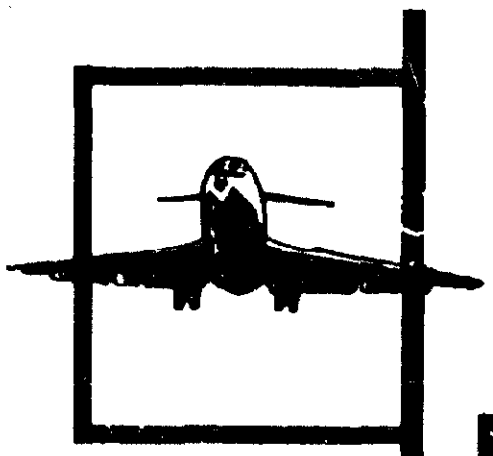
PB 296889

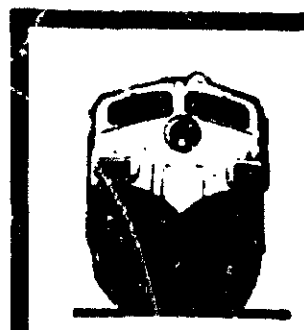
NATIONAL TRANSPORTATION SAFETY BOARD

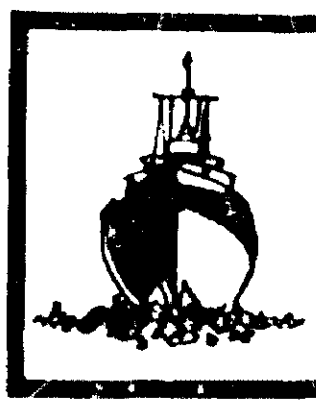
WASHINGTON, D.C. 20594

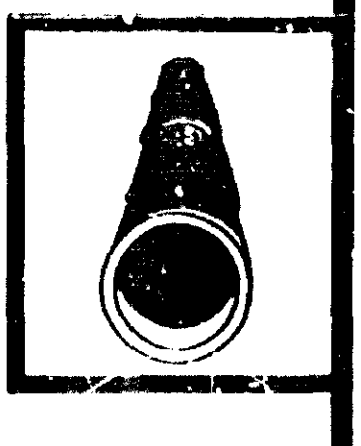
HIGHWAY ACCIDENT REPORT

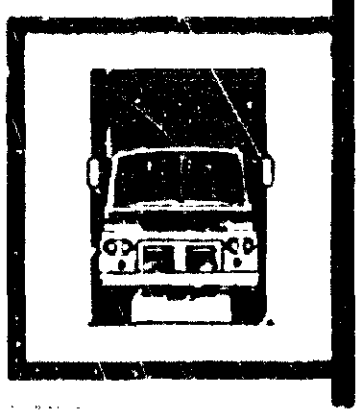
OVERTURN OF
ROSS AMBULANCE SERVICE AMBULANCE
STATE ROUTE 116
LITTLETON, NEW HAMPSHIRE
AUGUST 22, 1978











NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

ERRATA

HIGHWAY ACCIDENT REPORT - Overturn of Ross Ambulance Service Ambulance, State Route 116, Littleton, New Hampshire, August 22, 1978, Report Number: NTSB-HAR-79-4.

PLEASE NOTE: The photograph on page 4 (Figure 2) of the subject report was reversed in printing. See corrected page on reverse side of this ERRATA sheet.

June 4, 1979

UNITED STATES GOVERNMENT

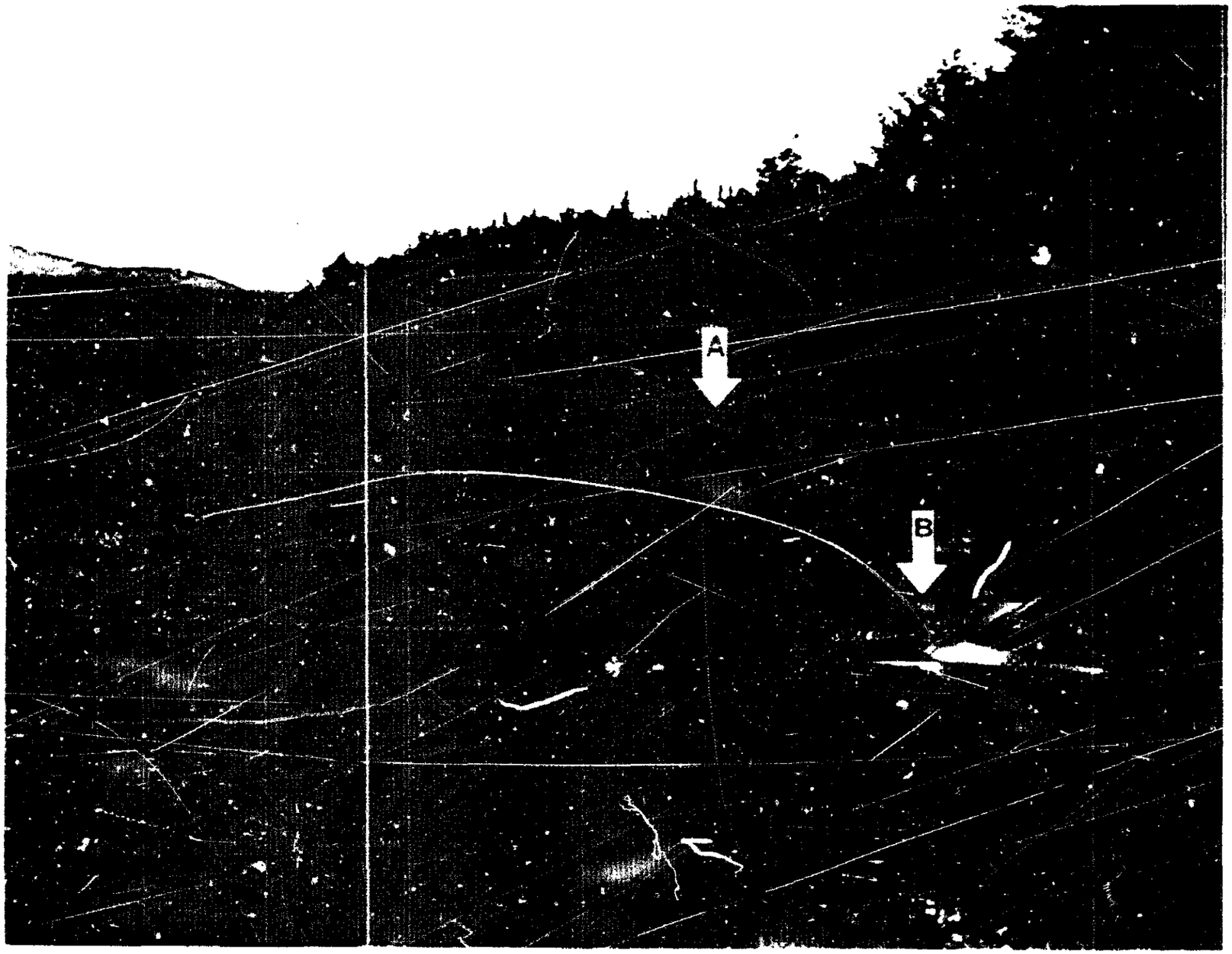


Figure 2. A - Final rest position of the ambulance.
B - Roof cap separated from its attachment.

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16. Abstract

About 3:30 p.m. on August 22, 1978, an ambulance transporting a cardiac patient to a hospital and traveling at a calculated speed of 90 to 95 mph failed to negotiate a curve on New Hampshire State Route 116 east of Littleton, New Hampshire, and rolled over. Two persons in the ambulance were killed and the driver was injured. The patient had died before the accident.

