1000 FREDERICK LANE, MORGANTOWN, WV 26508 · 304.285.5916

Career Firefighter Dies from Crush Injuries During Sand Trailer Operations – Florida

Executive Summary

On June 30, 2022, two firefighters (FF-A and FF-B) were assigned to relocate a hazardous materials spill unit (sand trailer) from the fire department storage facility. While hooking the sand trailer to the tow vehicle, the coupler of the sand trailer tilted upward, pinning FF-A underneath the load at the rear. FF-A was pinned across his shoulders, chest, and lower legs. FF-B immediately called for help using a portable department radio and verbally yelling for help. Firefighters nearby heard the emergency call for assistance and quickly responded to the storage facility. Medical evaluation was conducted while rescue efforts were initiated. FF-A was reportedly unresponsive and fully cyanotic (blueish discoloration of the skin due to a lack of oxygenation) from mid-chest and up, including fully involved cerebral and neck edema. Crews worked quickly to stabilize and lift the load from FF-A. Upon release of the load on FF-A's chest and shoulders, FF-A was heard taking in a deep breath and became progressively more responsive with diminishing cyanosis. Full extrication took place and FF-A was transferred to a stretcher and to the fire department's emergency medical service (EMS) unit. Request for a medical flight from the scene to the hospital was made; however, the driving distance to the hospital was determined to be faster than the provided response time of the medical helicopter. FF-A was transported by EMS, with full trauma protocol initiated, to the emergency room (ER). Upon arrival to the ER, FF-A was engaging in limited conversation with the EMS crew. FF-A was evaluated and diagnosed with crushing blunt force trauma to the trunk and upper extremities and a lower leg fracture. He was admitted to the intensive care unit. During the next 15-days, FF-A developed acute respiratory distress syndrome due to the crushing blunt force trauma, which required extracoporeal membrane oxygenation (ECMO) and kidney dialysis treatments. FF-A died from crushing blunt force trauma injury complications on July 15, 2022, as reported by the medical examiner.

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Contributing Factors

- *Vehicle and equipment inspection and maintenance*
- *Inspection criteria and accountability for vehicles and equipment*
- *Real-time risk assessment*

Key Recommendations

Fire departments should:

- *Develop a comprehensive vehicle and equipment inspection and maintenance program that includes emergency vehicle training and fleet management training.*
- *Work with AHJ, ASE-certified mechanics and Emergency Vehicle Technicians to ensure inspection and maintenance criteria are developed and available to identify deficiencies that render vehicles or equipment out of service.*
- *Develop a risk management program that reinforces personnel situational awareness throughout real-time risk assessments.*

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Introduction

On July 15, 2022, a career firefighter (FF-A) died from injuries sustained from a sand trailer tipping and crushing the firefighter on June 30, 2022. On July 18, 2022, The U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On August 22, 2022, a safety and occupational health specialist representing the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) met virtually with the fire department chief and initiated an investigation. A site visit was conducted, and all relevant documents, photographs, and applicable records were obtained.

Fire Department

The fire department consists of an administrative division and six fire stations. It has been Class 1 Insurance Services Office (ISO) certified since 2004. The fire stations are strategically located to provide coverage of the city, which spans over 35 square miles with a population over 57,000. The service area consists of industrial and commercial businesses, residential, mixed residential and apartments, and major highways. The combination fire department has approximately 100 full time firefighters. The fire administration division and one fire station share a building, along with an emergency operations center, in the city center. Reserve vehicles and equipment are stored in a separate storage building.

Training and Experience

Fire department policy sets annual training to meet mandatory ISO requirements. These requirements arrange training into the following categories: Company, Facility, Hazardous Materials, Officer, Existing Driver, New Driver, Investigator, and Life Safety Educator. Existing Driver training includes practical, or classroom activities related to vehicle operations. New Driver training is designated for those who have not completed a Relief Driver Program. Cumulative hours of training for each category are assigned quarterly.

FF-A completed the following training hours - Category: (Year/Number of hours).

