



## ***Volunteer Fire Fighter Dies in Tanker Rollover Crash – Texas***

### **SUMMARY**

On November 22, 2005, a 28-year-old male volunteer fire fighter (the victim) died while responding to a mutual-aid call for a major grass fire. The victim was driving the department's tractor trailer (tanker) on a two-lane state highway. The tanker went off the road, overturned, and came to rest in a field. The victim was ejected and found lying unresponsive on the roadway. He was pronounced dead at the scene by the Justice of the Peace.



Photo courtesy of the State Fire Marshal

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***ensure that water tankers are operated within safe weight restrictions that comply with the specific vehicle characteristics***
- ***ensure that all fire apparatus meet the requirements of NFPA 1901 Standard for Automotive Fire Apparatus***
- ***ensure that drivers of fire department vehicles receive training at least twice a year on each vehicle that they may be called upon to operate***
- ***develop and enforce standard operating procedures (SOPs) that require mandatory use of seat belts in all vehicles***

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at [www.cdc.gov/niosh/fire/](http://www.cdc.gov/niosh/fire/) or call toll free **1-800-35-NIOSH**.



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- *develop a comprehensive apparatus maintenance program that includes regularly scheduled inspections, documentation, and procedures for removing apparatus from service when required*

Additionally, states should

- *consider developing a vehicle inspection and repair program prior to distributing surplus military vehicles to the fire service*

## **INTRODUCTION**

On November 22, 2005, a 28-year-old male volunteer fire fighter responded in a tractor trailer (tanker) to a mutual aid call for assistance from a neighboring fire department. While en-route, the tractor trailer (tanker) left the roadway, overturned and came to rest in a field. The victim was ejected from the vehicle and found unresponsive on the roadway. He was pronounced dead at the scene.

On November 28, 2005, the National Institute for Occupational Safety and Health (NIOSH) was notified of this incident by the U. S. Fire Administration (USFA). On March 14-15, 2006, an investigation of this incident was conducted by a Safety and Occupational Health Specialist and an Epidemic Intelligence Service Officer from NIOSH. Meetings and interviews were conducted with the State Fire Marshal and the Assistant Chief from the volunteer fire department. Copies of the department's Standard Operating Procedures (SOPs) and by-laws, State Police report, Justice of the Peace report, Texas Department of Public Safety Vehicle Information Report for Fatal Accident (which included all witness statements), drawings and photographs of the incident scene, and National Highway Transportation Safety Administration (NHTSA) vehicle recall notices were reviewed.<sup>1</sup>

### **Fire Department**

The volunteer fire department involved in this incident served a population of 1,250 in a geographical area of 138 square miles and was comprised of 21 fire fighters. The department had two fire service apparatus, a fire suppression vehicle and a 5,000 gallon capacity tractor trailer water tanker. Repair and service of the two apparatus was provided mainly by department members, including the victim and his father who operated a family vehicle maintenance and repair business.

### **Training and Experience**

The victim was a member of the volunteer department for approximately three months. He held a Class C state driver's license and had extensive military experience driving fuel tankers. He was a truck mechanic by trade and worked in a vehicle maintenance and repair business. The state where the incident occurred has no minimum state training requirements for volunteer fire fighters. The department requires 70 hours of training to meet minimum standards for introductory fire fighting which the victim had not yet completed.



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**Equipment**

The vehicle involved in this incident was a tractor trailer tanker (Photo 1). The tractor was a 1979 cab-over-engine model. The military surplus trailer (tanker) was built in 1968 and had originally been used by the military to transport fuel.

The tractor had a gross vehicle weight rating (GVWR) of 15,500 pounds and was equipped with an air brake system. The tractor was equipped with seat belts but both the driver and passenger seat belt anchors were broken according to the state police report. According to witness statements, a line splice had been installed on the rear brakes of the tractor drive axle a week before the incident occurred. The rear axle was separated from the frame during the incident.