The National Transportation Safety Board determines that the probable cause of this accident was loss of control of the ambulance, which had oversteer characteristics, by an unskilled driver at a high rate of speed. Contributing to the cause of the accident was the driver's lack of training in the operation of the ambulance at high speeds.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: May 3, 1979

ROSS AMBULANCE SERVICE
AMBULANCE OVERTURN
STATE ROUTE 116
LITTLETON, NEW HAMPSHIRE
AUGUST 22, 1978

SYNOPSIS

About 3:30 p.m., on August 22, 1978, an ambulance transporting a cardiac patient to a hospital and traveling at a calculated speed of 90 to 95 mph failed to negotiate a curve on New Hampshire State Route 116 east of Littleton, New Hampshire, and rolled over. The attendants in the ambulance were killed and the driver was injured. The patient had died before the accident.

The National Transportation Safety Board determines that the probable cause of this accident was loss of control of the ambulance, which had oversteer characteristics, by an unskilled driver at a high rate of speed. Contributing to the cause of the accident was the driver's lack of training in the operation of the ambulance at high speeds.

INVESTIGATION

The Accident

On August 22, 1978, the Whitefield, New Hampshire, Police Department requested an ambulance from the Ross Ambulance Service to aid a "Code 3" 1/ cardiac patient at his residence in Whitefield. The ambulance driver, accompanied by an emergency medical technician, arrived to find another emergency medical technician administering cardiopulmonary resuscitation (CPR) to the patient. The ambulance driver and the medical technician found the patient unresponsive to the CPR and described him as being "cyanotic, no pulse, pupils dilated." They decided to transport him to the Littleton, New Hampshire, hospital, 12 miles away.

Once on State Route 116, the ambulance driver notified the hospital by radio of their pending arrival and the patient's condition. She said that she had been driving at speeds of between 65 and 95 mph and had slowed from 80 to 85 mph as she entered a curve near Bethlehem, New

1/ In this region, "Code 3" signifies "emergency, proceed with lights and siren and use utmost caution."

Hampshire. The driver said that "we were beginning to take the curve a little too wide. I pulled the wheel in slightly. I don't know what caused us to swerve the degree that we did, but we were heading for oncoming traffic." Witnesses said that the ambulance was traveling at a high rate of speed. One witness, a former wrecker operator, estimated the speed of the ambulance at about 90 mph as it approached the curve.

Tire markings on the road surface indicated that in the curve the ambulance initially traveled in a leftward curve at a smaller radius than that of the roadway, then traveled rightward toward the outside of the curve, and finally leftward at a very sharp radius. (See figure 1.) During the final leftward movement, with the ambulance in a tilting position, the right front wheel rim dug into the pavement, and the vehicle rolled over to the right. The fact that all vehicle components were deformed downward and toward the right suggests that the vehicle was airborne through the initial 180° to 225° phase of the roll. Evidence on the pavement and vehicle damage indicate that the roll continued through two to three rotations before the ambulance came to rest on its wheels. At some point during the rollover, the fiberglass roof cap shattered and separated from its attachment and all occupants of the ambulance were ejected. (See figure 2.)

The ambulance driver stated that she had no difficulty driving the ambulance before the accident and that she had not been distracted from the driving task by the activities of the attendants in the rear of the vehicle nor by traffic on the highway. She was not operating the radio when the accident occurred.

Injuries to Persons

Injuries	Driver	Passengers	Other
Fatal	0	2 1/	0
Nonfatal	1	0	0
None	0	0	0

1/ An autopsy determined that the patient being transported died before the accident.

Vehicle Information

The 1974 Chevrolet Suburban Custom 10, VIN CCY 164F127588, modified as an ambulance, was owned and operated by the Ross Ambulance Service, of Littleton. The odometer registered 10,962 miles after the accident. The ambulance was equipped with a V8 engine, Model 350 CID4BBL, power steering, power brakes (front disc, rear drum), a front stabilizer bar, heavy-duty front coil and rear leaf springs, and 225-15 Dunlop steel-belted radial tires. The ambulance was painted white with a reddish-orange band midway through the lower body panel.

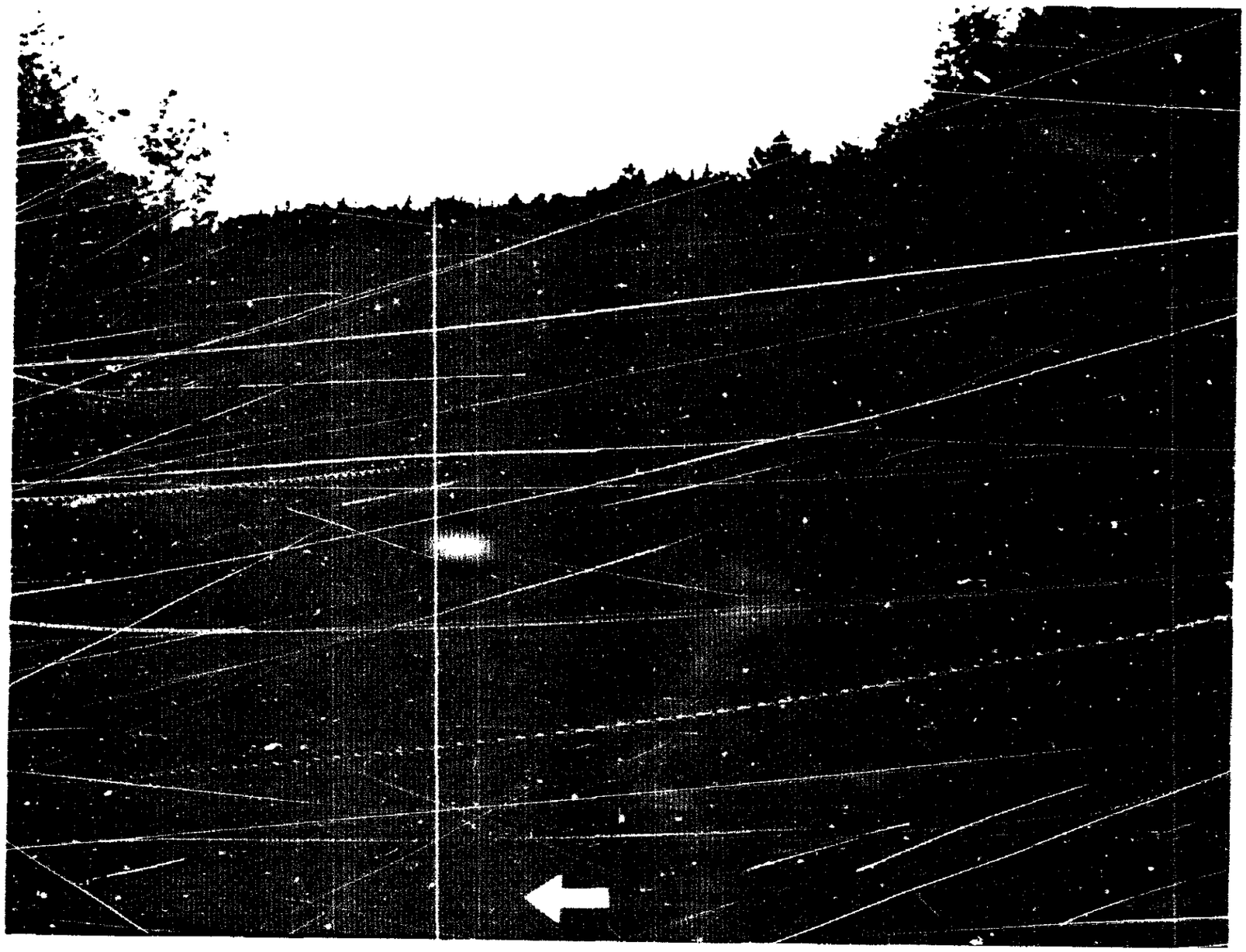

Figure 1. View of accident site. Note start of scuff marks.