- Company: (2020/150), (2021/308.50), (2022/119)

- Facility: (2020/27), (2021/32), (2022/14)
- Hazardous Material: (2020/17), (2021/38), (2022/14)
- Existing Driver Operator: (2020/11), (2021/8), (2022/2)
- New Driver: (2020/0), (2021/73), (2022/8)

FF-B completed the following training hours – Category: (Year/Number of hours)

- Company: (2021/164.5), (2022/128.5)
- Facility: (2021/29), (2022/21)
- Hazardous Materials: (2021/9), (2022/10)
- Existing Driver Operator: (2021/9), (2022/5)
- New Driver: (2021/22.5), (2022/2)

Hazardous Materials Spill Unit (Sand Trailer)

Trailer Acquisition and Use

The sand trailer was one of three sand trailers locally fabricated in the mid to late 1990's. At the time of this incident, two sand trailers remained; the second sand trailer was being used by a neighboring city, who placed it out of service and discarded following this incident. The involved sand trailer was fabricated as a single axle utility trailer with a mounted sand bucket, which was towed by one of the fire department's squad trucks. The sand trailer was used for roadway and other incidents where a release of hazardous materials was identified (i.e., the sand aided in containment and cleanup). After this fatal incident, the sand trailer was removed from service and stored at the city's fleet maintenance division for investigation purposes.

According to their website, the city's fleet maintenance division is responsible for the routine maintenance and repair of all city vehicles and equipment. This division is responsible for vehicles and equipment of eight city departments, including the fire department. The goal of the fleet maintenance division is to provide a service and replacement program that maintains vehicles and equipment to ensure operational safety and reliability. The sand trailer was kept at the fire department storage facility. It was stored on a concrete pad at the side of the storage building. The area was covered by an aluminum carport which provided protection from direct sun and weather-related exposure.

Emergency use of the sand trailer was not consistently reported to dispatch. When needed for an incident, one of the available stations would go to the storage facility and tow the sand trailer to the incident using the station's assigned squad truck. The responding squad truck would typically notify dispatch of the squad truck's assignment to the incident, and not notify that the squad truck was towing the sand trailer. This resulted in an inconsistent record of the number of times the sand trailer was used in comparison to the number of times dispatch would have recorded its use. Use of the sand trailer was reported in response to motor vehicle crashes, an overturned dump truck, and when a city garbage truck had a leaking hydraulic cylinder. Since 2019, the sand trailer stopped being automatically filled.

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Approximately one week prior to this fatal incident, the sand trailer was requested by the district chief to respond to a motor vehicle crash. However, the sand trailer was empty and did not respond. Approximately 2-3 days prior to the fatal incident, the fire department made plans to relocate the sand trailer to an outlying station.

Trailer Maintenance

After the incident, a fleet maintenance supervisor (supervisor) realized there were two different identification tag numbers assigned to the sand trailer. The supervisor, on staff for approximately 10 years, thought the sand trailer was out of service since 2010. Documentation provided by the supervisor included a *Request for Insurance Coverage* form (Request Form) and a *Florida Municipal Insurance Trust* form for Vehicle, Equipment and Property Change (Insurance form). The request form reflects the sand trailer as being homemade and added to the fire department assets in 2000. A vehicle identification number (VIN), unit number, and tag number were identified; however, State records did not have the VIN assigned to the sand trailer or the fire department and there was no VIN affixed to the sand trailer. The form assigned the sand trailer to the fire department fleet and listed the account number but did not list a requestor's name, the date received by the City Clerk's department, or the date added to the insurance. The *Municipal Insurance Trust* form listed a sand trailer effective on 2/17/1999 with no VIN or unit number listed although the tag number matched what was listed on the request form. The sand trailer was listed as a "custom built 1-1/2-yard sand trailer" with a load capacity of 1,160 pounds. A second tag number was identified in the computerized system with no associated maintenance records.

There were no available hard-copy records of historical pre-use or routine checks of the sand trailer by the fire department. Additionally, there were no hard-copy inspection and maintenance records by the city's fleet maintenance department. Electronic maintenance records for both tag numbers were minimal between 2000 and 2010 and verbally shared by the supervisor with NIOSH investigators. However, firefighters performed regular checks of all equipment located at the fire department storage building around 2004 and 2005. During this time, there were no checklists available to guide regular equipment checks. The firefighters used personal knowledge to check the sand trailer. There is a verbal fire department history of the sand trailer tipping backward while at the maintenance facility in 2005, similar to this incident, which did not cause injuries to maintenance staff. This prompted fleet maintenance to install a rear stabilizing jack on the sand trailer. Due to the design of the sand trailer, the rear stabilizing jack could only be installed on the frame beneath the sand bucket. The supervisor verbally reported the following work orders being performed on the sand trailer:

- 2003 – Replaced taillights
- 2005 – Replaced taillights and installed rear stabilizing jack
- 2007 – Replaced the front trailer jack
- 2010 – Repacked bearings and the holding pin at the coupler

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When the trailer was placed into service, Florida law required trailer lights at a trailer weight of 2,000-pounds. Lights were not placed on the trailer until the law changed in the early 2000's that required taillights on any trailer.

