Basic Guide for EMS Response to Industrial EMS Incidents

Brian S. Gettemeier

Our world in EMS is full of the unknowns. We typically enter an incident with a very basic idea of what the call might be and we perform our craft from there working with the signs and symptoms. Working within an industrial facility can create situations beyond our standard practices. It is imperative that EMS providers work with industrial facilities before an incident occurs. The situation could be along the lines of our typical medical or a trauma incident. However, the potential of a serious incident or an incident that might require the use of specialized rescue teams and resources exist. In any case it is imperative that municipal responders work with industrial facilities to prepare a general plan for responses within their facilities. The time to begin to plan for the unique incidents that can occur at an industrial facility is now

Providers on site and their level of care

Depending on how large a facility is it is not uncommon for a facility to have some sort of on-site medical services. Medical services maybe providers who provide care as their full-time responsibility with in the facility. Full time personnel may be a paramedic or nurse. Often the nurse will be on site for employee wellness and to treat minor injuries to reduce the need for employee visits to emergency rooms and urgent cares. Additional responsibilities may include respiratory fit testing and administering drug test. The nurse is also available to respond directly to the field to treat injuries or illnesses. Other facilities might utilize employees who will perform initial emergency response in addition to having a full-time job responsibility at the facility. In these cases, employee training will vary from first responder, to EMT, to Paramedic. Sometimes these employees will belong to an EMS organization outside the industrial facility in a part-time or volunteer capacity. These employees then bring their experience and skills to their full-time job. Membership on a medical emergency response team (MERT) could be voluntary or as a requirement of their position at the facility.

Outside EMS providers should familiarize themselves with the level of training of emergency responders on site. Is there an on-site infirmary? What level of service will the on-site responders provide first responder, BLS, or ALS? What type of equipment do they have? Is that equipment compatible with the equipment we have? Do they have transport capabilities? Some facilities will have ambulances on site to transport a patient to the facility gate to meet the outside EMS provider. Other facilities will transport patients directly to the hospital. Who is their medical control and what are their protocols?

Often times the remote location of industrial facilities and the severity of the incident will warrant the need for an air ambulance. Does the facility have a helipad for helicopters to land? It is not uncommon for large facilities to have a landing zone for helicopters. If they have a helipad are the coordinates for the landing zone on file with the air ambulance service(s). Has the air ambulance service looked at the helipad? Recently I was part of a team who conducted emergency response drills at 3 different coal fire power plants. In all three cases we had one of the local air ambulance services fly into the facility as part of the drill. This opportunity served two-fold. The first was the service was able to fly in and observe the helipad. In each case the

flight crews identified debris near the pads that could become dangerous projectiles. They also identify that one of the windsocks needed to be move for a more appropriate placement. The second benefit was for plant responders to work with the air ambulance team. In one of the cases the facility's team brough the patient to the area of the helipad prior to the arrival of the air ambulance. This was a valuable lesson to the responders on the hazards of the rotor wash kicking up debris, dust, and general cool air exposure to the patient. Responders should stay well away from the landing zone as aircraft is taking off or landing. Who is going to request the air ambulance? It is not uncommon for industrial facilities to establish a relationship with an air ambulance service and request the air ambulance outside the municipal emergency response system. In the event the facility requests the air ambulance it is vital the ground ambulance is aware of the request to avoid 2 air ambulance being dispatched to the scene.

Injury Potential

Beyond the typical injury or illnesses is there a possibility for an incident that may challenge us? Crews should meet with the facility to learn about their processes and potential hazards. These hazards could be chemical, mechanical, or environmental. Injuries can be exposure to a hazardous atmosphere from the release of a hazardous materials or confined space incident. Confined spaces require special training and equipment for entry. Where is the nearest confined space team. Atmospheric issues are number one cause of confined space fatalities. Crews must not enter a space without the proper precautions. Fifty percent of confined space fatalities are would be rescuers. Are workers working from heights and using fall protection? An employee hanging from fall protection will be saved from a fall but the effects of suspension trauma will begin to set in if the harness is not properly sized and the employee is not familiar with the deployment of stirrups to take the pressure off their body. Burns from exposure to high heat. Burns from electrical exposure. An interesting side note is responders are very familiar with orange high voltage cables in electric vehicles. These cables are typically 480 volts, in an industrial facility 480 volts is considered low voltage. This terminology is important for responders to understand as they arrive to a facility for an electrical injury and the industrial electrician states the patient was exposed to "low voltage". The shear mass and storge energy potential of industrial equipment could lead to crush injuries or trauma. EMS providers must work with facility rescue teams or local municipal rescue teams to establish lines of communications and expectations when it involves confined space rescues, man versus machine incidents, or other incidents where rescues are required. These lines of communications must be completed long before an incident occurs. Rescue can be a very difficult balance of tending to the patient's needs and patient extrication. Commonly space is very limited and simultaneous medical care and rescue is difficult or impossible. This challenge can be further complicated when the team responsible for providing rescue and the team responsible for providing patient care do not have an established working relationship.