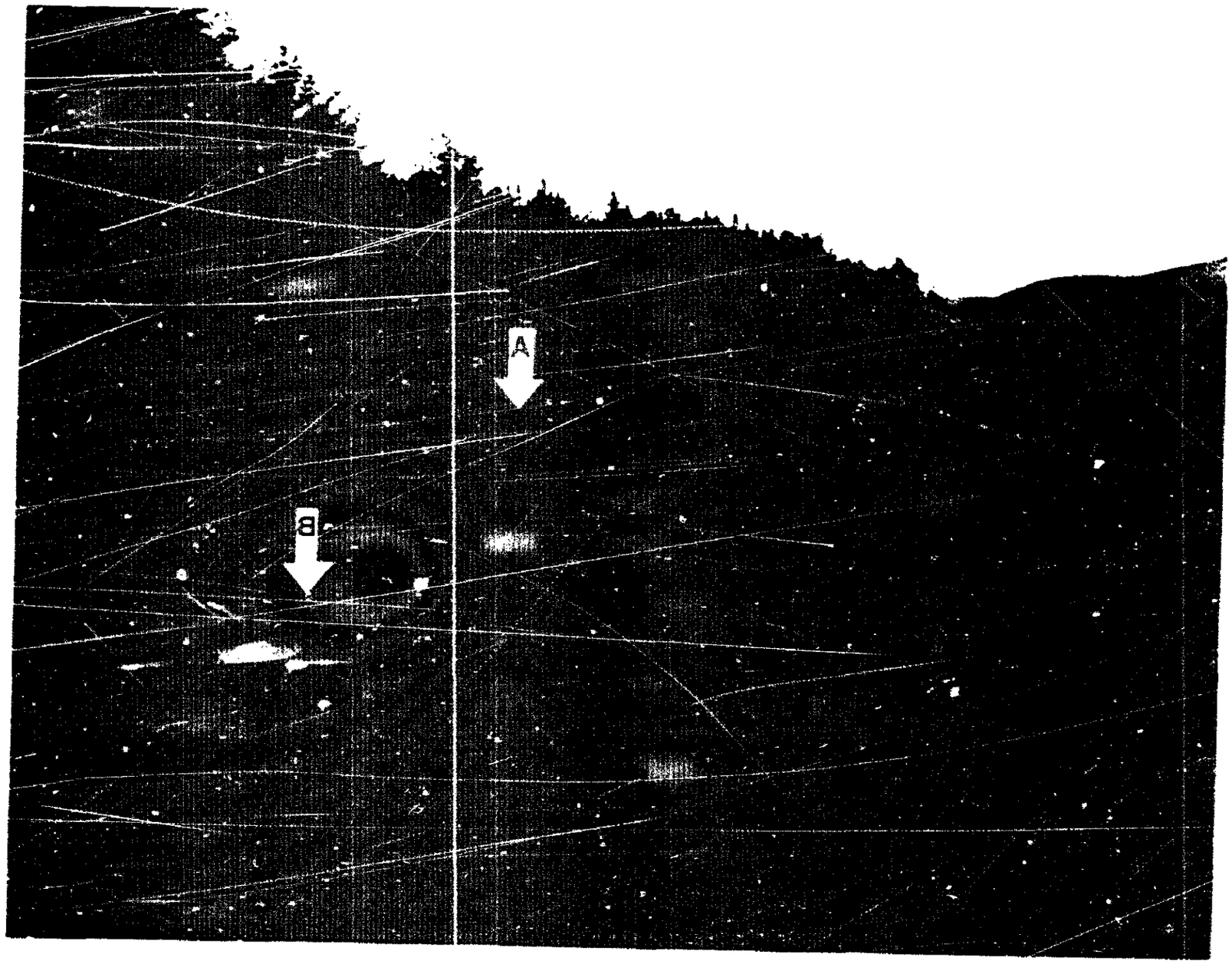

Figure 2. A - Final rest position of the ambulance.
B - Roof cap separated from its attachment.

The vehicle was originally manufactured as a multipurpose passenger vehicle with a gross vehicle weight rating (GVWR) 2/ of 5,400 pounds. The gross axle weight rating was 2,946 pounds for both front and rear axles. The vehicle was later modified by Yankee Coach, Inc., to be used as an ambulance. Ownership passed from Yankee Coach, Inc., to the Ludlow (Massachusetts) Fire Department, and finally on March 3, 1978, to the Ross Ambulance Service. The gross curb weight of the modified vehicle was approximately 6,260 pounds, based on the examination of a similar vehicle, similarly modified. This weight did not include occupants. The weight of the modified ambulance was distributed 47.5 percent (2,974 lbs) on the front axle and 52.5 percent (3,286 lbs) on the rear axle.

The exterior modifications to the accident vehicle included the installation of a custom, reinforced and insulated fiberglass roof cap, extending the full width and length of the roof, to provide 54 inches of headroom in the rear compartment and a metal step installed below the bumper across the rear of the vehicle attached to the chassis by angle iron brackets. Interior modifications included the installation of a vinyl-linoleum-covered plywood floor panel set on 2- by 4-inch wood stringers, unsecured to the vehicle's metal floor; a plywood partition with sliding plexiglass panels installed between the driver's compartment and the rear compartment, to which a rear-facing bench seat and a jump kit rack were attached; a squad bench along the right side of the rear compartment; and cabinets, to which the stretcher clamp-rail was attached, along the left side of the rear compartment. Two portable oxygen bottles were secured in the upper left corner of the rear compartment. The partition, benches, and cabinets were secured to the vehicle sidewalls by means of "L" brackets. These components rested on but were not attached to the plywood or metal floor.

Yankee Coach, Inc., no longer modifies this model vehicle because of insufficient customer demand since the issuance of the General Services Administration (GSA) Specification KKK-A-1822 3/ which applies to modification of ambulances purchased with Federal funds. This specification requires that ambulances have a height and width greater than the ambulance involved in this accident. Since this ambulance was not purchased with Federal funds, the requirements of the specification did not apply.

The vehicle, including a driver and three passengers, weighed 6,930 pounds -- 3,800 pounds (55 percent) on the rear axle and 3,130 pounds (45 percent) on the front axle. This total weight was

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2/ Gross vehicle weight rating is determined by the manufacturer in establishing the maximum capacity of the vehicle and is the total weight of the chassis, body, and payload. (Motor Truck Engineering Handbook, James N. Fitch, p. 24.)

3/ KKK-A-1822, January 2, 1974, Federal Specification - Ambulance, approved by Federal Supply Services, General Services Administration for the use of all Federal agencies.

1,530 pounds (28 percent) over the original gross vehicle weight rating. Federal Specification KKK-A-1822 permitted a payload of 1,000 pounds per "single rear wheel vehicle." If the accident vehicle was of similar weights, it would have been about 530 pounds overloaded, according to the specification.

Section 3.5.4, Weight Distribution of Specification KKK-A-1822 requires that the weight distribution of the fully loaded ambulance on level surface shall be such that not less than 30 percent of the vehicle weight is on the front suspension. Janeway 4/ in discussing cornering stability calls for a "combination of not less than 50 percent of the total weight on the front wheels under maximum load conditions, and independent front suspension."

Vehicle Damage

The postcrash inspection of the ambulance indicated that the fiberglass rooftop cap had shattered and separated completely from the body; all the glass was missing except the vent panel in the right front door and the left rear window glass between pillars C and D. The left front door was operable though severely buckled. The left side rear door and both right doors were jammed shut. The rear access doors were open and deformed.

The interior of the ambulance body was severely damaged. The flooring, oxygen bottles, litter, cabinets, and bench were either destroyed or ejected from the ambulance. Because the plywood flooring was not secured to the floor or chassis, everything attached or resting on it came loose when the ambulance rolled over. All body structures were deformed downward and to the right. (See figure 3.)

The tires and wheels had been removed from the ambulance before the Safety Board's inspection. It was later determined that the two rear tires were deflated due to crash damage. They were both cut or torn laterally. All tires had an average tread depth of from 5/32 to 7/32 inch, which was within acceptable limits. A new tire has a tread depth of about 10/32 inch. The right front tire inflation pressure was 27 psi. The recommended inflation pressure for these tires is 32 psi. It was not possible to determine the precrash inflation pressures of the tires.