Trailer Characteristics

The sand trailer was roughly 117-inches long by 103-inches wide. Sand was contained in an enclosed right-angle trapezoid-shaped metal box (Photos 1 and 2) measuring approximately 59.5-inches wide. The short base (bottom) measured approximately 22.5-inches and the long base (top) approximately 41-inches. The forward-facing leg (right angle, Photo 1) measured approximately 37-inches and affixed with a "warning" message, "WARNING DO NOT LIFT TRAILER", and the rear-facing leg (obtuse angle) measures 42-inches. The box was mounted within a flat-top A-frame and connected on each side with a swivel, which allowed the box to be tipped backwards to release its contents while being towed forward. The box front had a welded post reaching forward to be secured by a winch mounted on the frame for controlled tipping of the box. The front bottom of the box was secured to the A-frame by pins to prevent uncontrolled tipping of the box itself. A removable lid allowed top access for filling. The lid was fitted with metal hangers to store two shovels. The trailer had a six-leaf slipper spring suspension. There were two stabilizing jacks mounted on the frame. One jack was mounted on the towing driver's side of the front trailer framework while the other was located on the rear-most cross member of the trailer framework and positioned within the designed tipping area of the sand box. The mounted tires

Photo 1: Front of sand trailer with front stabilizing jack in retracted position located on the front frame behind the trailer coupler (not visible), while being stored at the city's storage yard. *(Photo by NIOSH)*

Photo 2: Rear of sand trailer with rear stabilizing jack in retracted position located on the center of the frame. The rear stabilizing jack was reported to be in this position when rescue efforts began. *(Photo by NIOSH)*

were tubeless 7.00x15 light duty (LT) with a single max load of 1720-pounds at 45-pounds per square inch (PSI) and a "C" load rating.

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Investigation

On June 29, 2022, two firefighters directed to tow the sand trailer from the fire department's storage facility to the city's fleet maintenance facility to be filled with sand and relocate it to an outlying station. The fleet maintenance supervisor (supervisor) put one scoop of sand into the sand trailer from an IT14 loader – approximately 3,000 pounds. For an unknown reason, the firefighters returned the filled sand trailer to storage facility instead of delivering it to the requested outlying fire station. These firefighters were not available to be interviewed. Fire department personnel did not receive a report of towing difficulty from the two firefighters.

On June 30, 2022, two firefighters (FF-A and FF-B) were assigned to relocate the sand trailer from the fire department storage facility to the fire station. FF-A and FF-B secured the station's squad truck (squad) which had the necessary towing capacity for the trailer, to prepare for towing. A regular mount ball hitch (regular hitch) was already present on the receiver tube. FF-A backed the squad to align the regular hitch to the trailer coupler while FF-B provided direction from the driver's side of the sand trailer at the coupler. FF-A exited the squad and went to the passenger side of the sand trailer coupler. FF-B reported that the regular hitch was approximately 0.5 inch higher than the trailer coupler. FF-B reported that both firefighters were trying to figure out how to connect to the regular hitch. A drop hitch was not available on the squad. FF-B reported that the intent of both firefighters was to "get the job done." FF-B was at the coupler with his back toward the trailer and FF-A was at the passenger side of the coupler. FF-B attempted to physically lift the coupler up the needed distance to make the hitch/coupler connection. At some point during FF-B's attempt to raise the coupler, FF-A walked away. FF-B was not aware of this due to his positioning in the lifting attempt. The coupler and the sand trailer tipped upwards. FF-B, realizing that FF-A was not at the coupler, rushed to find him pinned underneath the tipped trailer. FF-B immediately called for help using the fire department radio and verbally yelling.

Two firefighters heard yelling coming from the storage facility and quickly responded. Upon their arrival, they saw FF-A pinned under the load of the upended sand trailer with his right leg pinned under the frame. There was evidence of some sand escape. Other firefighters began to respond from nearby training grounds. The firefighters attempted to lift the load of the sand trailer. Rescue included coordinated efforts on both sides of the sand trailer using hydraulic spreaders to lift the sand trailer, placement of cribbing, and then moving the spreaders and repeating. These efforts could not gain the needed lift height to extricate FF-A. During this time, multiple fire department personnel and EMS arrived on-scene. EMS personnel were unable to access FF-A due to entrapment, but a visual assessment noted signs of traumatic asphyxiation and other traumatic injuries. One firefighter retrieved a winch from the squad truck. They removed the regular hitch from the bumper, mounted the winch onto the bumper of the squad, and connected a winch cable to the trailer coupler. Retracting the winch cable pulled down on the coupler causing the rear of the sand trailer to lift off of FF-A. There was immediate passive inhalation by FF-A and successful extrication.

