by 49 CFR 397.9 for the transportation of Class A or B explosives. Since heavy loss can also result from a hazardous materials spill, this precaution applied to Class A and B explosives should be extended to include shipments of bulk hazardous materials.

The truckdriver had been operting the truck prudently until he entered the advisory 20-m.p.h. maximum-safe-speed zone south of the rollover point. The bushes and trees alongside the highway prevented the truckdriver from seeing the southbound automobile as it came around the curve 600 to 700 feet ahead of him (400 to 500 feet across the curves). However, he could see the broken centerline marking of the 48° curve.

The broken centerline indicated only that it was legal to cross for passing or turning, and was not a guarantee of sight distance. Nevertheless, in most States, a broken centerline is used only where sight distance is sufficient to allow passing. The opposite condition, where sight distance is too short, is generally marked by a solid line. These standard markings are used in most of Virginia. Thus, the driver might have deduced that the absence of a solid line meant that passing sight distance was assured by the road design. This is particularly possible in view of the absence of any explanation in the Virginia Driver's Manual of the unique marking policy used on mountainous roads.

If this driver did conclude that the "PASS WITH CAUTION" sign and the broken centerline meant that sight distance was adequate for passing, he could also have concluded that the sight distance needed to take the curve on the inside would be adequate. If, on the other hand, a "NO PASSING" sign and solid barrier stripes had been present on this curve, the driver would have been better able to recognize the lack of adequate sight distance and the need to stay on the right side of the road.

After the truckdriver returned to his own lane, the automobile driver was able to stop well short of the point of overturn, and the vehicles were still about 100 to 150 feet distant when the truck came to rest. The distance between the passenger car and the truck when the truck regained its lane was about 300 feet, with the truck moving at 25 m.p.h., and the car at "about 30 to 35 m.p.h." Thus, the truckdriver could have employed a somewhat less radical lane-change maneuver. The sharpness of the lane change increased clearance for the other vehicle, but caused the overturn.

The fact that truckdrivers cannot be trained to visualize a certain degree of maneuver in relation to vehicle overturn tendencies is significant. In this accident, the driver could have employed a spiral path to reduce the effect of the lane change; however, since the truckdriver had no way of knowing the overturn boundary, he made a turn that proved too sharp. Lane-change tests have been standardized for passenger cars, which have great stability, but have not been standardized for trucks, which may have much less overturn stability.

Trailer Design

Manway cover assembly. Traveling at a speed of 25 m.p.h., the truck possessed more than 1.5 million foot-pounds of energy before impact with the rock outcropping. Since the 60-foot slide made by the vehicle before and after impact absorbed approximately 1 million foot-pounds of energy, about 500,000 foot-pounds must have been absorbed by the truck druing impact with the outcropping.

The impact forces sheared off six of the .625-inch-diameter studs which protruded above the manway cover. Based on the cross-sectional area of these studs and their estimated shear strength (determined by the Rockwell Hardness Test), approximately 150,000 pounds of force was necessary to shear the studs. This represents only the force component which was at right angles to the vertical centerline of the studs.

Other force components, of unknown magnitude and not involved in the shearing of the studs, pushed inward and rearward on the manway cover. These forces, along with the force which sheared the studs, were transferred through the relatively stiff manway cover and manway reinforcing member into the 0.250-inch-thick head material. The resultant buckling caused by this increase of loadings onto the head material induced stresses of sufficient magnitude to rupture the material. The rupture then crossed the circumferential welds into the thicker, 0.387-inch-thick shell material.

The course of the rupture across the head-to-shell circumferential welds attests to the integrity of those welds. Furthermore, the buckling of the right side of the head, adjacent to the welds, demonstrates the ductility of the steel used in this tank. That ductility probably could have absorbed the trailer-to-rock impact loading, if the loading transmitted by the manway cover assembly had not been concentrated on the head and shell material. If the manway cover had been located elsewhere, the impact loading would possibly have been distributed over a wider area, and the rupture might not have occurred.

The Federal specifications under which this tank was designed and fabricated (49 CFR 178 and 337) do not require a specific manway location. It is logical, however, to assume that the upper portion of the front head of an MC-331 cargo tank would be more likely to be exposed to high impact loadings in an accident than would a similar location at the rear of the tank.