There were no precrash mechanical defects observed that may have contributed to this accident or its severity.

4/ Robert N. Janeway, "Vehicle Design Aspects of Safe Handling," Passenger Car Design and Highway Safety, Proceedings of a Conference on Research, Association for the Aid of Crippled Children and Consumer Unions of the U.S., Inc., 1961, pp. 33 and 34.

Figure 3. Collision damage--floor severed from its mountings; seats and cabinets destroyed.

Driver Information

The ambulance driver, age 22, had been employed by the Ross Ambulance Service since February 3, 1978 as an emergency medical technician. Her driver training consisted of the standard high school driver training course while attending school in Vermont, and beginning in July 1978, on-the-job driver training by the owner/operator of the ambulance service and her co-workers. She had driven this ambulance on 10 emergency runs. She did not have formal training for driving an ambulance and did not have defensive or high-speed driver training. She held a valid New Hampshire driver's license with a restriction calling for corrective lenses. She was wearing contact lenses at the time of the accident. She said that she was not wearing the available seatbelt at the time of the crash.

On February 27, 1978, she was licensed as an ambulance attendant by the Emergency Health Services, New Hampshire Division of Public Health. She had completed the following emergency medical care training:

Red Cross Basic Support Course
May 27, 1977 - Central Utah Chapter
Red Cross Advanced First Aid and Emergency Care
May 27, 1977 - Central Utah Chapter
Graduate Emergency Medical Technician - Ambulance
May 27, 1977 - Provo, Utah
Heart Association Basic Life Support Instructor
February 12, 1978 - Berlin, New Hampshire.

She holds a certificate as a nationally registered emergency medical technician issued May 27, 1977. This certification expired on December 31, 1978.

The emergency medical technician course in Utah complies with Federal Highway Safety Program Standard (HSPS) No. 11 "Emergency Medical Services," which does not require that ambulance drivers receive advance driver instruction or pass a driving test. All training is of a paramedical nature. An American Academy of Orthopaedic Surgeons textbook 5/ dealing with emergency driving of ambulances states:

> "Inadequate training of the EMT (emergency medical technician): If the ambulance attendant is inadequately trained or has no confidence in his ability to assist the patient, again, he has little choice but to transport the patient rapidly and to function as a chauffeur rather than as an EMT.

* * *

5/ "Emergency Care and Transportation of the Sick and Injured," American Academy of Orthopaedic Surgeons, Second Edition, Chapter 48, p. 398.

"Inadequate driving ability: The EMT driver who has not been trained in the safe operation of the ambulance will be unaware of the principles governing its proper use. This driver will frequently be inclined to select speed over safety because he does not understand the added risks that speed brings."

* * *

"A comprehensive classroom course of instruction and supervised training on the road are essential to master the techniques and acquire the necessary knowledge for safe ambulance driving...."

Highway Information

New Hampshire State Route 116 is an east-west, two-lane, primary highway from Whitefield to Littleton through hilly terrain. The pavement and shoulders were constructed of asphalt concrete. It was resurfaced with 3/8-inch plant mix (asphalt overlay) in 1974 and again in 1977. The pavement markings consist of a solid, double-yellow centerline and white edgelines. They are in conformance with the "Manual on Uniform Traffic Control Devices" as adopted by the Federal Highway Administration.

At the accident location, the road traverses a cut section with 12-foot travel lanes. The cut slope is on the north side of the roadway. There is a 4-foot shoulder adjacent to the westbound lane, and a 2-foot shoulder adjacent to the eastbound lane. A post-and-cable guardrail is located 2 feet from the outer edge of the eastbound travel lane. A drainage channel runs parallel to the westbound travel lane 7 feet from the outer edge of the 4-foot shoulder. Concrete slab-covered catch basins are located intermittently in the drainage channel and are marked by a wooden post at the east edge of each basin.

The posted speed limit was 50 mph. A reverse curve warning sign was located at the beginning of the horizontal curve. (See figure 4.) The horizontal alignment at the accident site was a 1,206-foot radius curve, 1,663 feet in length. It curved to the left in the direction of travel of the ambulance. The superelevation throughout the accident site averaged 0.049 ft/ft for both lanes of traffic. Superimposed over a portion of the horizontal curve was a 700-foot-long vertical curve. In the westbound direction it connected a 2.82 percent upgrade to a 3.82 percent downgrade. It was estimated that the coefficient of friction for the dry pavement was 0.70. (See figure 4.)

In the direction of travel of the westbound ambulance, the first mark on the road surface that could be associated with the accident was a single 132-foot-long, leftward-curving tire scuff mark. It started in the westbound lane and ended in the same lane. The radius of this

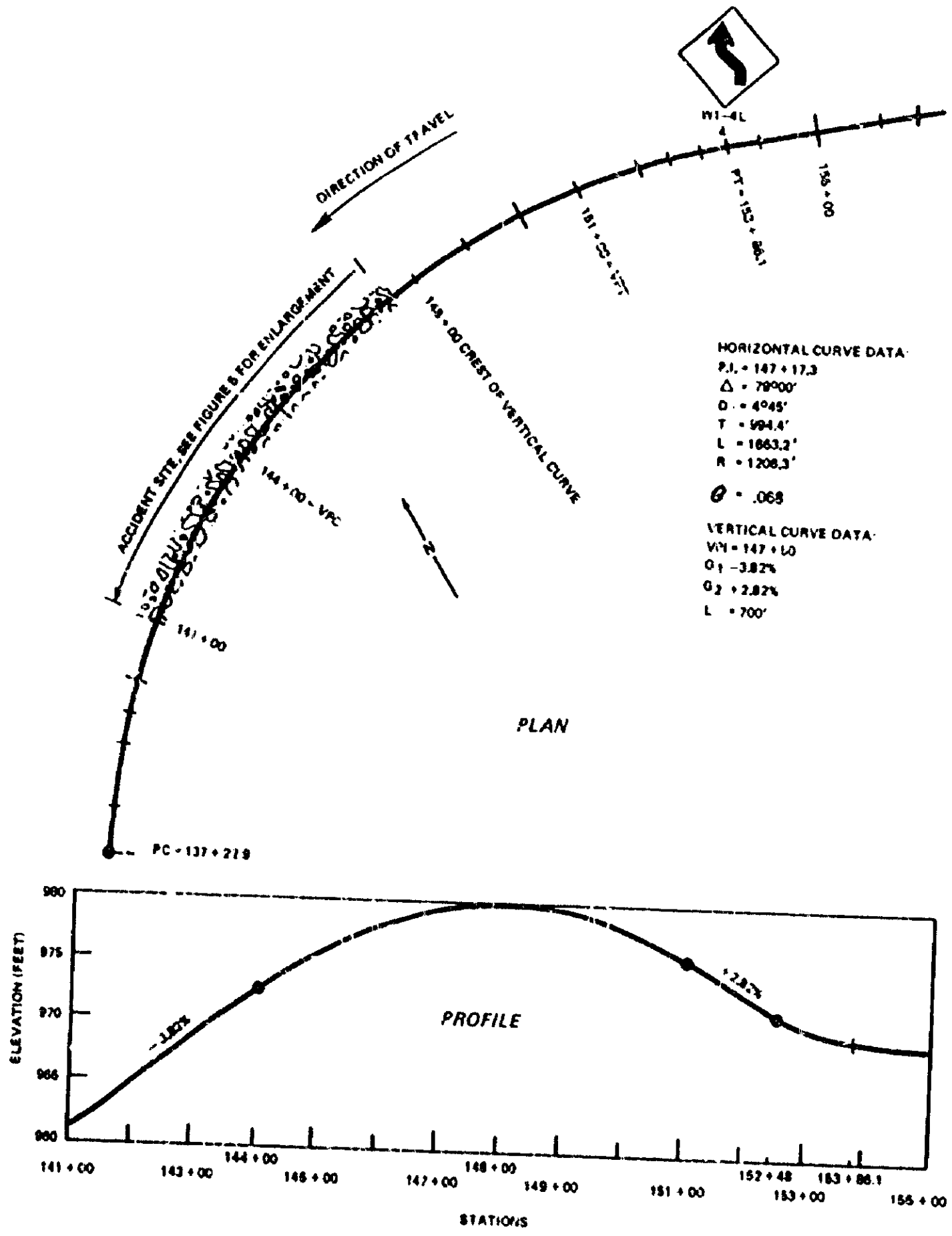


Figure 4. Alignment, profile and signing of New Hampshire Route 116 at accident site.

