Flash Fire

INCIDENT

On Tuesday, June 8, 2010, at approximately 9:25 p.m., a 38-year old service truck operator was killed while fueling a highwall rock drill. The victim notified the drill operator by CB radio that he was driving down to fuel the two drills operating on the highwall bench. The operator moved his drill into position to be fueled and idled down the drill engine. The victim backed the service truck perpendicular to the operator's side of the drill and was observed by the drill operator stepping over the back of the truck onto the drill while holding the fuel hose and nozzle. The drill operator looked away from the victim and felt what he described as a concussion/explosion. The operator exited the drill cab and observed that the drill was on fire and the victim was lying on the ground engulfed in flames. The drill operator called for help and other mine personnel responded to help extinguish the fire on the victim. The victim was transported to the mine entrance gate where medical personnel arrived shortly thereafter. The victim was transported by helicopter to a nearby hospital and died shortly after arrival to hospital.

NEED TO KNOW

Flash fires

A flash fire is a release of flammable vapor (or liquid that vaporizes) that premixes with air and expands, eventually igniting. Once ignition occurs, the burning velocity travels from the point of ignition toward the release point, potentially igniting the source as well. Since this ignites the entire volume of the vapor mixture, the volume of the flame is large and the majority of damage is due to flame impingement (American Institute of Chemical Engineers, Center for Chemical Process Safety. 2003). Large-scale flash fires are particularly dangerous as they can cover a large area and, once ignited, occur quickly and have the potentially to ignite the flammable release source. When premixed flammable mixtures are confined to smaller scales, flash fires may

become more violent, and even escalate to an explosion.

Eight Things to Know About Flash Fires

1. **Flash fires are short and intense.**

A flash fire is a rapidly moving flame front that spreads through a diffuse fuel. When a flash fire occurs, it is generally of a short duration and fuel limited.

2. **Flash fires have various causes.**

Fire is a complex chemical chain reaction that requires three components to occur: a thermal source, or heat, oxygen and fuel. Once the fuel and air are in the correct mixture, ignition can occur from various heat sources, such as welding, tool sparks, running engines, etc.

3. **Flash fires are different from fuel-fed fires.**

Flash fires are fuel-limited, have a typical momentary duration of only a few seconds, and self-extinguish. On the other hand, fuel-fed fires last much longer and will burn as long as there is a fuel source present.

Fuel-fed fires require primary protective apparel, such as turnout gear, which is heavier in construction. Secondary apparel, or daily wear Flame Resistant, can help minimize burn injuries from flash fires and is available in comfortable, breathable constructions that allow wearers to work comfortably throughout their day.

Those who work on gas lines in trenches, where it is harder to escape flames, should consider primary FR protection, while those who work around flash fire hazards can be protected with secondary FR daily apparel, which is available in a variety of comfortable fabrics, including denim.

4. **Flash fire injury can be increased by non-flame-resistant clothing.**

In the event of a momentary flash fire, everyday non-flame-

resistant work clothes can act as fuel and ignite and will *continue* to burn even after the source of ignition has been removed. This is where the saying “Stop, Drop, and Roll” comes into play because a person’s non-FR clothing will remain on fire until they put the clothing fire out. A clothing fire can continue to burn well after the brief flash fire event is over, resulting in more extensive burn injuries on skin clothed with non-FR fabric.

5. **Flash fire injury can be reduced by flame resistant clothing.**

FR apparel provides key roles in protecting oil and gas workers:

- It self-extinguishes to mitigate burn injuries when the source of ignition is removed.
- It provides insulation to reduce probability of a second-degree burn.

Unlike standard, non-FR clothing, FR apparel is uniquely engineered to interrupt one or more of the fundamental steps required for flames to propagate.

Developing a thorough, researched PPE program with trusted flame-resistant fabric for everyday wear is critical to protect yourself, and your team members, against potential injuries from unexpected flash fires.

6. **Not all FR clothing is suited to protect against flash fires.**

The National Fire Protection Association (NFPA) created guidelines and standards to aid the industry. NFPA 2112 is the industry standard on flame resistant garments for protection of industrial personnel against flash fire, providing clear testing guidelines.

One requirement of NFPA 2112 is for flash fire testing to be conducted at three seconds with a pass/fail criterion of 50 percent total body burn under the testing protocols of ASTM F1930 (Standard Test Method for Evaluation of Flame-Resistant Clothing for Protection Against Flash Fire Simulations Using an

Instrumented Manikin).

It’s important to reference standards appropriate to NFPA 2112 and flash fire hazards look for the appropriate certification for flash fire hazards in selecting the most effective PPE to minimize burn injury.

7. **Not all FR apparel provides the same protection.**

Fabric is the single most important aspect of a garment when it comes to FR protection. There is a vast range of FR fabric available; however, each FR fabric performs differently.