Metallurgical analysis of failure. Metallurgical examination of the tank-semitrailer disclosed no evidence of failure of any weld or any pre-existing cracks that might have contributed to the material failure. The characteristics of the tank material appeared normal for properly hardened and tempered 115 KSI tensile-strength steel.

Review of radiogrphic negatives taken during an inspection after construction of the tank disclosed no abnormalities.

Hazards Associated with the Transportation of Propane

Danger warnings. The bystanders injured in the explosion could not see the warning markings on the trailer because of the configuration of the wreckage, and, probably, because of the density of the vapor cloud. If they had been able to see the markings, the bystanders would have received no indication of the nature of the threat to their safety. The propane was odorized, but none of the injured recognized the odorizer as a warning of the danger. Thus, in this accident, both the warning markings on the truck and the visual and olfactory characteristics of the propane relied upon to warn bystanders failed. This problem requires attention, particularly if the material carried is heavier than air, disperses rapidly, and has a danger zone which extends a significant distance from the point of release.

If the hazardous information warning system now under consideration as proposed rulemaking by the Department of Transportation (Docket HM-103) had been in use in this accident, the results would have been unchanged. This system does not convey the message far enough to serve as an effective warning in the situation that existed.

Explosion hazard. The phenomenon of the "explosion" of a vapor cloud which results in casualties has been noted in accidents in other modes. The need for a better understanding of unconfined vapor cloud explosions is currently being studied,[11] and methods for predicting blast effects are being considered. However, the burn-injury mechanism which produced the casualties in this accident also merits examination. Development of a capability for predicting the full range of injurious effects from these explosions is necessary before more effective countermeasures to protect the public can be instituted.

[11] Roger A. Strehlow, "Unconfined Vapor Cloud Explosions–An Overview", AAE TR 72-1, University of Illinois, Urbana, Illinois, 1972.

Driver Licensing and Centralized Records

The truckdriver had been licensed to drive a motor vehicle in four States, and at the time of the accident he held two driver's licenses. At least two of these States do not require the surrender of driver's licenses issued by other States before issuing a driver's license to an applicant. Surrender is required by the Highway Safety Program Standard No. 5.

The truckdriver's Florida, New York, and North Carolina licenses were each obtained on falsified applications. Had each of these States checked with the previous licensing State and with the National Driver Register, the State would have discovered the false statements and should have refused to issue a license to this driver.

This illustrates the desirability of State adoption of the provisions of the Uniform Vehicle Code, Chapter 6 (Driver's licenses), and State implementation of the provisions of Highway Safety Program Standard No. 5.

Driver records from the National Driver Register are not available to employers. This source of information is limited to those State and Federal agencies that issue driver licenses and reveals only whether an individual's license to operate a motor vehicle has been suspended or revoked. No record of traffic convictions is maintained in the National Driver Register.

An employer's knowledge of an applicant's driving record depends on the accuracy and completeness of the information furnished by the applicant. If the applicant fails to give a true resume of his driving record, the employer will have difficulty in obtaining a full and complete report from each of the States which may have licensed the applicant.

By making the National Driver Register (NDR) available to employers of persons who as a requirement of their employment have to hold a valid driver's license, and by expanding the scope of the data in the NDR to include convictions for traffic violations, the number of improperly licensed and undesirable drivers would be greatly reduced.

In March 1973, the National Highway Traffic Safety Administration awarded a contract to the Safety Management Institute to conduct a study of the future role of the National Driver Register. The purpose of this indepth study is to produce a "State-Federal consensus plan" to determine what role the NDR will have in future nationwide, and perhaps international driver records communications. The contract Statement of Work does not require that the study give consideration of the accessibility to the NDR by employers or prospective employers as discussed above. The absence of such a specific requirement in the study thus omits an important factor.