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FF-A was extricated, immobilized on a long board to protect potential spinal injuries, moved to a stretcher, and into an ambulance. The timeframe from first call for help by radio to full extrication of FF-A was approximately four minutes. FF-A was unresponsive but breathing on his own once extricated. During the extrication process, the paramedic contacted dispatch requesting a medical helicopter to a nearby predesignated landing zone (LZ). Upon extrication and transfer of FF-A to the ambulance, there was no contact from dispatch that the helicopter was enroute to the LZ. EMS contacted dispatch for an update, who was on hold with the helicopter dispatch. When EMS was enroute to the LZ, a paramedic contacted dispatch by phone for an estimated time of arrival (ETA) of the helicopter. Dispatch reported a 14-minute ETA to the LZ. Based on estimated travel times, the paramedic determined that transport by ground would result in the quickest arrival to the emergency room. A rapid medical examination revealed cyanosis involving the entire head, neck, and the upper portion of the chest as well as open fractures to the lower left leg. EMS personnel initiated a trauma protocol. During treatment and transport, FF-A progressed to a conscious and coherent state and communicated with EMS personnel. Upon arrival to the ER, FF-A was admitted to an intensive care unit for continued evaluation and treatment for 15-days. FF-A developed pneumonia and acute respiratory distress syndrome due to crushing blunt force trauma injuries, requiring ECMO and kidney dialysis. FF-A succumbed to his injuries on July 15, 2022.

Contributing Factors and Recommendations

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in an injury or fatality. Recommendations may provide fire departments guidance to prevent similar incidents from occurring.

NFPA standards/editions discussed below reflect those that were in effect at the time of this incident. Appendix A reflects how the NFPA standards/editions discussed below have been consolidated since this incident. Please refer to the most recent standard/editions when implementing recommendations.

Contributing Factor #1 – *Vehicle and equipment inspection and maintenance*

> Discussion: The city's fleet maintenance maintains and repairs all city vehicles, machinery, and equipment. The fire department did not have written guidelines or policy in place, including a structured maintenance program to aid the inspection of trailers and trailering equipment.
>
> The city fleet maintenance did not have an updated list of trailers to inspect and maintain. Failure to establish inspection requirements for fire department trailers resulted in lapsed or missing inspections and maintenance for the sand trailer, boat trailers, and other equipment trailers. Fleet maintenance reported having ASE-certified mechanics, but these personnel did not have training for maintaining emergency vehicles as recommended by NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Emergency Vehicles*.

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The lack of written guidelines or policy on trailering equipment led to the lack of JPRs on trailering, identification of safety-related hazards, and knowledge, skills, and abilities (KSA) of personnel for safe equipment operation. Further, the fire department did not have a safety officer assigned to assist in training development or to provide safety oversight during vehicle and equipment training. Ensuring a comprehensive training program leading to authorized operator licensing would have allowed experienced operators to be assigned to this activity.

Recommendation #1 *–Develop a comprehensive vehicle and equipment inspection and maintenance program that includes emergency vehicle technician training and fleet management training.*

Vehicle and equipment inspection and maintenance program

Annual maintenance inspections and regular operator checks of the sand trailer may have identified deficiencies and placed it out of service. NFPA 1911 defines minimum requirements for establishing a program, provides criteria for placing emergency vehicles out of service, and identifies qualifications of personnel for inspections, maintenance, and testing of emergency vehicles. It is the responsibility of the Authority Having Jurisdiction (AHJ) to ensure fire apparatus, systems, and devices are included in the program. An AHJ is "an organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure" (NFPA 1500). Program implementation within the fire department should be completed in collaboration with the AHJ to ensure general oversight of all emergency vehicles and equipment. In addition to manufacturer recommendations, NFPA 1911 identifies minimal, specific, and general requirements for various fire apparatus, systems, and devices; for inspections, maintenance and testing schedules; and indicators for retirement of apparatus, systems, and devices. Specific to this investigation, NFPA 1911, Chapter 16, identifies minimum requirements and frequencies for trailer inspection and maintenance.