Unfortunately, FR qualities are not visible, so you must verify the performance of your FR apparel. For oil and gas workers exposed to flash fire hazard, having a daily workwear garment certified to NFPA 2112 is a necessary starting point. However, since all fabrics with less than 50 percent burn can be certified, it is important to know the actual body burn percentage of the ASTM F1930 test. Fabrics can be certified with 50 percent total body burn or 10 percent, and these differences should be understood.

8. **Proper maintenance is key to FR apparel performance.**

Care and maintenance not only extend the life of FR apparel—it is essential to allowing the garment to protect oneself to its fullest capability in the event of a flash fire. Keep FR apparel well maintained, patched with the correct FR fabric when needed, and as clean as possible, because flammable contaminants can compromise its performance.

BUSINESS / REGULATIONS

Providing the right type of PPE clothing to workers is the responsibility of employers, particularly when working in hazardous environments with a higher probability of flame and heat incidents. Even though a 100% protection cannot be guaranteed, standardized FR clothing with effective performance quality can definitely provide a strong protective layer to workers from flame and flash fire. Some of the burns, in fact, are not because of the

original physical hazard but due to the consequence of burning clothes. A dramatic reduction in the severity of burn injuries is witnessed when FR clothing is involved, which could very well draw the line between life and death. Despite the fact that flash fires are usually rare, it's still crucial that both workers and employers need to be prepared in case an incident does occur.

A lot can go wrong under flash fire incidents if proper protective gear is not provided. When a worker is exposed to fire, he is not only exposed to the fire but also exposed to the heat produced from the burning fabric. Hence the protective clothing needs to be designed out of high-quality flame retardant fabric and heat resistant fabric so that it offers maximum protection to the workers.

The core purpose of the flame-retardant fabric is to limit the exposure of flame and heat and stop burning when the source of flame is removed from the textile. This offers an adequate layer of protection to workers by reducing the probability of injuries when exposed to flash fire. FR clothing creates a wall between the flash fire and workers' body and limits the energy transmission to the skin which ultimately increases the survival chances of the workers.

To consider the protection level of the protective fabric against flash fires, the fabric is tested in a conditioned lab according to protective standards such as **NFPA 2112, EN ISO 11611 and EN ISO 11612.** In addition to performing the flame test, FR clothing needs to be tested against its thermal protection it offers to wearers during flash fire incidents. The energy which is needed to cause a second-degree burn is termed as thermal protective performance. Protective clothing having higher thermal performance will be offering more protection to wearers during flash fire incidents.

The latest released standards ensure that workers in potentially harmful industries will be provided with protective fire-retardant clothing with the purpose of minimizing burn injuries and increases survival rates. It is significant to forecast the expected threats of flash fire which can be done through analyzing the workplace and to evaluate FRC (flame retardant clothing)

against exposure levels. It is important to evaluate the FRC requirements to avoid any uncertain incidents. However, with an effective FRC system in place, the expected burn injury percentage in most cases can be minimized. The reduction in the body area affected by burn injury would mean that the victim will have a higher survival rate.

STATISITICS

Details of the Corpus Christi Flash Fire

Construction Accident Statistics

The following information was provided by the Occupational Safety and Health Administration (OSHA):

- 4,836 workers were killedon the job in 2015. This average to more than 93 deaths a week or more than 13 deaths every day.
- Of the 4,379 worker fatalities that occurred in private industry, 937 were associated with construction.
- The leading causes of construction-related deaths are:
- Falls
- Struck by object
- Electrocutions
- Caught-In/Between

A presentation on the causes of fatal fires and explosions in construction including the trades involved and the trend.

Background

- NIOSH's National Traumatic Occupational Fatality (NTOF) database reported 220 deaths due to fire and 354 deaths due to explosion in construction, an average of 36 fire and explosion deaths per year.
- The rates were 0.2 fire deaths and 0.3 explosion deaths per 100,000 construction workers.
- For all construction, there was an average of 1,071 deaths annually, with an average annual rate of 15.3 deaths per 100,000 workers.

Methods

- Used Census of Fatal Occupational Injuries (CFOI) from Bureau of Labor Statistics
- Deaths were classified into the following categories:

- Chemical explosions
- Fires
- Pressurized container explosions
- Arc flashes/blasts.

Results

- A total of 361 fire or explosion deaths involving 313 incidents were identified in the construction industry, an average of 30 per year.
- 32 multiple-death incidents involved 80 deaths (22% of total)

Location of Incidents

- 167 incidents (53%) occurred in industrial places, including:

- 59% of chemical explosions
- 66% of pressurized container explosions

- 53 incidents (17%) occurred in homes
- 28 incidents (9%) occurred in public buildings

Worker Activity at Time of Death

- Repair and maintenance activities accounted for 48% of pressurized container explosion deaths and 23% of all deaths.
- Welding accounted for 24% of chemical explosion deaths and 15% of all deaths.
- Other activities resulting in deaths included:

- Driving/operating/riding on vehicles (10%)
- Constructing/installing (10%)
- Painting/ finishing (7%)

RECOMMENDATIONS

Here are recommendations that you should keep in mind anytime you are refueling a vehicle or piece of equipment.