IV. CONCLUSIONS

1. The truck was being operated at 25 m.p.h., a speed slower than the legal posted maximum speed of 45 m.p.h. for trucks, but faster than the posted advisory maximum safe speed of 20 m.p.h. for the series of curves the truck was negotiating.
2. The existing traffic-control devices did not provide effective control. The advisory maximum-safe-speed sign, in conjunction with the winding-road sign, did not legally require the truckdriver to slow down to the posted speed. The "PASS WITH CAUTION" sign and the broken centerline implied that passing was practical in the curve and that sight distance was adequate for passing.
3. The 225-foot sight distance in the accident curve was inadequate for safe passing and therefore the curve should have been marked as a no-passing zone in compliance with FHWA Manual On Uniform Traffic Control Devices.
4. Had the "PASS WITH CAUTION" sign been a "NO PASSING" sign and had the broken centerline been a solid no-passing barrier line, it is doubtful that the truckdriver would have crossed into the opposing lane.

5. The truckdriver's use of the opposing lane for purposes other than passing was contrary to Virginia law.
6. The Virginia policy for signing and marking of sharp curves on mountainous highways is contrary to the FHWA Manual on Uniform Traffic Control Devices and had not been explained to the public.
7. Had the truckdriver been on the route he had been told to follow, the accident probably would not have occurred. No conclusion could be reached as to why the incorrect route was followed.
8. The evasive action taken by the truckdriver, i.e., turning to the right, back toward the northbound lane, to avoid the oncoming southbound car and then steering to the left to avoid the rock embankment, produced a centrifugal force. The lateral surge of the cargo, the centrifugal force, the instability of the truck which resulted from tractor-trailer misalignment, and a shifting center of gravity were sufficient to overturn the truck.
9. The truckdriver returned to the right lane well before his vehicle could have struck the oncoming southbound automobile.
10. The center-of-gravity height of the truck lowered the vehicle's overturn stability and limited its maneuverability to a degree which was difficult for the truckdriver to gauge. The calculated stability factor in the range of .5 to .6 g permitted the truck to be overturned by steering maneuvers substantially less severe than needed to produce overturning or skidding in most highway vehicles.
11. The design and fabrication of the MC 331 trailer performed well in this accident with one exception. The location and design of the manway cover assembly in the front hemispherical tank-head allowed the assembly to transmit impact loadings which caused failures in the head and shell materials.
12. The regulatory warnings displayed on the trailer, which met the requirements of 49 CFR 177, did not adequately inform the bystanders who were injured of the threat to their safety.
13. The use of an odorizer in the propane cargo to warn the public of hazards was not effective in this spill.
14. The vapor cloud ignited at the truck.
15. The failure of the States which issued driver's licenses to this driver to comply with all the provisions of Highway Safety Program Standard No. 5 enabled the truckdriver to obtain driver's licenses which should not have been issued.
16. If the truckdriver's complete motor-vehicle driver record had been known by his employer, he probably would not have been hired as a truckdriver.
17. The trailer rear spring dislocation occurred during the vehicle overturn and did not contribute to the accident.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the cause of the overturn was the driving of the tractor-semitrailer on the wrong side of the road, and a subsequent evasive steering action which exceeded the limited capability of the truck to resist overturn. Contributing factors included a misleading traffic-control sign, an inadequate road-marking system, and the high center of gravity of the truck. The cause of the burn fatalities and injuries were rupture of the tank at a point susceptible to rupture and the inadequacy of the required placards as a means of warning bystanders of the nature and range of the hazard.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Hazardous Materials Regulations Board of the Department of Transportation and

the Tank Truck Technical Council consider the desirability of amending 49 CFR 178.337-6 (Closure for manhole) to require that all manhole assemblies in MC 331 pressure vessels manufactured after a specified date be located in the upper quadrant of the rear hemispherical head to minimize the possibility of manhole-assembly collision with other vehicles or objects. (Recommendation No. H-73-20)