Professional development to support preventative maintenance activities

NFPA 1500 relates to inspection, maintenance, and repair of fire apparatus. Fire apparatus is defined in NFPA 1500 as "a vehicle designed to be used under emergency conditions to transport personnel and equipment or to support the suppression of fires and mitigation of other hazardous situations (NFPA, 1901 2016)". As an important element of firefighter safety, NFPA 1500, Appendix A, notes that all vehicles are to be inspected on a regular basis and proper operation of all safety features should be checked. It supports weekly checks for apparatus stored in unattended stations that are infrequently used and a pre-use check prior to being placed back in service.

Training qualifications of personnel authorized to complete checks and inspections should be identified by the AHJ. In accordance with NFPA 1911, inspections, maintenance, and testing of fire apparatus should be completed by personnel who meet the professional qualifications

requirements of NFPA 1071. The Fire Department Safety Officer's Association (Fire Department Safety Officers Association - Emergency Vehicle Technician) offers five levels of emergency vehicle technician training which meet the requirements of NFPA 1901, *Standard for Automotive Fire Apparatus*, and NFPA 1911, *Standard for the Inspection, Maintenance, Testing and Retirement of In-Service Automotive Fire Apparatus*. Management level 1 and 2 courses are based on the Association of Equipment Management Professionals (AEMP) publications and other resources and applicable to fleet maintenance and career equipment fleet managers. Inspections and maintenance should be conducted in accordance with the manufacturer recommendations and meet the federal or state and local laws for motor vehicles. NFPA 1911 Annex C offers a sample quarterly and annual inspection report, which should also be maintained for the life of the apparatus.

Daily and weekly visual checks should be completed by personnel certified as drivers/operators in accordance with NFPA 1002. NFPA 1002 prescribes that prior to operating fire equipment, the operator shall meet the JPR's of 4.2, Preventive Maintenance, and 4.3, Driving/Operating. Meeting these requirements enables the operator to ensure operational status of the apparatus, competence of those operating the apparatus, and any fixed systems and equipment on the apparatus. Visual and operational checks should be completed within 24-hours of a run or weekly if no runs are made during the week. NFPA 1911, Annex C, offers a guide to develop a preventive maintenance program and checklists for daily and weekly checks. Completed checklists should be maintained for the life of the apparatus.

Vehicle driver/operator education training programs

NFPA 1451 requires fire departments to adopt an official risk management plan for fire and emergency services organization vehicles. The plan shall cover administration, facilities, training, vehicle operations, protective clothing and equipment, operations at emergency incidents, operations at non-emergency incidents, and other related activities. The plan shall be incorporated into the vehicle operations training program and evaluated for effectiveness at least every three years. NFPA 1451, Appendix A recommends that organizations with unique vehicles ensure that all risks are reviewed. NFPA 1451 requires the establishment and maintenance of driver training and education program to aid in prevention of vehicular crashes, deaths, and injuries to members, employees, and the public. The training and education should be commensurate with the duties and functions expected of the members. Training should occur at a minimum of twice a year but should be offered more frequently as needed. Annual driver training should include hands-on operations of the actual vehicles assigned.

From a state perspective, the Florida State Administrative Code (FAC) 69A-62.02, *Minimum Requirements for a Firefighter Employer Comprehensive Safety and Health Program*, provides that the employer will ensure and document that each authorized emergency vehicle operator has taken a 16-hour training course of instruction. This training should include, but is not limited to, classroom training, defensive driving, accident avoidance, routine safety checks of vehicles, and

practical skills. The program requires training and education for firefighters be commensurate with the expectations of their duties and provided before they engage in any activity requiring the training. Training should be conducted frequently to ensure the firefighter is able to perform the assigned duties safely. Training should be documented and stored as a permanent record. FAC 69A-62.021(5) states that in-house training should meet the quality of the emergency vehicle operator training offered through the Florida State Fire College. (FAC 69A-62.02, 2017)

For example, in this incident, the coupler and tow hitch did not align. Some interviewees commented that a drop-hook was needed because of the height difference of the squad's bumper to the coupler. This knowledge is an example of a safety-related hazard that could be included in operator training. Ensuring a comprehensive training program leading to authorized operator licensing may have resulted in experienced operators being assigned to this task.

Individual training meets JPRs prior to task assignment

Finally, it may be useful to align training with JPRs prior to assigning tasks. The firefighters in this incident were tasked with towing a loaded trailer from one location to another. They had never received formal training for this operation and were not being supervised by someone with experience. The firefighters recognized that they did not have the correct equipment. NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, provides professional qualification standards that are written as JPRs which describe the performance required for a specific job and grouped according to the job duties (NFPA, 1001 2019). NFPA 1001, Annex C and NFPA 1041, *Standard for Fire and Emergency Services Instructor Professional Qualifications*, (NFPA, 1041 2019), Annex B, address how to use JPRs for instructional purposes. Training institutions, fire departments, and individual fire service instructors can use NFPA JPRs along with jurisdictional resources in their instruction and evaluation development.