The military surplus trailer (tanker) had a GVWR of 35,250 lbs. It was equipped with an air-over-hydraulic brake system. According to witness statements, the air canister on the trailer was replaced approximately one month before the incident. The surplus military fuel trailer (tanker) contained two 2,500 gallon compartments that were divided by a longitudinal bulkhead. To facilitate water discharge and movement, the department cut holes in the bulkhead. The tanker was owned by the U.S. Department of Agriculture, Forest Service and had been acquired by the department through the Texas Forest Service Federal Excess Personal Property (FEPP) program.<sup>2</sup>

**Weather / Road Conditions**

The incident occurred on a clear day with no precipitation present in the area. The road surface was comprised of asphalt pavement. There was a grassy shoulder that extended into a fairly steep ditch in the area where the apparatus left the roadway and there were no guard/guide rails. The speed limit was 55 miles-per-hour (mph) with a caution speed of 40 mph posted approximately one fourth mile prior to the curve where the incident occurred.

**INVESTIGATION**

At approximately 1400 hours the volunteer department was dispatched to a mutual aid call for a major grass fire. The victim and his father, who were working together at the family owned auto repair shop, were the first to respond to the station. They decided to utilize both of the department's apparatus. The suppression vehicle was driven by the victim's father who was the first to leave the station and therefore did not witness the incident. The victim who responded in the department's tractor trailer tanker, left several minutes later after giving the apparatus time to warm up. According to witness statements, the water tank was routinely filled to capacity.

The route to the fire was a two-lane state road with a posted speed limit of 55 mph. The roadway had several moderately sharp turns which the victim had negotiated successfully prior to the crash. The road was straight with a slight grade that descended into a sharp turn to the left where the incident occurred (Photo 2). Although there were no witnesses to the crash, it is believed that as the victim approached the curve, for reasons unknown, he ran off of the road and while attempting to steer the tanker back onto the roadway lost control of the vehicle. The tractor trailer tanker rolled to a stop in a field approximately 30 feet from the edge of the roadway (Photo 3). The tractor rolled one time



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landing on its wheels and the trailer came to rest on the driver's side. Several tire/axle assemblies were separated from the tractor trailer by the force of the rollover.

There were no witnesses to the incident and the police report did not indicate an estimated speed. Various factors, including the roadway grade, diminished braking capacity and difficult steering caused by the excess weight of the water and possibly under-inflated tires, may have contributed to the victim's inability to safely maintain control of the tanker. According to the police report, he was not wearing a seat belt and was thrown into the passenger area during the rollover. He was then ejected from the cab following a short skid prior to the apparatus coming to rest in a nearby field. The victim was found lying unresponsive on the roadway shortly after the crash by a civilian motorist who was traveling from the opposite direction. The motorist called 911 and State Police were dispatched to the scene arriving at approximately 1500 hours.

The victim was pronounced dead at the scene by the Justice of the Peace.

**CAUSE OF DEATH**

The Justice of the Peace listed the cause of death as an open skull fracture resulting from an automobile accident.

**RECOMMENDATIONS**

***Recommendation #1: Fire departments should ensure that water tankers are operated within safe weight restrictions that comply with the specific vehicle characteristics.***

Discussion: It has been reported by the USFA and NIOSH that fatal incidents have occurred when fire department water tankers are operated while exceeding their safe load carrying capacity.<sup>3-6</sup> According to USFA, *Safe Operation of Fire Tankers*,<sup>3</sup> the most common safety issue affecting tankers made from used or retrofitted vehicles is the tendency for them to be overweight when filled with water. This occurs most often because of the fact that water weighs 8.3 pounds per gallon and the tanker was originally designed to carry fuel oil that weighs 7.12 pounds per gallon, or gasoline that weighs 5.6 pounds per gallon. A common result of operating in excess of the GVWR is a vehicle that will be subject to frequent mechanical breakdowns, may be difficult to steer, and may have insufficient braking abilities. When converting a fuel tanker to a water tanker, the vehicle's suspension system, chassis, axles, tires, and braking system should be upgraded so that the original GVWR is not exceeded. This type of upgrading is a very complex and expensive process, but acquiring a government/military surplus vehicle is often the only cost effective means for small or rural departments to obtain any type of fire service apparatus. Many times fire department personnel are unaware of the potential danger posed by failing to perform required upgrades and conversions to apparatus acquired through surplus property programs. Entities supplying surplus or used fire apparatus should provide pertinent safety information to the departments that are receiving the vehicles.



