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NIOSH
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation **August 21, 2008**

Volunteer Fire Fighter Dies in a Tanker Crash – Louisiana

SUMMARY

On March 28, 2008, a 33-year-old male volunteer fire fighter (the victim) was fatally injured after the tanker truck he was driving left the roadway and overturned. The victim was enroute to a structure fire, took an unfamiliar route, and failed to negotiate a 90° curve to the right. The tanker left the roadway rolling onto the driver's side then slid through a ditch into a row of pine trees crushing the cab. The victim was extricated by emergency personnel, air-lifted to a local medical center, and later pronounced dead.

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

- ***ensure that tankers are driven at a safe and reasonable speed***
- ***ensure that fire fighters are familiar with the location of the roads in their coverage areas***
- ***consider staffing tankers with a minimum of two fire fighters***
- ***consider supplying responding units with maps or verbal directions to incident scenes, using computer aided dispatch (CAD) or a global positioning system (GPS) device***
- ***develop oversight of the preventive maintenance program for fire apparatus***

Fire departments and fire service training organizations should:

- ***consider additional driver training for fire fighters on safe tanker driving and operations***

Fire departments and fire apparatus manufacturers should:

- ***ensure that tankers meet all the requirements of NFPA 1901, Standard for Automotive Fire Apparatus***

INTRODUCTION

On March 28, 2008, a 33-year-old male volunteer fire fighter (the victim) was fatally injured after the tanker truck he was driving left the roadway and overturned. On March 28, 2008, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH)

of this incident. On April 21-24, 2008, two safety and occupational health specialists from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Louisiana to investigate this incident. The NIOSH investigators met with the Chief of the victim's fire department, his training officer, the crash scene Incident Commander (IC), the civilian who made the 911 call and the Sheriff's Office personnel involved with the crash investigation. The investigators reviewed the victim's driver/operator training records, inspected the apparatus, visited the incident site and took photographs and measurements. The investigators also reviewed the 911 dispatch logs, the vehicle's maintenance log, the State of Louisiana Uniform Motor Vehicle Traffic Crash Report, law enforcement photographs of the incident, and the victim's patient care report.

Fire Department

This combination fire department has 3 paid fire fighters and 14 volunteer members that serve a population of 3,000 within a rural area of about 22 square miles. *(Note: Volunteer members can be called in to work a paid shift due to low staffing).* The department had recently consolidated from two fire stations into a single new facility. The department has 3 pumpers, 2 medical units, a tanker (the incident apparatus), a heavy rescue vehicle, a grass truck, and a command vehicle. The department has an automatic mutual aid dispatch arrangement with the neighboring fire department to provide their tanker for water supply in areas without hydrants.

Training and Experience

The victim had served 12 years as a volunteer with this fire department and routinely drove and operated this tanker. From January 1, 2007 to the incident date, the victim had driven and operated the tanker under emergency conditions 20 out of the last 100 responses. He had recently taken a required driver training renewal program established by the fire department's insurance carrier. This training contained 8 hours of classroom training and 8 hours of driver training. The 8 hours required for driver training was divided among all members in the class and was limited to a parking lot obstacle course. The victim had also received his state Fire Fighter I certification, Haz-Mat Awareness, Driver Awareness, and monthly training topics via the Fire & Emergency Training Network (FETN). The victim had no previous vehicle crashes while driving emergency vehicles or personally owned vehicles.

Road and Weather Conditions

The incident occurred on a rural parish road (see Photo 1) approximately four miles from the fire station. The road was asphalt and 16 feet wide approaching the 90° turn. The Sheriff's Office surveyed the road and determined the road had a 4% down grade approaching the 90° turn. The asphalt road faded without a shoulder into sand and loose dirt leading into a shallow ditch. According to the fire department and a local resident, there have been no serious vehicle crashes in that location in the past 20 years.

The road has a posted speed limit of 25 mph with a 10 mph cautionary speed limit sign a few hundred feet before the turn. The Sherriff's Office investigators estimated that the speed of the tanker exceeded the maximum safe speed to negotiate the 90° turn. The road was dry and the weather was overcast at 68°F on the day of the incident.

