



**National Fire Fighter Near-Miss Reporting System
Reports Related to Oxygen Cylinders**

Report #	Synopsis	Page #
05-316	Flow friction blamed for oxygen cylinder fire	2
06-145	EMT struck by regulator assembly while refilling O2 cylinders	3
06-420	Aerial ladder comes in contact with electrical lines	3
06-437	Shocking maintenance event	4
08-487	Aerial ladder strikes power lines	4

05-316

Event Description

A portable oxygen cylinder ignited and the cylinder failed violently during routine morning check off.

The cause was related to the gasket used to attach the regulator to the cylinder. The plastic gasket had been re-used a number of times and would no longer seal properly when contact was made. This oxygen leak was then ignited by a pen light that was left in the bottom of the jump kit that contained the oxygen.

The fire and violent cylinder release narrowly missed the fire fighter involved and could have severely injured or killed him.

(The following is an addendum filed by the reporter. It clarifies findings that were determined after further investigation. Reviewer #1)

The point of origin of the fire developed at the CGA870 crush gasket. The ignition source was flow friction. Ignition at this location resulted in promoted ignition of the EMS bag and contents along with oxygen-enrichment and accelerated burning within the bag. Pressure rupture of the cylinder resulted from the accelerated burning of the bag and bag contents after the autogenous ignition of the burst gasket and further oxygen-enrichment of the area surrounding the burst disk. The probable ignition mechanism that was active in this fire was associated with the heat developed by oxygen leaking across the CGA870 gasket in a weeping or seeping manner. This ignition mechanism is referred to as "flow friction" and has been implicated in several previous oxygen related fires.

Lessons Learned

The plastic gaskets were removed from all of our fire units and replaced with the proper seals made of rubber surrounded by brass. All oxygen bags in the fire department were checked for crescent wrenches and bent "turn down" handles. This indicated that the fire fighters were not getting a good seal with the hand tight "ears", so they got a bigger wrench and over tightened the regulator trying to get a good seal.

1. All personnel should be made aware of the dangers of all compressed gases and especially oxygen. Oxygen will make items not normally ignitable---extremely flammable.
 2. Training, and education on using the right equipment.
 - 3.If something doesn't seem right---investigate and ask for help.
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06-145

Event Description

While refilling oxygen bottles, the attachment assembly detached from the O2 bottle and struck the EMT. This was determined to be a result of someone cross threading the assembly.

Lessons Learned

Regular inspection and training are necessary to avoid future occurrences.

06-420

Event Description

During morning equipment check, a back-up driver was in process of lubing the ladder on the truck. The back-up driver extended the ladder to work lube in and remove any excess. In extending, the back-up driver extended the ladder between the 19,000 volt service lines and the lower cable/phone lines. The right back seat person, at the same time, had a compartment door open on the officer side of the truck. It was one of the higher compartments over the rear duals and was checking the oxygen cylinder. He pulled it part way out and was bleeding the pressure off the regulator, at this same time the back-up driver raised the ladder into the 19,000 volt service line. An electrical arc approx. 12 inches came out of the side compartment and struck the firefighter in the chest and then a bright flash which is assumed to be the oxygen lighting. Witnesses moved the firefighter away from the truck and held the back-up driver in place until the power company could de-energize the lines contacting truck.

The firefighter appeared unharmed but was transported for evaluation at a nearby hospital. Both firefighter and back-up driver were removed from the line for remainder of shift. It remains unclear why the firefighter was not electrocuted. Situational awareness was a major factor in this near miss. Training to re-enforce safety distances for working around electrical lines is also a contributing factor in this event.

Lessons Learned

Keep aerial device minimum distance (of ten feet) from overhead electrical lines. Re-enforce safe practices with all back-up drivers. DO NOT SHOOT LADDER BETWEEN SERVICE LINES. All members maintain a situational awareness of apparatus condition, placement, use and what others are doing at all times.