leftward turning tire scuff was 550 feet. (See figure 5.) After a gap of 41 feet, a single, rightward-curving tire scuff mark began in the eastbound lane. It continued for 79 feet at a radius of 430 feet. It ended in the westbound lane. After another gap of 11 feet, two tire scuff marks began in the westbound lane, with narrow cross striations. The striations increased in width to their end, or 96 feet from their beginning. The radii of the leftward-turning tire scuff marks were 430 feet and 390 feet, respectively. The last 8 feet of one scuff mark contained a deep, 81-inch-long gouge. The gouge was 4 inches wide at its widest point.

There were no marks for the next 20 feet. Then over a distance of 20 feet, there were scrape marks on the shoulder and small pieces of fiberglass and red plastic material imbedded in the asphalt. A paint transfer and tire scuff mark were found 18 feet farther west. Fifteen feet farther, small gouges and scrapes were found at a distance of up to 14 feet from a catch basin. The catch basin cover and marker had been hit, and the post was found 50 feet west of the catch basin.

The next markings were found 42 feet west where an orange paint transfer and some scrapes extended for a distance of 4 feet. The driver of the ambulance was found lying on the north shoulder near this location. Eleven feet farther west, the body of one of the technicians was found. Five feet farther west was a paint transfer. After a gap of 18 feet, additional scrape marks and paint transfers were found. The scrape marks were intermittent for a distance of 15 feet along the highway. The body of the second technician was found adjacent to these scrapes. Twenty feet from the second technician were side rim imprints from a wheel hub and a portion of an outside rim. The center of these imprints was at an angle of 55° to the centerline of the highway. Three additional rim impressions were located in the next 40 feet.

The ambulance came to rest right side up at an angle 110° to the centerline of the highway, 587 feet from the start of the first scuff mark. Its rear wheels were just off the westbound shoulder and its front wheels were in the westbound travel lane. The body of the patient was found on the edge of the shoulder adjacent to the right rear wheel. Sixty-one feet farther west was the last piece of debris from the ambulance.

Medical and Pathological Information

According to the autopsy reports, the two technicians died as a result of the injuries received in the accident and from being ejected, and the patient died before the accident. The unrestrained ambulance driver was ejected but survived with only minor injuries.

Meteorological Information

The weather was fair and the sky was clear with light winds. The temperature was 70° F. The pavement was dry and in good condition. The sun was at an azimuth of S 59° W, and at an elevation angle of 43°. The sun rays did not adversely affect the driver's vision.

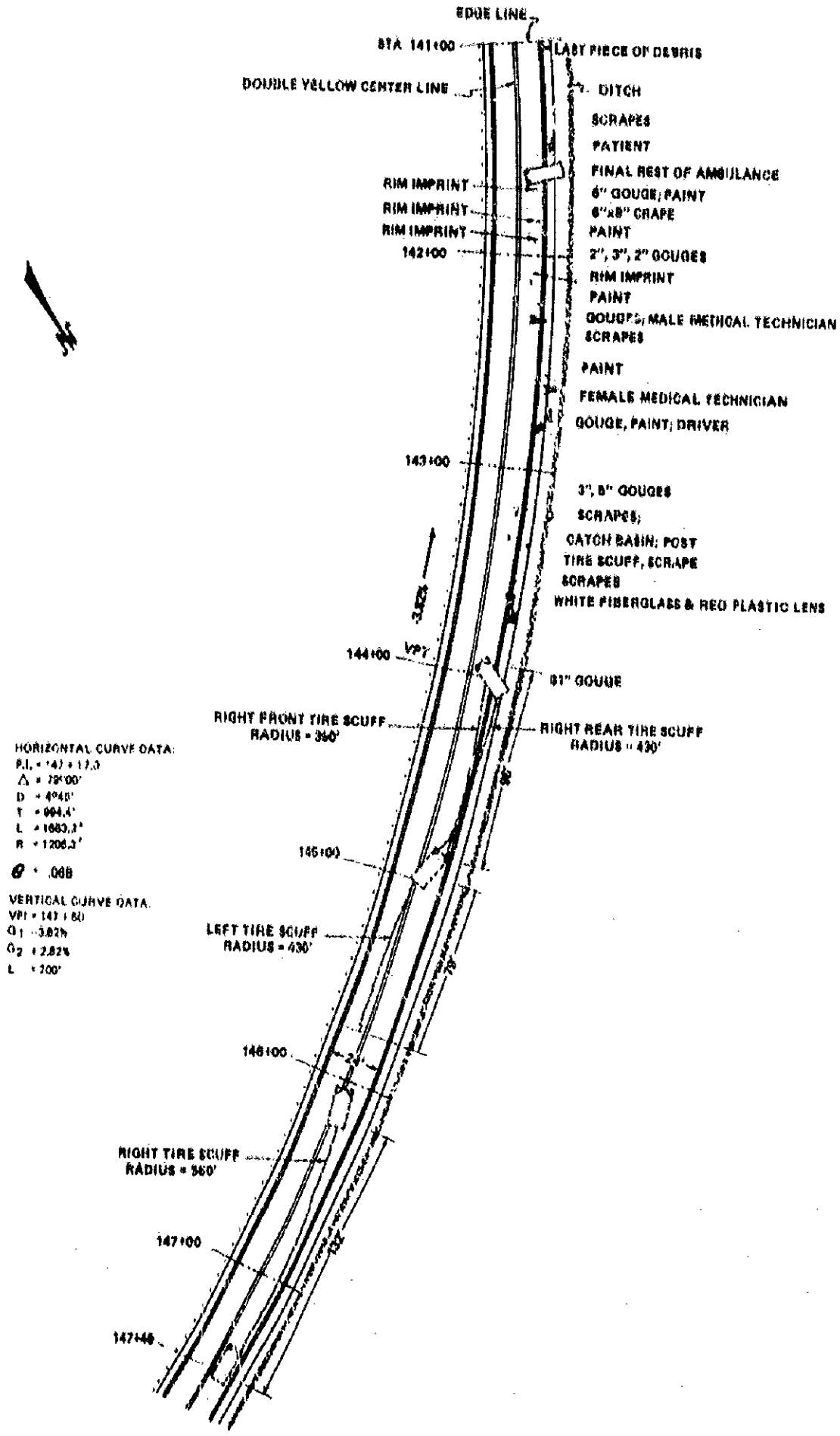


Figure 5. Wreckage distribution, tire marks, and horizontal alignment at accident site.

Tests and Research

To calculate the critical cornering speed of the ambulance, it was necessary to determine its center of gravity. Because of the severe deformation of the accident vehicle, measurements were made of a similar vehicle, a 1975 Chevrolet Suburban Van, VIN CCY165F171485 which also had been modified by Yankee Coach, Inc., substantially in the same manner as the ambulance. It was calculated that the center of gravity of this vehicle was 71 inches to the rear of the front axle and 27 inches above the ground level. These calculations suggested that the modification moved the center of gravity rearward 6 inches without raising it significantly. (See figure 6.)

During a rerun of the driving sequence, an ambulance of similar design, loaded in the same manner as the accident ambulance and driven by an experienced ambulance driver, safely negotiated this curve at a speed of 95 mph.

Based on the physical evidence available, the speed of the ambulance was calculated to have been between 90 and 95 mph 6/ as it entered the curve.