- NO SMOKING! The burning cigarette can ignite flammable vapors that are emitted from the liquid fuel, causing a flash fire or explosion to occur. Also make certain there are no other potential sources of ignition, such as open flames or spark-producing equipment operating in the area, as they too can ignite a fire or explosion;
- Only use safety cans or other approved portable fuel containers, such as those marked as D.O.T. approved for transporting and transferring fuels, to refuel vehicles and equipment. Unapproved containers can easily leak, spill fuel, or even rupture, leading to a potentially dangerous situation;
- Always kill the engine of the vehicle or equipment before you refuel. Also, be certain to let portable equipment such as lawn mowers, generators, chain saws, blowers, trimmers, or anything else with a fuel-powered engine cool down before you add fuel to the tank. Spilling liquid fuel on a hot motor instantly creates a cloud of highly flammable vapor, which can easily catch fire or explode;
- Before dispensing fuel into your car or truck, be sure to touch a metal part away from the fuel tank on your vehicle or equipment with your bare hand. This helps dissipate any static build-up on your body created when you slid out of your vehicle. Also, touch the gas dispenser nozzle or hose to the fill tube on the gas tank before you start to add fuel to the tank, and keep it in contact throughout the entire refueling process. This step helps prevent hazardous static electricity from building up and causing a spark in the vapor area as you refuel;
- Never dispense fuel into a can or other portable container while it is sitting in your vehicle truck or truck bed. Doing so allows hazardous static electricity to build up. Instead, sit the container on the ground and then add the fuel;

PREVENTION

The fatality report noted that proper engineering and administrative controls were not in place with that resulted in a fatality.

The incident occurred because the work practices/procedures in use at the time of the accident were not adequate to fully protect the service truck operator. There was no provision for equipment shutoff/cool down prior to fueling, the operator was required to be in close proximity to potential ignition sources, the fueling system was susceptible to accidental discharge, and there was no provision for actions to be taken in the event of an accidental fuel discharge.

Other controls like proper P.P.E would have protected the employee. It would have saved his life.

It makes sense that FR clothing should be worn by oil employees who handle fuel.

MORE PREVENTION

When receiving fuel from the delivery truck

- Do not allow smoking, flames, sparks or other sources of ignition near the fuel storage and handling areas. Gas vapours are heavier than air and will drift downward from the source. It is the vapour, not the liquid, which burns.
- Follow safety recommendations of your fuel supplier during fuel delivery. Report fuel spills according to environmental and health and safety regulations.
- Use absorbent materials to clean up and prevent the spill from spreading.
- Position the fuel delivery truck so that it does not interfere with the movement of other vehicles.
- Make sure that fuels are delivered into the correct tank.
- Check the levels in the tank to determine quantity needed before receiving commercial delivery.
- Check the area around the vents of the receiving tanks for

possible ignition sources.
- Observe the vents during delivery for proper operation. Stop delivery if fuel is being ejected.
- Have the driver stay near the truck flow valve while the fuel is flowing into the storage tank in case of the need for emergency shut-off.
- Reinstall the fill and gauge caps.
- Mark gauge and fill caps clearly to indicate the fuel type.
- Open caps only during filling and gauging to minimize the release of fuel vapours.
- If a fire starts, do not remove the hoses or nozzles. Leave the area immediately. Alert others to do the same. Call the fire department.

Gasoline Vapors are Flammable, are Heavier than Air, and can Travel Long Distances to an Ignition Source

- Never siphon gasoline by mouth. It is harmful and may cause death if swallowed. If ingested, do not induce vomiting. Get medical help immediately.
- Do not smoke.
- Avoid prolonged or repeated skin contact with fuel. Wash skin thoroughly with soap and water in case of contact.
- Avoid breathing in vapours or mists.
- Remove any clothing that is wet with fuel. Allow fuel to evaporate completely outdoors before washing. Thoroughly clean clothing before reuse.
- Never use gasoline as a cleaning agent.

Re-Fueling Protocol

- Refer to the vehicles operating manual for special instructions.
- Identify and know how to operate emergency fuel cut offs.
- Know the location of, and how to operate fire extinguishers.
- Always shut off an engine while fueling.
- Remove twists and small loops in the fuel delivery hose. These kinks can cause the hose to fail or catch on bumpers as vehicles move around the pump islands.

- Insert delivery hose nozzle firmly into the fill pipe of the vehicle. Maintain contact with the tank until the delivery is complete to reduce possibility of static electricity sparking.
- Avoid spills by not over-filling the tank.
- Reinstall the cap on the fill pipe when delivery is complete. Hang the hose in place on the pump.
- Fill motorcycles slowly to prevent fuel from spilling and making contact with the hot engine.
- Do not use the gas cap or other objects to hold the fuel delivery nozzle open.