2. The Office of Hazardous Materials study the warning system deficiencies demonstrated in this accident. The proposal for a Hazardous Material Information System issued by OHM on June 6, 1972 should be carefully reviewed to insure that warnings of impending danger and advice are given in an understandable manner to the general public as well as to emergency personnel. The capability of the system to warn those at a distance should be equal to the range of the hazard and should not rely on the physical condition of the driver. The system should function under all weather conditions and the range of warning should be specified by regulation. (Recommendation No. H-73-21) This recommendation was previously published in the Board's report NTSB-HAR-72-5, *Automobile/Truck Collision Followed by Fire and Explosion of Dynamite Cargo, U.S. Highway 78 near Waco, Georgia, on June 4, 1971.*
3. The Bureau of Motor Carrier Safety (Federal Highway Administration) revise the Motor Carrier Safety Regulation contained in 49 CFR 397.9 as follows:
   a. Part (a) be revised to require the safest feasible route with strict compliance by the driver;
   b. Part (b) be revised to include, in addition to Class A and Class B explosives, all bulk hazardous materials that can disperse or react with violent, abrupt, incapacitating or lethal effects; and to require that a driver preparing a written route plan when he begins a trip at a location other than the carrier's terminal, mail a copy of the written route plan to the carrier before departure. (Recommendation No. H-73-22)
4. The National Highway Traffic Safety Administration expedite its proposed rulemaking on Highway Safety Standard No. 5 (Driver licensing), and expand the standard to require that each State, before issuing a new or renewal driver's license, check with the National Driver Register to determine whether the applicant's right to drive is under suspension or revocation in any jurisdiction. (Recommendation No. H-73-23)
5. The Bureau of Motor Carrier Safety (Federal Highway Administration), in cooperation with the Tank Truck Technical Council, investigate the overturn stability problem created by liquid cargo surging in tank-truck combinations. The ultimate objective of such an investigation should be the promulgation of Federal regulations to specifically limit the effects of surge. (Recommendation No. H-73-24)
6. The National Highway Traffic Safety Administration modify the work statement of the National Driver Register study being conducted by the Safety Management Institute, to assure that specific consideration is given to the accessibility to the Register by employers or prospective employers of persons who are required, as a condition of employment or retention, to possess a valid motor-vehicle driver's license. (Recommendation No. H-73-25)
7. The Federal Highway Administration (FHWA) review the policies of the Commonwealth of Virginia relative to compliance with the standards in the FHWA Manual on Uniform Traffic Control Devices which concern the signing and marking of highways in mountainous areas. (Recommendation No. H-73-26)
8. The Commonwealth of Virginia review its policies of signing and marking highways in mountanous areas for conformity with the FHWA Manual on Uniform Traffic Control Devices. (Recommendation No. H-73-27)

9. The National Highway Traffic Safety Administration amend its proposed revision of Highway Safety Program Standard No. 5, Driver Licensing, to add the provisions of Chapter 6, Article I, Section 6-106(c) of the Uniform Vehicle Code, Revised 1968, and require that whenever an application is received from a person previously licensed in another jurisdiction, a copy of such driver's record be obtained from such other jurisdiction, thus determining, before issuing or renewing any motor vehicle driver's license, if the applicant had an accident or traffic-violation record which might preclude the issuance of a motor vehicle driver's license in the inquiring State. (Recommendation No. H-73-28)

10. The several States adopt and fully implement the provisions of Chapter 6, Article I, Section 6-101 (c) of the Uniform Vehicle Code, Revised 1968, which sets forth the "one license concept" of driver licensing, to assure that each licensed motor-vehicle driver holds only one valid driver's license. (Recommendation No. H-73-29)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

Louis M. Thayer, Member, filed the attached statement, concurring and dissenting.

May 24, 1973.

Thayer, Member, concurring and dissenting.

I concur in the report of this accident and the recommendations except Recommendation 6, and collectively Recommendations 4, 6, 9 and 10.

With respect to Recommendation 6, I believe that the work statement of the National Driver Register study is sufficiently broad to include employers and prospective employers. Specifically, Task 10 in the work statement applies to the public in general, which would include employers and prospective employers. Therefore, I consider this recommendation to be redundant.

Recommendations 4, 6, 9 and 10 are inter-related. If Recommendation 4 were implemented by the National Highway Traffic Safety Administration, and if the study of the National Driver Register mentioned in Recommendation 6 determines that the National Driver Register, which is authorized to include virtually all kinds of denials and withdrawals of driver licenses, is to serve as a national clearing house for driver records, Recommendations 9 and 10 would be superfluous. I believe that the ultimate goal is to assure that a driver's license is truly valid and that the National Driver Register should be the mechanism to reach that objective. At such time as that ultimate goal is reached, most of the regulations in 49 CFR 391.11 through 391.27, applicable to employers and prospective employers, would be unnecessary.

In the meantime, I would recommend that no resources should be expended on interim or stop-gap programs, but that every effort should be made to reach the ultimate goal at the earliest time.