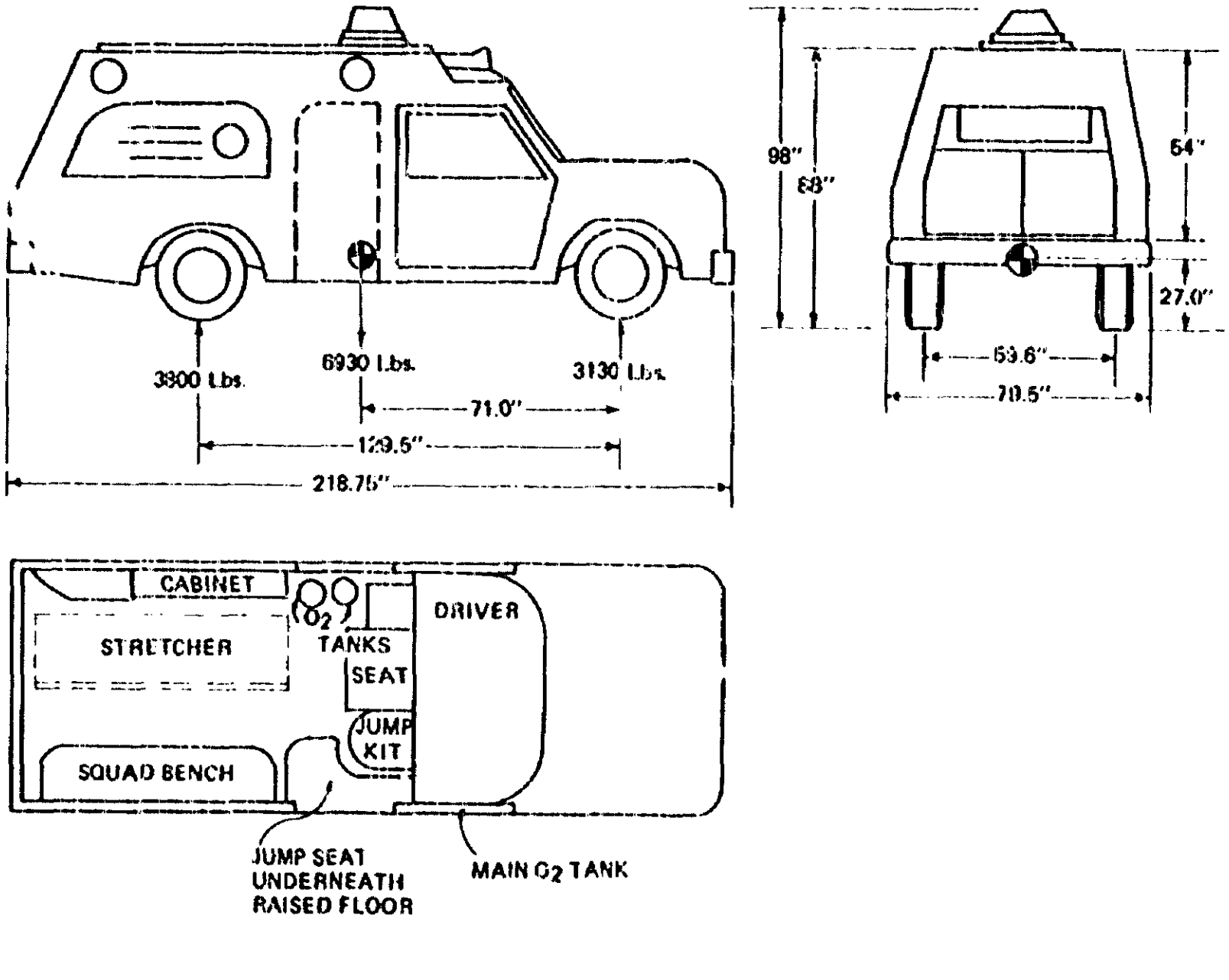
Other Information

Ambulance accidents. -- There is little available data concerning the complete population of accidents involving ambulances operating under emergency conditions. The National Highway Traffic Safety Administration (NHTSA) Fatal Accident Report (FAR) lists an average of 27 ambulances involved in fatal accidents for the years 1975, 1976, and 1977. The National Safety Council Accident Facts estimated that there were 80 fatalities in ambulance accidents in 1976. 7/ A special study by the State of Connecticut states that in 1975 there were 48 ambulance accidents resulting in 1 fatality and 42 injuries to occupants, and in 1976, there were 48 ambulance accidents which produced 2 fatalities and 45 injuries. 8/ The State of New Hampshire reported that this was the only ambulance accident in the State during 1978. There is no nationwide data available on this problem.

6/ Calculations of speed traveled are in the Public Docket No. HY-81-78 at Safety Board headquarters, Washington, D.C.

7/ Accident Facts, National Safety Council, 1978 Edition, p. 56, "Type of Motor Vehicles Involved in Accidents, 1977."

8/ A report to Governor Grasso on the Use of Emergency Vehicles in Connecticut, Connecticut Safety Commission, Revised March 1, 1978, pps. 12, 26, and 27.



● = C.G. = Center of Gravity
O_2 = Oxygen

Figure 6. Drawing of a Suburban Custom 10 van conversion showing dimensions.

Applicable Standards, Regulations, and Laws. -- A review of the Federal Motor Vehicle Safety Standards (FMVSS) revealed that there are no standards or specifications which assure that the total design and construction of ambulances as modified by the after-market installers are of sufficient structural strength and stability to withstand impact forces similar to requirements imposed on the original vehicle manufacturer. FMVSS 208, Occupant Crash Protection in Passenger Cars, Multipurpose Passenger Vehicles, Trucks and Buses, applied to the 1974 Chevrolet Suburban Custom 10 Van as manufactured. However, this protection was not extended to the patient(s) or medical personnel occupying the body of the ambulance since it did not apply to the modifications made after the vehicle was sold by the manufacturer.

There are no performance requirements related to the after-market modified vehicle structural integrity, crashworthiness, interior occupant protection, and the anchorage of items such as litters, benches, cabinets, oxygen bottles, or flooring. The only guidance concerning these safety factors provided for the after-market installers are as follows:

1. GSA Specification KKK-A-1822, dated January 2, 1974. It provides specifications for the use of new commercial vehicles modified as ambulances and purchased with Federal funds. Ambulances complying with these specifications need only meet the requirements of FMVSS 105, 106, and 116 (brakes), be capable of a sustained speed of 70 mph, have a fuel range of at least 150 miles, and other vehicle performance characteristics.

2. Truck Body and Equipment Association, Ambulance Manufacturers Division (AMD): Standards 101, Static Load Test for Ambulance Body Structure; 003, Oxygen Tank Retention System; 004, Litter Retention System; 005, Ambulance Electrical System; and 006, Sound Level Test Code for Ambulance Patient Compartment Interiors.

3. NHTSA Ambulance Design Criteria sets forth as a guideline the same criteria as the AMD standards.

A review of the AMD Standard 101 showed that:

1. The Static Load Test for Ambulance Body Structure partially corresponds to FMVSS 220, Vehicle Rollover and calls for the similar requirements. This does afford some degree of crash protection to the occupants of an ambulance.

2. The Oxygen Tank Retention System provides for the retention of the oxygen bottle within the bottle holder against a force equal to 25 times the weight of a fully loaded oxygen bottle.

3. The Litter Retention System shall not fail or release when subjected to a force of 1,500 pounds. The system is attached to the side wall of the ambulance.

The Uniform Vehicle Code (UVC) 9/, a guide for uniform traffic laws for voluntary compliance, also provides for exemption from posted speed limits for ambulances. Section 11-106(b)3 states: "The driver of an authorized emergency vehicle, when responding to an emergency may... exceed the maximum speed limits so long as he does not endanger life or property."