Equipment and Personnel

The tanker truck was built on a 1993 model chassis that was formerly used as a semi-truck (see Photos 2&3) and acquired by the fire department in 2000. The truck was remanufactured into a fire apparatus in 2000 by a local truck and equipment builder. The truck had a diesel engine, three axles, 10 tires, an automatic transmission, an air brake system and was equipped with an engine brake. The braking system had passed state inspection in February 2008. The vehicle had a gross vehicle weight rating (GVWR) of 50,000 lbs. The truck builder estimated the dry weight of the completed truck at approximately 20,500 pounds upon delivery to the fire department. This did not include diesel fuel, tank water, tools and equipment, and occupants. Based on estimated weight calculations, it is believed that the tanker truck was not over its GVWR at the time of the crash. The front axle was rated at 12,000 lbs; each rear axle was rated at 19,000 lbs. The tanker measured 29 feet 4 inches in length, 9 feet 2 inches in height, and 8 feet 5 inches wide. The tires were in good condition (with the exception of the right front tire which had outer edge wear) and fully inflated. The vehicle was equipped with two seats each with combination shoulder and lap seatbelts. The tanker contained a center dashboard radio mount that was within arms reach of the driver. The tanker was equipped with an electric siren, air horn, and a single red and white light bar mounted on the roof of the cab.

The tanker truck had an elliptical 3,000-gallon water tank and was designed to use the containment method of baffling. The tank was constructed of metal and measured 15 feet long, 4 feet 7 inches in height, and 7 feet 6 inches in width. The tank had three transverse (cross-sectional) vertical baffles that ran side to side and top to bottom dividing the tank lengthwise into four chambers each less than four feet in length. It also had a longitudinal baffle centered halfway between the side walls of the tank that ran the length of the tank and rose approximately 31 inches in height from the bottom of the tank. Additionally, there were flow "windows" offset from each of the transverse partitions and air flow openings. The tank was filled to capacity at the time of the crash. According to department standard operating procedures (SOPs), if the tank water got below 400 gallons, the tank was to be emptied or filled to capacity before the tanker was driven again.

The local Parish Fleet Services Division handled basic maintenance and state inspections for this apparatus since October of 2005. The apparatus passed state inspection in February 2008. A review of the maintenance log indicated that only minor repairs had been performed on the tanker. The vehicle's mileage at the time of the incident was 820,980 miles, which was only 123 miles more than at the time of the state inspection in February 2008. The vehicle was totaled as a result of the incident.

The Louisiana State Police Division of Safety Enforcement requires that a fire apparatus receive a state inspection annually. *(Note: The state inspection requirements for fire apparatus are the same as for personally owned vehicles).* The State of Louisiana motor vehicle regulations do not require that emergency vehicle operators possess any special training or driver's licenses such as a commercial driver's license (CDL).

The timeline for this incident with key events includes:

- **0937 hours** Automatic mutual aid dispatch of tanker to mobile home fire in neighboring district
- **0938 hours** Victim enroute in tanker from fire station
- **0942 hours** Victim radioed mutual aid department IC for directions, with no response
- **0945 hours** Victim radioed mutual aid department IC again, with no response
- **0946 hours** Mutual aid fire fighter radios victim with directions to fire
  Victim "acknowledged" directions to fire
- **0949 hours** 911 call reporting a "fire truck crash"
- **0950 hours** Mutual aid fire department dispatched to crash scene
- **0951 hours** Chief radios victim twice, with no response
- **0952 hours** Chief radios victim again, with no response
- **0953 hours** Medic 120 responded to crash scene
- **0955 hours** Medic 120 arrived on scene and establishes incident command
  Medic 120 requested mutual aid for a rescue truck and engine company
- **1000 hours** Medic 120 requests air medical transport helicopter
  45 minutes elapsed during extrication
- **1050 hours** Air medical helicopter leaves crash scene with victim
- **1105 hours** Air medical helicopter lands at metropolitan trauma center

INVESTIGATION

On March 28, 2008, the victim started his shift at 0800 hours after he was called in to work a paid shift for his department. At 0937 hours, the tanker was automatically dispatched with the neighboring fire department to a mobile home fire. This was an automatic response for the tanker to provide water because the area where the fire was reported did not have hydrants. The victim placed his personal protective clothing (bunker gear) between the seats of the tanker, fastened his seatbelt and responded with lights and siren at 0938 hours. His fire chief was in the fire station when the call was dispatched and told him to "be safe."