L. M. Thayer
June 13, 1973

APPENDIX A
CHARACTERISTICS OF PROPANE

Propane is classified as a liquefield petroleum gas (LPG) because at atmospheric pressures and ambient temperatures it is gaseous, but can be readily contained and stored as a liquid under increased pressure. When the pressure on propane is reduced below the critical point, the liquid vaporizes and forms a gas about 1.5 times as heavy as air. Liquid propane has a direct pressure temperature relationship; at minus 50° F. propane is a liquid under atmospheric pressure; at 100° F. propane is a liquid at 192 p.s.i.g. When propane vaporizes, it expands rapidly and absorbs a tremendous amount of heat from any substance with which it comes in contact. The whitish haze or fog commonly associated with spilled propane is not propane gas itself, but is the frozen water vapor present in the surrounding air which has been chilled rapidly. Some additional properties of propane are:

Vapor pressure, p.s.i.g. at 100° F.	192
Boiling point, °F. at 14.7 p.s.i.g.	- 51
Cubic feet of vapor per gallon of liquid	36
Specific gravity gas	1.554
Specific gravity of liquid propane	.507 [12]
Flammable limits:	
Lower, percentage by volume in air	2.4
Upper, percentage by volume in air	9.6

[12] This data furnished by Dixie Pipleline Company, supplier of the load in the tank.

APPENDIX B
LICENSING AND DRIVING HISTORY OF TRUCKDRIVER

Licenses

A Virginia chauffeur's license, number R15075-48635-664182, was issued to the truckdriver involved in this accident on June 29, 1968 and was revoked on June 27, 1969, under State financial-responsibility requirements, as the result of an accident on April 9, 1969. The driver, however, did not surrender his license to the Department of Motor Vehicles. On June 1, 1969, he applied for a renewal of his license and was issued a temporary permit, number K00041660. The request for renewal was denied on August 25, 1969, on which date the driver gave a sworn statement to the Department of Motor Vehicles claiming that he had lost his license. The subsequent department report showed that the truckdriver had a valid Florida driver's license, which was to expire on June 30, 1970. The revocation of the Virginia chauffeur's license was lifted on April 9, 1970, in compliance with State law. However, the truckdriver did not apply for reinstatement.

The Florida driver's license, number 1339960, had been issued to the truckdriver on August 16, 1969, restricted to corrective lenses. On the license application, the driver did state that he held the Virginia license and that he had surrendered that license to Florida authorities. The Virginia Department of Motor Vehicles, however, has no record of having received the surrendered license.

On December 11, 1969, a New York chauffeur's license, number R15075-48635-664182-44, restricted to corrective lenses, was issued to the truckdriver. This license was to expire on November 30, 1972. The license application indicated that the driver had surrendered the Florida license to New York authorities.

A North Carolina chauffeur's license, number 284726, was issued to the truckdriver on December 15, 1971, to expire on January 20, 1973. In obtaining this license, as well as the Florida and New York licenses, the truckdriver had falsified the application by stating that his driving privileges had not been suspended or revoked in any State and that he had not been involved in a motor-vehicle accident or traffic violation. The laws of each of these three States provide a penalty if a license is obtained by means of a falsified application.

Traffic Record

The known motor-vehicle record of the truckdriver in Virginia includes actions which resulted from two accidents. On April 9, 1969, the driver was involved in a personal-injury accident in Chesapeake. As a result of that accident, he was convicted in Chesapeake Municipal Court, on April 29, of having defective equipment on his vehicle and, on June 27, his license was suspended.

On August 1, 1969, the truckdriver was involved in a property-damage accident in Norfolk. The case against him, which alleged an improper turn, was dismissed.

The driver's record in New York is more extensive. On May 8, 1968, he was convicted of having an unregistered motor vehicle and was fined $15. On December 31, 1969, he was involved in a property-damage accident. On April 18, 1971, the truckdriver was given a summons for speeding and for turning without a signal. He was found guilty of both charges and fined $10 for each.

In North Carolina, the driver was cited for going 55 m.p.h. in a 45-m.p.h. zone on January 20, 1972, and for going 60 m.p.h. in a 45-m.p.h. zone on February 2, 1972. He was convicted on both charges in the Oxford District Court on February 18 and in the Winton District Court on February 14, respectively.