Guidance from other NFPA publications should be referenced within the JPRs and identified as appropriate for the duties and responsibilities of the position. NFPA 1451, Chapter 5 provides information on driver's training and education. 5.1.3 states that members shall be provided driver's training and education appropriate for their duties and responsibilities before being authorized to operate vehicles or apparatus. 5.3.8 discusses the potential hazards of unconventional or specialized units. Appendix A.5.3.8 provides examples of unconventional and specialized equipment which includes towing vehicles. These unconventional or specialized vehicles have unique road-handling characteristics which requires additional training and certification.

Contributing Factor #2 – *Inspection criteria and accountability for vehicles and equipment*

Discussion: The sand trailer was locally fabricated 20 years prior to this incident. It was designed so the full load was positioned above the single axle and the rear cross member of the frame approximately 14-inches behind the axle. The front of the frame extended forward approximately

84-inches from the single axle. This design did not provide a protection that would prevent the sand trailer from tipping over to the rear if lifted from the front. It did have a "Do Not Lift" warning stenciled on the front of the covered sand bucket.

Further, in 2007, the sand trailer reportedly tipped over to the rear while at the maintenance facility, similar to the tipping in this incident. This prompted fleet maintenance staff to install a utility jack on the center of the rear cross-member of the frame. This positioning required operating personnel to raise or lower the utility jack by entering an area vulnerable to the weight of the load if a tip over event occurred. Being locally fabricated, the sand trailer did not have an owner's manual or manufacturer's recommendations as would be provided with a commercially manufactured trailer.

As discussed in the previous recommendation, the sand trailer was not part of a vehicle and equipment inspection and a maintenance program that would have identified potential safety concerns, even after the 2007 tip over event. Thus, there was no process for rendering the sand trailer out-of-service and considering it for retirement.

Recommendation #2 – *Work with AHJ, ASE-certified mechanics and Emergency Vehicle Technicians to ensure inspection and maintenance criteria are developed and available to identify deficiencies that render vehicles or equipment out of service.*

It is important for fire departments and, in this case, city fleet management to work together to ensure all vehicles are properly inspected, maintained, and tagged out of service if deemed unsafe. NFPA 1911 provides minimum required maintenance and inspection criteria in addition to any manufacturer recommendations. The fire department and fleet maintenance staff could have ensured serviceability and safety with adherence to requirements of NFPA 1911 such as:

- requirements for trailer
- towing operations
- safety equipment
- training recommendations
- inspection and maintenance recommendations

NIOSH's visual inspection of the sand trailer identified that the sand trailer did not have an identified Gross Vehicle Weight Rating (GVWR) or Gross Axle Weight Rating (GAWR). This information is ordinarily included with commercially manufactured vehicles and equipment so that safety recommendations are identified and listed in manufacturer's recommendations. The absence of these should have placed the sand trailer out of service until those items could be obtained through a qualified person. NFPA 1911 describes the requirement for all emergency vehicles to undergo annual vehicle axle weight testing. The fully loaded vehicle is weighed to ensure that the weight on the axle(s) does not exceed the GVWR and GAWR assigned by the

manufacturer. There was no evidence that annual vehicle axle weight testing was completed at any time prior to this incident. The absence of the GAWR was more relevant in this incident. Specifically, the GAWR:

- Informs the user of the maximum capacity of the sand trailer's total weight, including the load, on its axle(s)
- Is used to determine the appropriate towing vehicle and the proper size, type, or inflation pressure of the tires to carry the weight of the load. 49 CFR, 571.110, requires that "the sum of the maximum load ratings of the tires fitted to an axle should not be less than the GAWR."

The sand trailer had been fitted with 7.00-15 LT tires with a load rating "C." Only one tire mounted on the sand trailer had a visible capacity rating of 720-pounds with tire inflation pressure of 45. Assuming both tires mounted on the sand trailer had the same capacity rating, the total capacity of load on both tires together would be a maximum of 3,440-pounds. The post-incident investigation completed by the state police reported that the weight of the loaded sand trailer was 4,500-pounds. This exceeded the capability of the tire manufacturer's recommendation, which could have led to damage and instability of the tires.