The victim approached a major highway intersection that lead into the neighboring fire department's territory and radioed the fire's incident commander (IC) at 0942 for a "better location" on the incident channel. The victim continued through this intersection after receiving no response and radioed the IC again at 0945 hours on the incident channel with still no response. At 0946 hours, a member of the neighboring fire department radioed the victim on the victim's department radio channel. He provided directions to the fire scene and the victim "acknowledged" the directions at 0946 hours. There were no further radio transmissions from the victim. The radio directions given required him to go back to the intersection where he had originally radioed for directions. It is believed he took a cross street that looped back around onto the main highway so that he would not have to perform a 3-point turn with the tanker. The victim turned onto this cross street and then turned once more to take a road back to the main highway. The victim came upon a 90° turn which he failed to negotiate (See Photo 4 and Diagram). The left front tire went off the asphalt road into

sand and loose dirt that graded down into a ditch. This combined with the influence of the fully loaded tanker's high center of gravity and the speed at which it was traveling caused the tanker to roll onto the driver's side and slide into a row of pine trees. The cab of the tanker came to rest against a large pine tree that intruded into the cab crushing and pinning the victim inside.

A 911 call came into the dispatch center at 0949 hours. The caller stated "a fire truck had just over turned beside my residence and someone was hurt really bad…hurry up!" The neighboring district fire department was dispatched to the call at 0950 hours. At this point, it was not determined whose fire truck was involved in the crash. The victim's fire chief called the victim three times between 0951 and 0952 hours with no response. He immediately left the station and followed the possible route that the tanker would have taken. Medic 120, from the neighboring district fire department, responded to the tanker crash at 0953 hours and arrived at 0955 hours taking command. The tanker's lights and siren could be seen and heard in operation upon first responder arrival after the crash. The victim was found entrapped in the tanker still wearing his seatbelt. Medic 120 placed a mutual aid call for a rescue truck and engine company from another area fire department at 0955 hours. Medic 120 also requested an air medical helicopter for transport at 1000 hours. The extrication took 45 minutes and required a heavy wrecker to free the victim. The victim was stabilized and flown by helicopter to a near-by metropolitan trauma center where he was later pronounced dead.

CAUSE OF DEATH

According to the parish coroner, the cause of death was blunt force injury to the head secondary to a motor vehicle accident.

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that tankers are driven at a safe and reasonable speed.

Discussion: The Sheriff's Office investigators determined that the victim was going too fast to negotiate the turn. The cautionary speed sign indicated 10 mph and this should be considered the maximum safe speed limit for passenger vehicles on dry roads. In many cases, tankers should be driven at a much slower speed through curves than what is posted. Tankers should never be driven at a speed at which the vehicle cannot be fully controlled.[1-5] Tankers tend to be heavier and have a higher center of gravity than other fire vehicles.[2] Both of these factors affect the driver's ability to control a tanker. Based on physics, a top-heavy vehicle is inclined to tip or roll over if driven through a curve at an unsafe speed.[2] To reduce speed, many fire departments do not equip tankers with red lights and sirens as first response vehicles, but have opted to equip them with yellow or amber lights and use them as fire ground support vehicles.

Recommendation #2: Fire departments should ensure that fire fighters are familiar with the location of the roads in their coverage areas.

Discussion: Fire departments should ensure that fire fighters have familiarity with their coverage areas and mutual aid districts. During this incident the victim failed to negotiate a 90° turn. By being

familiar with the various routes within the response district, the driver will be able to anticipate dangerous curves or other hazards to safe vehicle response. Response times can also improve if fire fighters know the location or best routes to incidents.

Recommendation #3: Fire departments should consider staffing tankers with a minimum of two fire fighters.

Discussion: In this jurisdiction it is common for a tanker to be staffed by only a driver. However, the U.S. Fire Administration recommends that tankers being used to shuttle water be staffed by a minimum of two personnel (one driver and one passenger).[2] The second fire fighter in the cab can act as a second set of eyes to monitor potential hazards as well as operate warning devices, check maps, and act as a spotter for backing operations when necessary. The second person can also assist with hose connections, portable tank deployment, and other necessary tasks on the emergency scene or at the fill site. The victim was asking for directions on the radio, driving the tanker, and responding with lights and siren in an area he was unfamiliar with. The second individual could have handled communications on the radio and obtained directions to the scene allowing the driver to concentrate on driving and road conditions. The passenger should not hesitate to warn the driver when they feel that the tanker is being driven at an unsafe speed.