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The capacity of the tractor trailer's tank that was involved in this incident was 5000 gallons; therefore the weight of the water when the tank was full was 41,500 pounds. The tractor trailer's payload<sup>a</sup> GVWR was 35,250 pounds.

***Recommendation #2: Fire departments should ensure that all fire apparatus meet the requirements of NFPA 1901 Standard for Automotive Fire Apparatus.***

Discussion: NFPA 1901, *Annex D Guidelines for First Line and Reserve Apparatus* states that "to maximize fire fighter capabilities and minimize risk of injuries, it is important that fire apparatus be equipped with the latest safety features and operating capabilities. Any apparatus, whether in first-line or reserve service, should be upgraded as necessary to ensure that certain safety features are included as a minimum.<sup>7</sup> Some examples of recommended upgrades include:

1. *Brakes, brake lines, and filters replaced in accordance with the manufacturers' maintenance schedule(s).*

When converting or retrofitting a vehicle into a fire department tanker, the capabilities and condition of the vehicle's braking system is as important as the chassis and weight limit considerations. The braking system must be evaluated before placing the converted tanker into operation. The system as originally designed may not have sufficient braking capabilities to safely serve as a fire department tanker. Even vehicles that previously served as fuel tankers may not have a braking system suitable for an emergency vehicle because typically fire department vehicles brake more frequently and more harshly than standard commercial vehicles. These actions may cause the system to overheat and lose its capability to safely slow or stop the vehicle. If specific information is not provided by the apparatus supplier, the manufacturer of the vehicle's chassis and/or braking system should be consulted when retrofitting a vehicle into a fire department tanker.<sup>3</sup>

2. *Tires and suspension in serviceable condition.*

According to the article "Avoiding Tire-Related Vehicle Crashes,"<sup>8</sup> a recent study examined the inflation pressures of dual-tire assemblies on emergency medical service vehicles. The results of the study revealed that 39% of the tires could not be checked because there was no access to the valve stem and of those that could be checked, two-thirds were found to be under-inflated by at least 25% of capacity. A tire that is run in this condition may result in damage to the tire. Tire pressures must be checked regularly to ensure they are properly inflated and although routine vehicle inspections are common within fire departments, often a comprehensive check of the tires is not included. Frequently it is assumed that if a tire does not appear to be flat, or if there are no outward signs of damage, there isn't a problem. However, an improper seal between the tire and rim, small punctures from road hazards, or simply air permeating through the tire membrane can result in an average air loss of one to two psi per month resulting in a 20% under-inflated tire in a period of several months. The investigating police officer reported that following the incident the tire pressures varied. If this was the condition of the tires prior to the crash it could have contributed to difficulty in steering the apparatus.

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<sup>a</sup> The payload is the load carried by a vehicle exclusive of what is necessary for its operation.



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3. *NFPA 1901 Chapter 14 Driving and Crew Areas, Section 14.1.3 states that “Each crew riding position shall be provided with a seat and an approved seat belt designed to accommodate a person with and without heavy clothing. 14.1.3.2 states that “All forward-facing seats adjacent to a side wall shall be provided with a Type 2 pelvic and upper torso restraint-style seat belt assembly conforming to the Federal Motor Vehicle Safety Standard (FMVSS) No. 209, Seat Belt Assemblies.”<sup>7</sup>*

There was a lap type seat belt located on the driver’s side of the truck tractor involved in this incident; however the police report indicates that following the crash the seat belt anchor was found to be broken. There was no evidence that the victim was wearing the seat belt and due to the dynamics of the crash, it is difficult to determine his survivability had he been wearing the lap belt. However, a Type 2 pelvic and upper torso restraint-style seat belt assembly as called for in NFPA 1901 has been shown to be effective in supporting a drivers positioning and assisting in maintaining control of a vehicle.