06-437

Event Description

While performing maintenance of ladder truck, back-up driver operating aerial device for the purpose of cleaning & lubing ladder. Operator had extended the ladder between the 19,000 volt service lines and the general utilities (cable/phone). Jump seat fire fighter was inside one of the side compartment checking EMS equipment. The firefighter was working in one of the high compartments over the rear wheels. He pulled the oxygen kit part way out to check supply after which he started to bleed off pressure on the regulator (both hands were on the oxygen regulator). At this time, the operator had shot the ladder fly section approx 8 feet through the lines and then raised the ladder up into the lines energizing the aerial. The firefighter working in the compartment was struck by a bolt of electricity coming out of the compartment. At that time, a bright flash (thought to be oxygen igniting) consumed the firefighter.

At this point, the fire fighter (appearing to be fine) was moved back from the truck and evaluated by the engine medic. The operator was held in place until the power could be de-energized at which time the operator could be evaluated.

Lessons Learned

Keep aerial device minimum distance (of ten feet) from overhead electrical lines. Re-enforce safe practices with all back-up drivers. **DO NOT SHOOT LADDER BETWEEN SERVICE LINES.** All members maintain a situational awareness of apparatus condition, placement, use and what others are doing at all times.

08-487

Event Description

On August 15, 2006, after 0900 hours, a firefighter acting as the driver/operator of a ladder truck had completed the application of lubricant to the aerial ladder. The firefighter fully extended the aerial over the cab of the vehicle at a relatively low angle, between power lines in front of the station. The turntable of Truck [1] was approximately 86 feet from the power lines. The angle of the ladder was approximately 15 degrees. The firefighter then retracted the ladder about 5 feet when the ladder contacted a 19,900 volt power line. At the same time, a firefighter was completing his check of the oxygen in a right side compartment. The firefighter heard a loud boom as "something exploded in the compartment." Firefighters who witnessed the event reported seeing an arc from the compartment strike the firefighter in the chest. One firefighter was transported to the hospital primarily as a precaution. No injuries or fatalities occurred.

Due to the fact that this event nearly resulted in the electrocution of one member of the department, an investigation of the incident was initiated.

[Brackets denote identifying information removed by reviewer.]

Lessons Learned

Findings and Discussion:

1. The operator of the ladder truck extended the aerial ladder into the power lines.

The action of placing the aerial ladder near the electrical lines endangered the life and safety of anyone who was operating near the vehicle. The manufacturer's recommendations and OSHA standards indicate that the ladder should not have been positioned within 10 feet of power lines. This precaution is clearly indicated numerous times on the exterior of all of the department's aerial devices as well as on the control pedestal. Additionally, this action is contrary to all training that members receive during recruit firefighter school, training by utility company representatives, and during effective driver training (to include a reading of the manufacturer's operator's manual). The actual extension of the aerial device into the right-of-way of the power lines was a conscious decision by the operator. The amount of space between the wires is very limited when considering the space required for an aerial at a low angle, though this is irrelevant, as the ladder should never have been positioned near the lines.

2. The process for training drivers and backup drivers lacks consistency and structure.

The process for qualifying personnel to drive and operate vehicles occurs at the station/shift level which results in a variety of training procedures and a range of criteria to become a driver. The department's apparatus qualifications checklists make little distinction between the various types of vehicles in the department's fleet. The "aerial" checklist makes no distinction between rear-mount aerials, rear-mount towers, and mid-mount towers, nor does it account for vehicles from different manufacturers.

In this event, the driver had been trained and "approved" to drive the ladder truck. The incident occurred on [one type of aerial the department uses]. While the trucks are both rear-mount aerial ladder trucks, there are notable differences between the operation and performance of both the vehicles and the aerials. In this case two features of the aerial that may have contributed to the incident include:

- The aluminum ladder on [one of the models] flexes or bends far more than does the steel ladder on [the other model]. The driver was retracting the ladder when it contacted the wire. It is conceivable that the act of retracting the ladder may have reduced the "flex" of the ladder enough to allow it to contact the wire (assuming no other changes were made to the positioning of the ladder, it should then also have contacted the wire during the extension process).
- The configuration of the aerial controls on [different manufacturer's] aerials is significantly different. The location of the extension/retraction control and the raise/lower controls are reversed on [aerials made by two of the manufacturers we use]. Additionally, the raise/lower control motions are reversed between the two builders. Though the driver stated she was retracting the ladder, it is conceivable that driver could have been confused by the change between the controls she was trained on and the ones on the device she was operating.