Available maintenance records do not show any tire changes within seven years prior to the incident, as is required by NFPA 1911. The weathering damage visible on tires post-incident is evidenced by the worn capacity rating molding on the sidewall and ozone cracking of the sidewall. In addition, the wheel showed corrosion and a small amount of flaking (see Photos 3 and 4).

Photo 3: Passenger side tire with visible size, type and capacity rating. Wheel displays rusting and flaking. (Photo by NIOSH)

Photo 4: Driver side tire showing extensive weathering of the tire and rusting and flaking of the wheel. (Photo by NIOSH)

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The GAWR is also needed for safety modifications. The 2007 tip over incident prompted the installation of a rear utility jack. The NIOSH investigator verified an installed Fulton utility jack located at the center of the rear crossbeam of the sand trailer frame. The stabilizing jack was stamped with a static capacity of 1,000 pounds. Instructions for similar Fulton utility jacks online indicate that a failure to follow the warnings could result in property damage, serious injury, and/or death. The first warning is to never position any part of the body under any portion of the product or the load being supported (Fulton, n.d.). The utility jack located in the center of the rear crossmember of the frame placed the jack immediately beneath the load. This placement required operation of the utility jack to include whole body positioning underneath the load. The 1,000-pound static capacity of the utility jack was not enough to support the weight of the load, which was estimated to be 3,000-pounds of sand plus the weight of the sand trailer. A potential reason that FF-A was found in the area beneath the load could be attributed to FF-A retracting the utility jack to allow the coupler to be hoisted to meet the hitch. Witnesses reported, and post-incident photos showed, that the utility jack was in the fully retracted position following extrication of FF-A. There are no reports that rescuers fully retracted the utility jack and locked it into position. Moving forward, all equipment at this department is expected to have available an owner's manual with included manufacturer's recommendations.

Photo 5: Post-Incident - Rear utility jack in fully retracted position
(Photo by fire department)

Manufacturer's recommendations provide safety-related information, inspection and maintenance requirements, and associated training requirements, as indicated for the specific piece of equipment. All manufactured equipment will have available manufacturer's recommendations incorporated in the owner's manual. There are no written fire service recommendations when equipment does not have manufacturer's recommendations. However, NFPA 1911 states "The provisions of this standard shall not supersede any instructions, specifications, or practices defined or required by the emergency vehicle manufacturer, component manufacturer, equipment manufacturer, or authority having jurisdiction". An AHJ could review operational risks as identified by a qualified person, and procedures related to capacity and limitations as identified by a professional engineer, to determine the serviceability of the piece of equipment or requirement for retirement.

Contributing factor #3 – Real-time risk assessment

Discussion: During this incident, the firefighters were tasked with towing a loaded trailer from one location to another. They had never received formal training for this operation and were not

being supervised by someone with experience. the two firefighters identified a problem when the tow hitch could not be properly aligned with the trailer coupler and that they did not have the correct equipment. The tow hitch was reportedly 0.5 inch above the trailer coupler. The firefighters were unsuccessful in locating a drop hitch in the squad, which would have allowed proper alignment. It was reported that the two firefighters walked around the sand trailer to find a resolution. It is unknown if any plan was communicated, however, as FF-B attempted to physically hoist the trailer coupler to meet the tow hitch, FF-A walked away. Because his back was toward the sand trailer, FF-B was not aware that FF-A walked away until the attempt to hoist the trailer coupler caused the sand trailer to tip backward. FF-B then realized FF-A was not at the front of the sand trailer. After the sand trailer tipped backwards, FF-A was located pinned beneath the load of the sand trailer. The rear stabilizing jack was secured in a retracted position, which indicates that the rear stabilizing jack was retracted by FF-A. It can be assumed that FF-B attempted to hoist the coupler up at about the same time that FF-A retracted and secured the rear stabilizing jack.

Recommendation #3 – *Develop a risk management program that reinforces personnel situational awareness throughout real-time risk assessments.*

Section 4 of NFPA 1500 provides criteria that fire departments can use to develop and maintain a comprehensive risk management plan. A risk management plan should cover a variety of emergency and non-emergency topics, including training and vehicle operations. The risk management process relies on identifying hazards, assessing those hazards, implementing controls for each hazard identified, supervising the effectiveness of those controls, and monitoring for any continued or new hazards. NFPA 1500, D.1.4 defines risk control for firefighter safety under risk management plan factors. A risk management plan should be developed at the organizational level of the fire department (NFPA, 1500 2021). Known, or anticipated hazards and hazard controls can be implemented in training and addressed in standard operating procedures.