4. *NFPA 1901 Chapter 19 Water Tanks, Section 19.2.5 states that “All water tanks shall be provided with baffles or swash partitions<sup>b</sup> to form a containment or dynamic method of water movement control.”<sup>7</sup>*

According to USFA, *Safe Operation of Fire Tankers*,<sup>3</sup> the most crucial aspect of water tank design relative to the safe operation of the apparatus is the use of baffles or swash plates within the tank to control water movement during road travel. Properly installed baffles prevent excessive longitudinal and lateral movement of water within the tank. A baffle system is designed to prevent a liquid surge from occurring and contributing to a loss of control caused by the shifting weight of the water. There are two primary baffle design methods:

- *Containment Method – uses a series of swash plates to divide the tank into a series of smaller, interconnected compartments.*
- *Dynamic Method – uses a series of baffles to disrupt the movement of water by changing its direction of travel. These baffles are often staggered so the changing direction of the water creates a turbulent motion that results in the water itself absorbing much of its own energy.*

The 5,000 gallon capacity tank involved in this incident contained two 2,500 gallon compartments that were divided by a longitudinal bulkhead. The fire department cut holes in the bulkhead to facilitate water discharge and movement, but there was no evidence of a baffle system that would assist in controlling side-to-side water surges.

NFPA 1901 Annex D recommends that fire department administrators and fire chiefs should exercise special care when evaluating the cost of refurbishing or updating an apparatus versus the cost of purchasing a new fire apparatus.<sup>7</sup> A thorough cost-benefit analysis of the value of upgrading or refurbishing should be conducted and it may be found that refurbishing costs will exceed the current

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<sup>b</sup> A baffle (swash partition, swash plate) is a divider within a liquid tank that is designed to prevent liquid surges from occurring.



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purchase price or leasing costs of similar apparatus. NFPA recommends that apparatus not built to NFPA standards, or manufactured prior to 1979, should be considered for upgrading or replacement.

***Recommendation #3: Fire departments should ensure that drivers of fire department vehicles receive training at least twice a year on each vehicle that they may be called upon to operate.***

Discussion: NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*<sup>9</sup> and NFPA 1002, *Fire Apparatus Driver/Operator Professional Qualifications*<sup>10</sup> state that fire departments should establish and maintain a driver training education program and each member should be provided driver training on each vehicle that he/she will operate not less than twice a year. The training should be documented and cover defensive driving techniques (visual lead time, braking and reaction time, combating skids, evasive tactics, knowledge of weight transfer, and anticipating other drivers' actions) during emergency and non-emergency situations. The American National Standards Institute (ANSI) standard Z15.1, *Safe Practices for Motor Vehicle Operations*, contains minimum requirements for workplace traffic safety programs and is intended to give employers, whose employees drive on the job, tools to prevent motor vehicle crashes.<sup>11</sup>

Fire department vehicle drivers are responsible for the safe operation of the vehicle under all conditions. Vehicle characteristics, capabilities and limitations should be incorporated into driver training programs. Tankers tend to be heavier and to have a higher center of gravity than other fire vehicles. These factors affect the driver's ability to control a tanker. Based on simple physics and inertia, a top heavy vehicle like a tanker is inclined to tip over if the driver suddenly steers in an effort to bring the wheels back onto the road or if he/she drives through a curve at an unsafe speed.

***Recommendation #4: Fire departments should develop and enforce standard operating procedures (SOPs) that require mandatory use of seat belts in all vehicles.***

Discussion: Fire departments should develop, implement and enforce SOPs on the use of seat belts.<sup>6</sup> The SOPs should apply to all persons riding in all emergency vehicles.<sup>12-14</sup> All occupants of an emergency apparatus must be seated within the cab or body and wearing their seat belts before the apparatus is put in motion.<sup>15</sup> Fire department apparatus operators must be trained to understand that a driver who is properly secured by a seat belt has a better chance of maintaining control of the vehicle and possibly avoiding a crash, as well as a greater probability of survival should a traffic incident occur. In this incident the tractor was equipped with a driver lap belt, however according to the police report the seat belt anchor was broken. The victim was ejected from the apparatus. The fire department had a SOP on driving but did not have written SOPs on the use of seat belts.