Note: Regardless of the features listed above, the aerial should never have been positioned near the power lines as outlined in finding #1.

3. All personnel who responded to the incident, specifically the personnel who were located in the apparatus bay, immediately took action simultaneously with isolating the danger area around the vehicle, maintaining communication with the operator, providing medical assistance to the injured firefighter, notifying the officer in charge, and requesting the power company.

The firefighters who were in the apparatus bay immediately recognized the hazard, assumed that the vehicle was still energized and removed the firefighter from his position near the vehicle. They also directed the driver to remain at the position on the turntable. They notified the officer in charge (OIC) of the event and the OIC made the proper notification using the fire phone. The OIC requested additional units to the incident. They provided medical assistance to the firefighter and communications was maintained with the driver who remained on the truck until the power company de-energized the power lines.

The incident was properly managed with definitive barriers being established around the vehicle and personnel assigned to monitor these boundaries. All appropriate notifications were made to handle all aspects of the incident, both immediate and long term.

Recommendations:

1. Establish a working group to develop the process/procedures and regular skills maintenance training for driver/operators (to include backup drivers) to meet and become qualified on a given class of vehicle.

The Training Division in collaboration with Safety, Operations and Risk Management, is to develop and utilize a standardized training and evaluation criteria that can be administered at the station level. The group will provide detailed knowledge and performance requirements. The group should seek input from a range of members to ensure that standards are established for specific vehicle types.

Example:

- Aerials, rear-mount and mid-mount towers.
- Engines and tankers.
- Specialty units (HM Unit, Field Communications Unit, etc.) could have unique standards.
- Consideration should be given to the unique requirements of reserve apparatus and variations between manufacturers or operating systems.
- The process of becoming qualified should include a method for communicating member's qualifications to the department such as a protected process for updating profiles.

2. An in-station drill should be developed and issued to provide information to members on the hazards of electricity, the components of the distribution system, and guidelines for handling incidents involving electricity.

Firefighters deal with electricity during the course of many events from building fires to “wires down” calls to investigations. Most firefighters received some level of electrical safety training during recruit training. Many others have received training from representatives from local power companies and additional knowledge has been acquired through experience and interacting with utility personnel during incidents. This training has led to correct decisions during most of our encounters with electricity; however, this event and others, both inside and outside of our department (pulling of meters, forcing entry into transformer boxes, potential PCB incidents, national firefighter near-miss and LODD’s reports), coupled with the potential consequences of incorrect decisions, indicate that regular/additional training should occur.

The training should cover topics such as:

- Basic information about electricity, the components that comprise the distribution system and the hazards presented by both.
- Awareness of overhead hazards when deploying ground ladders, aerial devices, and other devices such as light towers, antennae, cameras, etc.
- Guidelines for handling “routine” events involving electricity, as well as unusual events.
- Considerations of routine aerial maintenance and hazard awareness.

3. There is a need in the Fire and Rescue Department to change the culture of safety. We, as members, need to do everything possible everyday to minimize our risk and exposure to danger and harm.

As firefighters and paramedics, we are exposed to a variety of situations that each offer a hazard and challenge. From extensive training and education, most of the hazards and challenges have a preventative measure that each of us needs to utilize at every incident.

The Safety and Health section along with the Training Division provides education in a variety of ways, to include:

- In-station drills
- Practical exercises
- Lecture presentations
- Specialty schools
- Safety newsletter (FDSOA)
- Firefighter Near Miss reports (IAFC)
- Report of the Week (ROTW)
- LODD reports (NIOSH)
- Everyone Goes Home campaign (IAFC)

[Brackets denote identifying information removed by reviewer.]