The NHTSA Highway Safety Program Standard (HSPS) No. 6, Codes and Laws, recommends that the States model their traffic codes after Section 11 (Rules of the Road) of the UVC. The New Hampshire Motor Vehicle Traffic Code, Section 262A: 55 Speed exception states: "The speed limits shall not apply to vehicles when operated with due regard for safety...to public or private ambulances...when traveling in emergencies."

At the time of the investigation, Safety Board investigators were advised that the Ross Ambulance Service did not have guidelines for its drivers relating to speed. Since this accident, the Ross Ambulance Service has promulgated specific guidelines relating to speed. These revised guidelines, among other things, contain the following: "Code 3: red light and siren -- move as expeditiously as possible; as fast as road, weather, traffic and patient conditions allow -- never to exceed 80 mph -- and preferably not more than 15 mph above posted speed limit."

ANALYSIS

The Accident

Tire scuff marks at the accident site indicated that the ambulance went out of control as it was negotiating the 1,206-foot-radius curve before it rolled over. The initial scuff mark showed that the rear wheels began sliding to the right, toward the outside of the curve, causing the vehicle to travel to the inside. The tire marks farther along the road indicate that the vehicle reversed the direction of turn heading toward the right and finally leftward at progressively smaller radii. During the final left swerve, the right front wheel rim dug into the pavement and the vehicle flipped over to the right. The fact that the major deformation of the ambulance components was basically downward and toward the right indicated that the vehicle was airborne through the initial 180° to 225° phase of the roll. Physical evidence at the accident scene and vehicle damage indicate that the roll continued through two or

9/ National Committee on Uniform Traffic Laws and Ordinances, Uniform Vehicle Code Revised 1976, Section 11-106 Authorized Emergency Vehicles, p. 135.

three rotations before the ambulance came to rest on its wheels. At some point during the rollover the fiberglass roof cap shattered and separated from its attachments and all occupants in the ambulance were ejected.

A subsequent test demonstrated that this curve could be negotiated at 95 mph by a vehicle of this type in the hands of an experienced driver. However, the inexperienced ambulance driver's problem in maintaining control in the curve was compounded by an oversteer characteristic displayed by the vehicle. Oversteer is avoided in the design of most domestically manufactured automobiles and is, therefore, seldom a contributing factor to accidents, unless a factor not implicit in design is present.

In this case, the radii of the tire scuff marks left by the rear tires clearly indicated that the vehicle was in oversteer during the initiating phase of the accident dynamics. No similar marks were left by the front tires. Technically, the neutral steer center of the ambulance was forward of the center of gravity. This was shown by the fact that a large slip angle was present at the rear wheels, which produced marks, while only a small slip angle was present at the front wheels, which did not produce marks. In this condition, the front wheels were producing the lateral force needed to follow a circular path while the rear wheels did not produce sufficient lateral force to permit the rear of the vehicle to follow the intended circular path.

When oversteer is present in a vehicle and the driver does not immediately recognize it and respond with the proper amount of corrective steering action, the vehicle will tend to run off the road toward the inside of the curve. The oversteer condition has been regarded as:

> ...disconcerting and dangerous except to an expert driver of sports cars or racing cars. The required reversal of steering wheel direction after initiating the turn is an unstable situation that is difficult for the ordinary driver to handle without overcorrecting, resulting in potentially dangerous swings on both sides of the proper curved path....From the standpoint of safety, oversteer is an intolerable condition and has always been recognized as such by the industry in the U.S.... 10/

The path of this vehicle exhibited not only the characteristic inward curving during its first change of direction of the left, but also the results of driver overcorrection and vehicle oversteer to the right, followed by overcorrection and oversteer to the left.

10/ Robert N. Janeway, "Vehicle Design Aspects of Safe Handling," Passenger Car Design and Highway Safety, Proceedings of a Conference on Research, Association for the Aid of Crippled Children and Consumer Unions of the U.S., Inc., 1961, pp. 33 and 34.

There are several factors which affect the steering characteristics of a vehicle such as axle weight distribution, tire pressures, steering geometry, and suspension design. The steering characteristics may even change from understeer to oversteer depending on speed and radius of curve. This vehicle as originally manufactured was not designed to oversteer under normally encountered conditions. In modifying the vehicle, the handling characteristics were changed by increasing the weight ratio to the rear of the center of the vehicle. The gross vehicle weight rating was increased 28 percent (1,530 lbs) over the original manufacturer's gross vehicle weight rating. The majority of this weight as distributed at the time of the accident was distributed to the rear axle resulting in 45 percent to 55 percent front-to-rear distribution. The effect of tire pressure could not be determined.

There are no standards available to guide the after-market installer to avoid these changes. The only guideline available to the after-market installer is the GSA Specification KKK-A-1822. Yet the only reference to loading instructions in the specification is the requirement that not less than 30 percent of the vehicle weight be on the front suspension. However, Janeway calls for a "combination of not less than 50 percent of the total weight on the front wheels under maximum load conditions, and independent front suspension." The Safety Board concludes that explicit standards applicable to after-market modification of emergency medical vehicles are needed. This is especially urgent since the after-market modifier or installer may have little or no capability to test his final product. These explicit specifications should be worded to insure operational safety of all vehicle systems.

Driver Training

Patients being transported in ambulances usually have no control over the selection of the driver or the vehicle who will take them to the hospital. Once they are in the ambulance, they have no control over the actions of the driver or operation of the ambulance. Also, the emergency medical technicians in the ambulance, who are often totally preoccupied with the care of the patient, need to be provided a working environment which is as safe as it can be made.

The driver of the ambulance had passenger car driver training and 1 month experience driving the accident ambulance, with no specific emergency or high-speed driver training. She had driven this ambulance on 10 emergency runs. She had not been trained to recognize or identify the handling characteristics of the ambulance under high-speed driving conditions. If the driver had been trained to recognize and react to the onset of the control loss she probably could have negotiated the curve without an accident. As the driver tried to bring the ambulance under control, there is a strong probability that the oversteering characteristic of the vehicle compounded her attempts at corrective input as evidenced by the repeated and radical changes in vehicle

direction following the initial leftward steering movement. The driver's actions attempting to control the ambulance's oversteer characteristic should not be regarded as incompetent driving for an ordinary driver. This accident was made up of a very probable series of events likely to be encountered by the average driver that could only have been recognized and properly controlled by a driver trained in high-speed driving techniques. This driver was not aware that the vehicle was unstable.

The driver plays an important but little understood part in the handling characteristics of a vehicle. Few handling criteria can be properly defined by consideration of the vehicle alone. Training which includes both classroom and behind-the-wheel experience can prepare a driver to anticipate, identify, and properly react to oversteer characteristics when they occur. Only by experiencing the approaching loss of control on the driving range or under real-world conditions can a driver develop a feel for driving vehicles both in emergency and nonemergency situations. The need for such training has been advocated in the report on the use of emergency vehicles in Connecticut. The study recommends a statewide coordinated special training and licensing program for all operators of emergency vehicles.

During the investigation of this accident, the trend in the scope of training provided to and required by ambulance drivers became apparent to the Safety Board. At the same time, the NHTSA was developing a model training program for the operation of emergency vehicles as an adjunct to HSPS No. 11, Emergency Medical Services. The course is designed to provide additional training in the techniques of driving emergency vehicles for drivers who have passed a defensive driving course. The Safety Board recognized that the new training program did not address the need for behind-the-wheel training in driving techniques under high-speed driving conditions. Neither the standard nor the new program require a final examination, both written and behind-the-wheel, to demonstrate and provide a record of the student's aptitude and/or proficiency.

With recent design changes in ambulances toward large, truck-type units, the operating problem becomes more complex. Just as drivers of heavy commercial vehicles require special training and skills, it is equally necessary to provide specialized training in emergency handling for ambulance drivers. This problem is recognized by persons who direct emergency service operations. The director of one such service has said there is a "serious void" in the trend of training advocated for those who drive ambulances and rescue vehicles and that Emergency Medical Services at all levels has been devoting all of its efforts to paramedical services, "with an assumption that emergency driving was a natural ability." 11/

11/ Letter of December 13, 1978, from Larry W. Joy, Director, MED-ACT, 8500 Grandview Lane, Overland Park, Kansas 66212.