***Recommendation #5: Fire departments should develop a comprehensive apparatus maintenance program that includes regularly scheduled inspections, documentation, and procedures for removing apparatus from service when required.***

Discussion: Persons responsible for the maintenance and readiness of emergency vehicles should establish a maintenance schedule and recordkeeping system to facilitate review of each vehicle and



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ensure an accurate maintenance history.<sup>16</sup> All fire department apparatus and vehicles need to be scheduled for routine preventive maintenance with a timetable based upon pertinent factors such as number, duration, and type of use. At a minimum, this inspection should include seat belt/restraint(s) and assemblies, tires, brakes, warning lights, wipers, mirrors and fluids. Vehicles should be removed from service until all unsafe conditions are corrected. Maintenance was performed on the tractor trailer (tanker) involved in the crash, one month prior to the incident. According to witness statements, the brakes were tested and found to be functional with no leaks.

During this investigation, all National Highway Traffic Safety Administration (NHTSA) safety recall notifications and technical service bulletins pertaining to the incident vehicle (cab over tractor) were reviewed. Examination of these documents revealed a steering gear box recall (vehicles manufactured from 1976-1979, Recall #80V095000) and steering gear mounting bracket recall (vehicles manufactured from 1978-1989, Recall #89V124000) for the tractor.<sup>1</sup>

The summary for NHTSA Recall #80V095000 states, “On involved vehicles, the connection between the steering control shaft and the input shaft on the steering gear box may be defective. The yoke on the shaft may loosen, allowing the splined surfaces on the yoke and shaft to wear. Continued operation may result in wear and eventual rotational slippage of the joint. Consequences of defect: this condition could cause a loss of steering control and possibly an accident.” The summary for NHTSA Recall #89V124000 states, “The steering gear mounting bracket welds may crack under certain steering load conditions. Steering control would be adversely affected with potential for loss of truck control and an accident.” It is unknown if either of these recall notifications directly impacted the incident vehicle, however, vehicle maintenance personnel should be made aware of all recalls that affect the safe operation of department apparatus and/or equipment and react accordingly.

***Additionally, states should consider developing a vehicle inspection and maintenance program prior to distributing surplus military vehicles to the fire service.***

Discussion: Surplus military equipment obtained through the FEPP<sup>2</sup> must only be used for fire related activities and the fire department is responsible for all additional repair, operational costs, maintenance, upkeep, liability insurance, and annual inspections. States should consider conducting vehicle safety inspections and developing maintenance programs prior to surplus vehicles being distributed to fire departments. Since the fire departments are responsible for maintenance on surplus vehicles, small departments with limited resources would benefit from a state funded vehicle inspection and maintenance program. To assist departments in ensuring that the apparatus is brought into compliance with safe operating requirements, information regarding conversion and safe retrofitting, including the difference in the weight of water to fuel and gasoline should be provided by the states or those who are supplying the excess or surplus fire service vehicles or apparatus.

## **REFERENCES**

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**INVESTIGATOR INFORMATION**

This incident was investigated by Virginia Lutz, Safety and Occupational Health Specialist, NIOSH, Division of Safety Research, Surveillance and Field Investigation Branch and Marilyn Ridenour, Epidemic Intelligence Service Officer, NIOSH, Division of Safety Research, Analysis and Field Evaluations Branch.