NFPA 1500 calls for training, education, and professional development for all members of a department commensurate with duties and functions they are expected to perform. Risk management is a requirement for vehicle operations. NFPA 1451 identifies the driver's/operator's responsibilities, which includes several measures related to safe operation of the vehicle.

Real-time risk management, within risk management programs, emphasize the individual ability to continuously assess and respond to risks as they occur. The ability to accurately assess risks in real time is a cumulative reaction based on training, knowledge, and past experiences. The U.S. Air Force describes real-time risk management as managing risks at the execution phase of an activity. This requires the individual or small group to implement "immediate or near immediate action to mitigate risk(s)" (DAFPAM 90-803, 2022). Real-time risk management utilizes formal risk management principles at the tactical level. A well-planned activity can easily produce an unexpected outcome. Firefighters can prepare to respond to unexpected outcomes by practicing

how to manage risks, anticipating and mitigating probabilities, and communicating unexpected outcomes to all involved.

Further, developing real-time risk management skills may lead to improved situational awareness. Both are an ongoing process as hazards can rapidly increase and change as an incident develops. That is, situational awareness is better supported through a continuous risk assessment and the identification of hazards or a changing environment. In this incident, several barriers were present that may have impacted the firefighter's situational awareness and eventual ability to accurately perceive, comprehend, and forecast the actual risks present during their task including:

- Self-imposed need to act and subsequent stress – The firefighters' intent was to complete the mission they were given. The sand trailer coupler did not align with the tow hitch, preventing the firefighters from completing their assigned task. Physical and mental stressors encountered can negatively impact the cognitive abilities to sense, comprehend, and forecast. This can result in acting very quickly before developing effective situational awareness.
- Fixation – Each firefighter appeared to focus on the resolution they thought was needed. When attempting to accomplish a given task, personnel can overfocus to the point of developing tunnel vision. When this occurs, other critical cues can be easily missed, and the process of forecasting can stop.
- Lack of procedures – There were no formal procedures for the firefighters to follow for this specific task. They were not provided the education, training and experience opportunities to understand how to properly conduct towing operations.

Situational awareness can function as one tool within real-time risk management. However, these skills are usually developed from practice and opportunities (Gasaway 2013, 2017, 2019, 2023). The greatest chances for success come when all personnel utilize effective situational awareness, effectively communicate their findings with key personnel, and there is shared situational awareness at all levels of the incident or activity.

References

As of 2024, NFPA has started a consolidation of standards. Some NFPA references listed below, although active at the time of this incident, have changed. A summary of consolidations can be found in Appendix A.

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Investigator Information

This incident was investigated by Tammy L. Schaeffer, Safety and Occupational Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. A technical review was provided by the National Fire Protection Association, Emergency Response & Responder Safety Division.

Disclaimer

The information in this report is based upon dispatch records, audio recordings, witness statements, and other information that was made available to the National Institute for Occupational Safety and Health (NIOSH). Information gathered from witnesses may be affected by recall bias. The facts, contributing factors, and recommendations contained in this report are based on the totality of the information gathered during the investigation process. This report was prepared after the event occurred, includes information from appropriate subject matter experts, and is not intended to place blame on those involved in the incident. Mention of any company or product does not constitute endorsement by NIOSH, Centers for Disease Control and Prevention (CDC). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

Career Firefighter Dies from Crush Injuries During Sand Trailer Operations – Florida

Appendix A

NFPA Standards Consolidation Project

NFPA Standards Council will implement a consolidation plan of the Emergency Response & Responder Safety standards to improve the overall standard development process. The transition will be completed over five years, and it began in 2020. More information regarding the consolidation project can be found at Emergency Response and Responder Safety Consolidation Project. The table below contains the NFPA references in this report and crosswalks the NFPA original standard number, the consolidated standard number, and the consolidated standard title.

Original Standard	Consolidated Standard	Consolidated Standard Title
1901	1900	Standard for Aircraft Rescue and Firefighting Vehicles, Automotive, Fire Apparatus, Wildland Fire apparatus, and Automotive Ambulances
1911	1910	Standard for the Inspection, Maintenance, Refurbishment, Testing, and Retirement of In-Service Emergency Vehicles and Marine Firefighting Vessels
1001	1010	Standard on Professional Qualifications for Firefighters
1002	1010	Standard on Professional Qualifications for Firefighters
1500	1550	Standard for Emergency Responder Health and Safety
1041	1020	Standard for Fire and Emergency Services Instructor, Fire Officer, and Emergency Medical Services Officer Professional Qualifications
1451	1400 (consolidation August 2026)	Standard on Fire Service Training