On February 1, 1979, the Safety Board recommended that the NHTSA modify HSPS No. 11, Emergency Medical Services, to include the requirements for behind-the-wheel training in the principles and techniques of high-speed driving and that students successfully complete both a written and behind-the-wheel examination to demonstrate their proficiency before being licensed. Also, the Safety Board recommended that the NHTSA urge the States to make the records of all licensed emergency vehicle operators available through their licensing agency to employers so that they can determine if an applicant for an emergency vehicle driver position is qualified for the position.

Vehicle Integrity

Although the integrity of the vehicle involved in this accident is not being challenged because of the excessive speed involved, the condition of the vehicle after impact demonstrates a need to include a performance-type standard in Federal Specification GSA KKK-A-1822, as it relates to vehicle operation, body assembly, anchorage of equipment within the ambulance, and occupant protection. Current Federal crashworthiness standards 12/ are based on a 30-mph impact speed into a barrier. However, the national speed limit is 55 mph and most State statutes permit ambulances to exceed the posted speed limits in emergency situations. Speed limit exceptions and emergency situations set the stage for high-speed crashes of ambulances.

GSA Specification KKK-A-1822 should also include specifications on general body construction and ambulance body structure that assures that patients and medical technicians riding in the ambulance body have the same protection as the driver. The completed ambulance should be capable of withstanding reasonable impact forces. The current FMVSS standards are applicable only to the basic vehicle before modification, rather than to the complete after-market product.

Speed Limit Exemptions

The New Hampshire law is typical in that it allows ambulances to exceed the posted speed limit under emergency situations, providing the "driver does not endanger life or property." The Safety Board believes that such laws, which are similar to the Basic Speed Law 13/, are much too general. Also, State laws and regulations related to emergency vehicles should be modified to include criteria to guide the drivers of emergency vehicles under adverse conditions in making judgmental decisions regarding the speeds selected and driving procedures. The Safety Board concludes that the National Committee on Uniform Traffic Laws and Ordinances,

12/ Part 571: FMVSS 213, Windshield Mounting; FMVSS 219, Windshield Zone Intrusion; FMVSS 301, Fuel System Integrity.
13/ Uniform Vehicle Code, Chapter II, Rules of the Road, Section 11-801, p. 155.

in cooperation with the American Bar Association, should review Section 11-106(b)3 of the Uniform Vehicle Code and make it more specific, including the possible imposition of a maximum speed that can be traveled above the posted speed limit under prescribed conditions.

Criteria to be considered should include: (1) The experience and training of the emergency vehicle driver; (2) the condition of the patient or the gravity of the injury as determined by a medical doctor; (3) road traffic and weather conditions; and (4) type and condition of vehicle.

In addition, the Safety Board believes that State laws should set forth a maximum speed limitation such as "No more than 10 mph above the posted speed limit under normal conditions." Such controls are in effect for a rescue service titled "MED-ACT"operated by the Johnson County, Kansas, Board of Commissioners. The MED-ACT operates six ambulance/rescue units over 480 square miles and services 260,000 people. It maintains an average response time of 5.3 minutes. Its regulations provide that on emergency runs of any type, the maximum speed authorized is 10 mph over the posted speed limit with normal road, weather, and traffic conditions. If adverse weather and traffic conditions exist, necessary reductions in speeds are required.

In addition to setting criteria justifying operation of an ambulance at high speed, States should consider setting limits on the use of high speed by ambulances altogether. In the words of the director of MED-ACT, "We do not feel the risk of 'high speed' driving is worth it to possibly save one life. Our philosophy is that we must reach the scene and the hospital, or all of our expertise, equipment, and investment is to no avail." 14/

CONCLUSIONS

Findings

1. The driver lost control of the ambulance in a high-speed maneuver due to lack of knowledge of the vehicle handling characteristics.

2. This ambulance could have negotiated this curve safely at a speed of 90 to 95 mph if it had been driven by a capable driver.

3. The handling characteristics of the ambulance were changed through vehicle modification and loading to produce oversteer instability when driven at high speeds.

14/ Letter of December 13, 1978, from Larry W. Joy, Director, MED-ACT, 8500 Grandview Lane, Overland Park, Kansas 66212.

4. The Ross Ambulance Service failed to provide the ambulance driver with sufficient training and guidance concerning the driving of the ambulance under emergency conditions.

5. The ambulance driver's training, background, and experience did not enable her to recognize and counteract adverse vehicle handling characteristics.

6. There is a need for performance standards or guidelines for after-market installers to follow to assure that modifications do not adversely affect the integrity of the vehicle and the protection to occupants under crash conditions.

7. There is a need for performance standards to assure that after-market modification and installations do not adversely alter the handling characteristics of the vehicle as originally manufactured.

8. The GSA Specification KKK-A-1822, as it relates to ambulance body modifications and installations, needs to be revised to assure vehicle integrity and occupant protection.

9. State laws related to the speed exceptions for ambulances are too general. They fail to provide drivers with the necessary specific criteria to enable them to make sound judgmental decisions as to travel speeds under adverse, emergency driving conditions.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was loss of control of the ambulance, which had oversteer characteristics, by an unskilled driver at a high rate of speed. Contributing to the cause of the accident was the driver's lack of training in the operation of the ambulance at high speeds.

RECOMMENDATIONS

During its investigation, the National Transportation Safety Board recommended on February 1, 1979, that the National Highway Traffic Safety Administration:

"Modify Highway Safety Program Standard No. 11, 'Emergency Medical Services,' and the NHTSA Training Program for Operation of Emergency Vehicles to provide for behind-the-wheel training in the principles and techniques of high-speed driving, and to require that a student successfully complete both a written and a behind-the-wheel examination before he is licensed. (Class I, Urgent Action)(H-79-1)

"Urge the States to maintain and make available, through the State driver licensing agency, the records of all licensed emergency vehicle operators so that employers can determine if an applicant for an emergency vehicle driver position is licensed for the operation of emergency vehicles. (Class II, Priority Action)(H-79-2)"

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

-- to the National Highway Traffic Safety Administration:

"Extend the application of Federal Motor Vehicle Safety Standards 220, Schoolbus Rollover Protection; 221, Schoolbus Body Joint Strength; and 301, Fuel System Integrity to include ambulances and other emergency vehicles. (Class II, Priority Action)(H-79-27)

"Study the feasibility of extending Federal Motor Vehicle Safety Standards relating to vehicle interior padding, occupant protection, and the anchorages of seats, flooring, and equipment to include ambulances and other emergency vehicles. (Class III, Longer Term Action)(H-79-28)"

-- to the General Services Administration:

"Add to the Federal Specification KKK-A-1822 of January 2, 1974, Ambulances approved by Federal Supply Services, performance-type requirements in the following areas:

(1) Maintenance of the manufacturer's vehicle handling characteristics during modification procedures;

(2) loading instructions to guide users so as not to change vehicle handling characteristics;

(3) body structural integrity;

(4) anchorages for all equipment installed; and

(5) occupant protection.

(Class II, Priority Action)(H-79-29)"

-- to the National Committee on Uniform Traffic Laws and Ordinances, in cooperation with the American Bar Association:

"Consider the modification of Section 11-106(b)3 of the Uniform Vehicle Code to include the following criteria to justify an exemption from posted speed limits:

(1) The determination by a medical authority that the gravity of the patient's situation requires emergency operation, and

(2) the condition of the vehicle, traffic, and roadway will permit such operation, and

(3) the environmental conditions are conducive to such operation, and

(4) the vehicle is being operated by a certified ambulance driver, and

(5) the ambulance speed limit will be restricted to no more than 10 mph over the posted speed limit with normal road, weather, and traffic conditions.

(Class II, Priority Action)(H-79-30)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

May 3, 1979