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**Photo 1**  
**F2006-06 TX**  
**Apparatus Involved in Incident**



**Photo courtesy of the State Fire Marshal**



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**Photo 2**  
**F2006-06 TX**  
**Roadway Approaching Bend Where Incident Occurred**



Photo courtesy of the State Fire Marshal



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**Photo 3**  
**F2006-06 TX**  
**Location Where Incident Occurred**

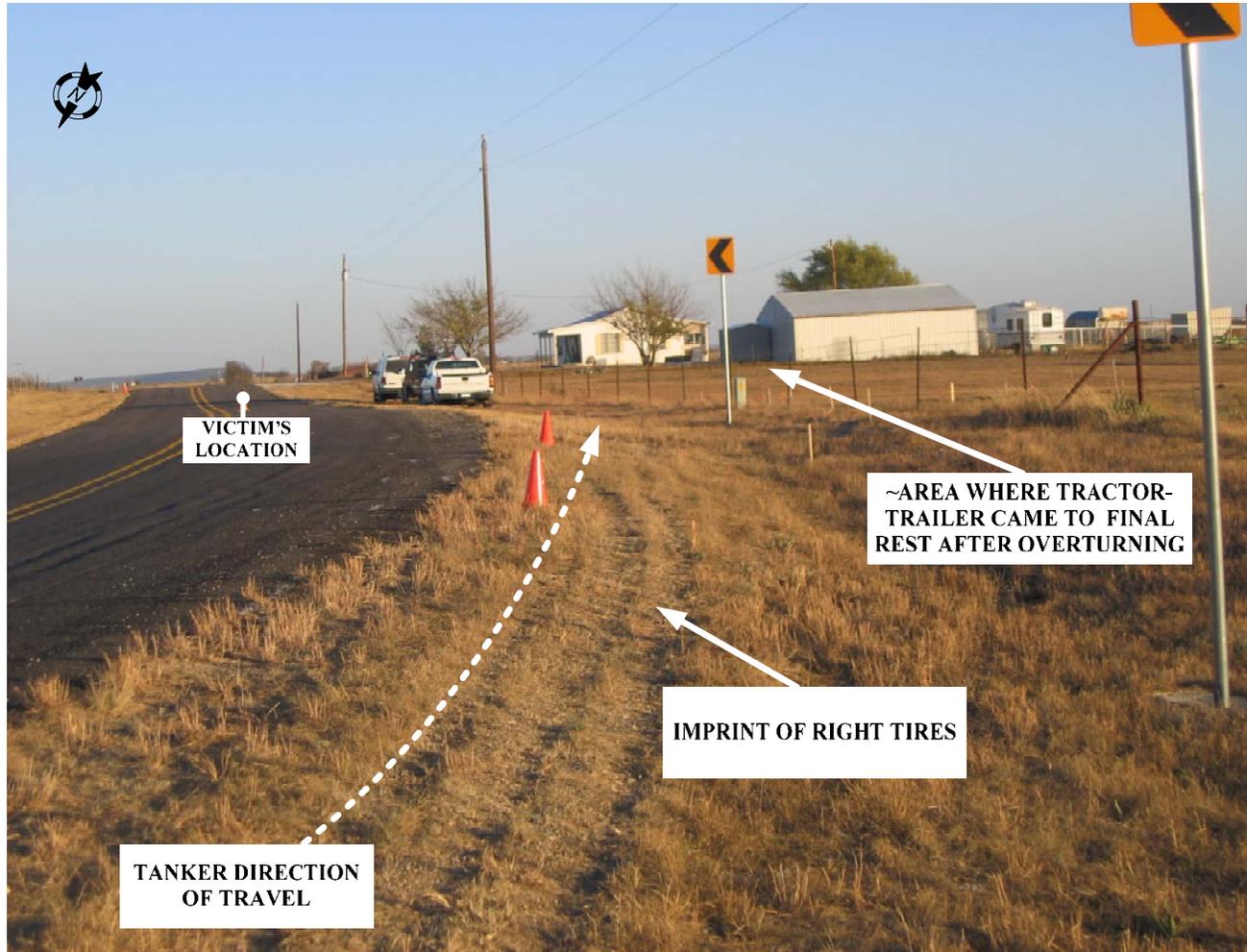


Photo courtesy of the State Fire Marshal