Recommendation #4: Fire departments should consider supplying responding units with maps or verbal directions to incident scenes, using computer aided dispatch (CAD) or a global positioning system (GPS) device.

Discussion: The victim's fire department was set-up to automatically send their tanker into their neighboring fire district for structure fires. The victim was not aware of the best route to take to the fire scene. Before crossing a major highway he radioed the incident commander for a "better location," and did so again minutes later after crossing another major highway that was a more direct route to the fire scene. He continued into unfamiliar territory until a member from the neighboring fire district gave him directions. These directions required him to go back to the intersection where he had called for directions the first time. He chose to take a secondary road that looped back to that intersection. This route of travel ultimately led to the crash scene. Having directions or reviewing a map before leaving the station could have prevented the victim from taking the route he took. Computer-aided dispatch (CAD) linked to a mobile data terminal (MDT) installed in the cab of the emergency vehicle is another way of providing information to emergency responders in emergent and non-emergent situations. These MDTs can display the following type of information: details from the 911 caller, responding and available apparatus, directions to the incident, and incident information including prefire plans. Some software programs even allow for turn-by-turn directions with voice prompts and maps. A global positioning system (GPS) device uses satellite signals to pin-point a location and can give turn-by-turn directions to a specific location and provide a map to follow. The neighboring fire district had a GPS system installed in their quick response vehicles and were beginning to outfit their fire trucks as well. Currently, the victim's fire department is in the process of installing MDTs in their emergency apparatus which will be linked to the CAD system.

Recommendation #5: Fire departments should develop oversight of their preventive maintenance program for fire apparatus.

Discussion: NFPA 1911, Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus states that fire apparatus should be serviced and maintained to keep them in safe operating condition and ready for response at all times.[4] Maintenance schedules should be established and recorded as an integral part of a well-planned maintenance program. The maintenance program should include daily, weekly, and periodic maintenance service checks. The maintenance checks should be based on the manufacturer's service manuals, the tire manufacturer's recommendations, local experience, and operating conditions. In this incident, the tanker received an inspection sticker in February of 2008. The tanker's right front tire had outer edge wear (see Photo #5) possibly from a wheel alignment issue. (*Note: According to the Parish Fleet Services Manager this tire met the required tread depth to pass the state inspection*). The tanker's left front tire had previously been replaced in October of 2005 after the state vehicle inspection was performed. A good practice would have been to replace both front tires at the same maintenance interval. NFPA 1911, 6.3.1 states that vehicles are to be taken out of service if the tires have a tread depth of less than 4/32 inch on any steering axle or 2/32 inch on any non-steering axle at any adjacent major tread grooves anywhere on the tire. The National Safety Council recommends a minimum tread depth of 4/32 inch on all tires.[6]

Recommendation #6: Fire departments and fire service training organizations should consider additional driver training for fire fighters on safe tanker driving and operations.

Discussion: An emergency vehicle operators course (EVOC) including a defensive driving segment and practical exercises should be completed once every three years. Fire departments should also consider whether a Commercial Driver's License (CDL) is appropriate based on vehicle characteristics and state requirements. Driver training should be conducted in accordance with NFPA 1451, Standard for a Fire Service Vehicle Operations Training Program and NFPA 1002, Fire Apparatus Driver/Operator Professional Qualifications.[3, 7] These standards state that departments should establish and maintain a driver training education program and each member should be provided driver training not less than twice a year. During this training, each driver should operate the vehicle and perform tasks that the driver/operator is expected to encounter during normal operations to ensure the vehicle is safely operated in compliance with all applicable State and local laws. Driver training should address vehicle characteristics, capabilities and limitations.[2]

NFPA 1451, Section 5.2.2 also states that annual driver training shall include hands-on exercises, excluding virtual reality driver training simulator (DTS), using actual fire apparatus.[7] This training needs to fully prepare fire fighters for any potential emergencies involving a fire apparatus. In addition to hands-on training, a vehicle apparatus simulator could augment the required road training by placing the operator in situations like tire blow outs, inclement weather, sharp turns at varied speeds, or turns at varying tank water levels. The vehicle driver could learn by mistakes in the simulator rather than during an actual roadway driving event.

Recommendation #7: Fire departments and fire apparatus manufacturers should ensure that tankers meet all the requirements of NFPA 1901, Standard for Automotive Fire Apparatus

Discussion: Fire apparatus manufacturers and fire departments should ensure that their tankers meet all the requirements of NFPA 1901, Standard for Automotive Fire Apparatus, and specifically Chapter 7 Mobile Water Supply Fire Apparatus and Chapter 19 Water Tanks.[8] The apparatus builder of the incident apparatus had mounted a 3,000 gallon steel tank on the chassis of a former semi-truck. The apparatus builder routinely purchased water tanks from several vendors that designed the tanks in accordance to NFPA 1901 requirements. NFPA 1901 specifies design methods to reduce the impact of sloshing liquids in partially loaded tanks on vehicle stability. Although the tank in this incident was fully loaded and sloshing effects may have been minimal, its baffle arrangement did not meet all of the requirements of NFPA 1901 at the time of manufacture.[9] The 1999 edition of NFPA 1901, Chapter 17 Water Tanks, Section 2.4.1 states "If a containment method of baffling is used, a minimum of two transverse or longitudinal vertical baffles shall be provided. There shall be a maximum distance of 48 inches (1220 mm) between any combination of tank vertical walls and baffles. Each baffle shall cover at least 75 percent of the area of the plane that contains the baffle." The tank had 3 transverse baffles dividing the tank lengthwise into 4 chambers each less than the 48 inch maximum length required by the standard. With the tank 90 inches wide, the longitudinal baffle divided the tank between each transverse baffle into 2 compartments each less than 48 inches wide as required by NFPA 1901. NFPA 1901, 17-2.4.1 would also require those longitudinal baffles to cover at least 75% of the area of the plane that contained the baffle. Since the baffle plate extended vertically 31 inches and the tank was 55 inches high, the longitudinal baffle covered only 56% of the area of the plane.

REFERENCES

1. NIOSH [2001]. NIOSH Hazard ID: Fire fighter deaths from tanker truck rollovers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-111. [http://www.cdc.gov/niosh/hid14.html]

2. USFA/FEMA [2003]. Safe operation of fire tankers. Emmitsburg, MD: U.S. Fire Administration, Publication No. FA 248. [http://www.usfa.dhs.gov/downloads/pdf/publications/fa-248.pdf]

3. NFPA [2003]. NFPA 1002, Standard on fire apparatus driver/operator professional qualifications. Quincy, MA: National Fire Protection Association. [http://www.nfpa.org/freecodes/free_access_agreement.asp?id=100203]

4. NFPA [2007]. NFPA 1911, Standard for the inspection, maintenance, testing, and retirement of in-service automotive fire apparatus. Quincy, MA: National Fire Protection Association. [http://www.nfpa.org/freecodes/free_access_agreement.asp?id=191107]

5. Brunacini AV [1985]. Fire command. Quincy, MA: National Fire Protection Association.

6. National Safety Council. CEVO II - Coaching the Emergency Vehicle Operator II: Fire Apparatus Defensive Driving Course. [http://www.nsc.org/onlinetraining/driving/cevo.cfm]

7. NFPA [2007]. NFPA 1451, Standard for a fire service vehicle operations training program. Quincy, MA: National Fire Protection Association. [http://www.nfpa.org/freecodes/free_access_agreement.asp?id=145107]

8. NFPA [2003]. NFPA 1901, Standard for automotive fire apparatus. Quincy, MA: National Fire Protection Association. [http://www.nfpa.org/freecodes/free_access_agreement.asp?id=190103]

9. NFPA [1999]. NFPA 1901, Standard for automotive fire apparatus, chapter 17 water tanks. Quincy, MA: National Fire Protection Association.

INVESTIGATOR INFORMATION

This incident was investigated by CDR Steve Berardinelli and Stacy C. Wertman, Safety and Occupational Health Specialists with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. Technical reviews were provided by Mike Wilbur, nationally recognized in emergency vehicle operations and co-editor of www.EmergencyVehicleResponse.com and Carl Peterson, Assistant Director, Public Fire Protection Division, National Fire Protection Association.

Photo 1. Crash Location.
(NIOSH photo)

Photo 2. Front of Tanker after Incident.
(NIOSH photo)

Photo 3. Rear of Tanker after Incident.
(NIOSH photo)

Photo 4. Incident Scene.
(Photo courtesy of Sheriff's Office)

Photo 5. Condition of the tread on the front tires.
(NIOSH photos)

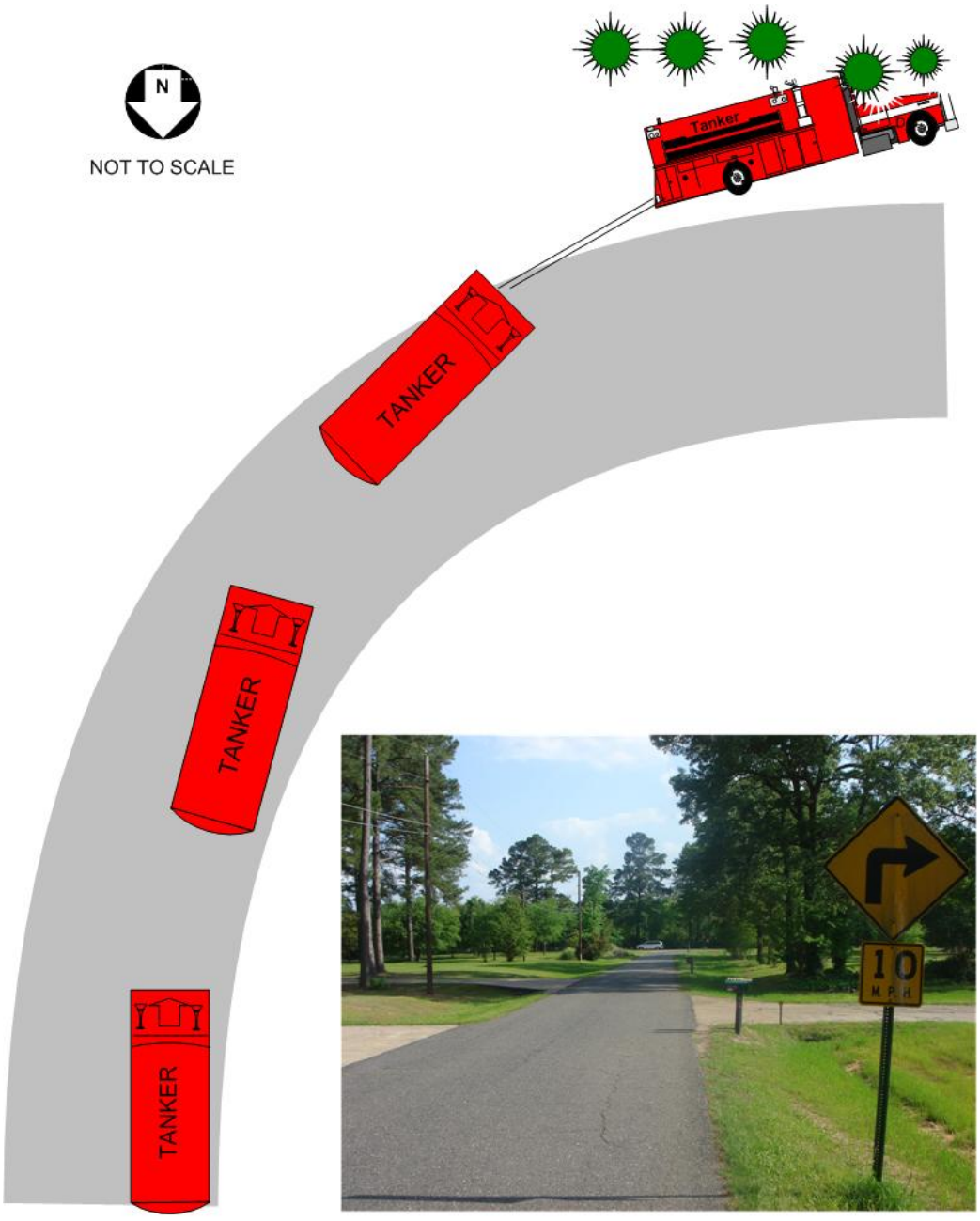

Diagram. Aerial View of Incident Scene.