Hazardous Materials are very common in industry however, sometimes the chemicals go beyond what we typically associate with a particular manufacturing process. For example, some industrial processes require ultra clean water so a facility might have a water treatment facility on site. For example, a coal fired powerplant uses demineralized water in their boilers. The hazards associated with coal is an obvious hazard but as emergency responders are we thinking about the various caustic chemicals that go into water treatment? When it comes to dealing with

hazardous materials is there an onsite Haz Mat team that has the ability to respond and evacuate the patient from the Hot Zone and perform decontamination prior to handing off the patient to EMS? It is imperative that the patient is thoroughly decontaminated prior to handing off the EMS. Decon will reduce the exposure effect on the patient. Decon will also reduce the secondary exposure of cross contamination of the EMS crew or the ambulance. EMS must communicate the expectation that the facility will have a Safety Data Sheet (SDS) available to EMS prior to their arrival. The SDS will provide us some guidance on the strength and concentration of the chemical and first aid requirements. What is the hazard level and the appropriate treatment of the chemical exposure? For example, facilities that pickle titanium with hydrofluoric acid so strong that it requires a medication to be applied immediately to the affected area to start to combat the devastating damage this high corrosive material will do on the human body. Failure to apply the antidote cream as soon as possible can result in devastating injury, in the case of a limb exposure the loss of the limb is highly likely. Many of these facilities have the medication on site and plan on applying it prior to the arrival of first responders. As an EMS provider are we familiar with this chemical and with this treatment? How does this treatment fall within our protocols? From an economic standard it is better for the site to purchase and maintain this specialized agent and to leave the agent on site for rapid treatment.

General Facility Conditions

What are the facilities general personal protective equipment (PPE) requirements? Is our personnel familiar with these requirements? Do we have the equipment required or can the facility provide the equipment upon arrival? Basic PPE on most industrial sites is hard hat, eye protection, long sleeve shirts, and safety shoes. Crews might need to wear personal air monitors while working on site. For example, in refineries personnel within the operational area are required to wear a hydrogen sulfide (H2s) monitor. There may be restrictions on the use of electrical equipment due to a potential flammable atmosphere, does our EMS equipment meet those requirements? If not, our patient will need to be moved to a safe area to begin our assessment. Our cell phones do not meet the intrinsically safe requirements of many potentially explosive atmospheres within an industrial facility.

There are general stressors in industry that will often times expose us to extreme conditions and will challenge us on providing patient care. The noise level will make it extremely difficult to communicate with the patient and fellow team members. Ambient noise conditions may require responders to wear hearing protection and, in some cases, double hearing protection. The general temperature of many facilities is typically greater than emergency responders are used to. Responders must take precautions not to touch the equipment but more importantly may need to take heat precautions for extended operations, even for incidents in the winter. Industrial workers are typically conditioned to work in this extreme heat but fellow responders may quickly fall ill to heat exposure creating additional patients.

Responders must be aware of their surroundings within an industrial facility. Moving equipment and self-starting equipment can find an emergency responder in a bad place. Crews need to be very aware of their surrounding and the hazards that exist.

General Facility Layout & Access

When arriving at a facility is there a standard location for EMS to arrive at or are there multiple locations? In the case of multiple locations how will the location be communicated to first responders? Will someone meet us at the gate to escort us to the patient? When arriving at a facility is always beneficial to have someone there to escort emergency services to the emergency area. Industrial facilities are complex and personnel can quickly find themselves lost or in a place where they should not be. When traveling through a site non-emergency crews must be aware of the site speed limit. Generally, the speed limit is extremely low for employee safety. Site speed limits and general plant safety rules are extremely enforced.

Are there streets within the facility? Do the streets have names? Often times you will find numbered streets run one direction and alphabet letters indicate the streets running the opposite direction. For example, numbered streets may run east and west and lettered streets may run north and south. Columns inside the structure can be labeled the same way. A row of columns is labeled with letters going one way across the structure and a row of numbers going the opposite way. So, each column will have a letter and number designation.

Is the building and the process units laid out in floors, grades, or grades above sea level? Many industrial facilities are laid out in tiers based on equipment needs. Sometimes there may be a half floor located between two levels. Other times one may travel 20 feet or more vertically before the next elevation. To combat the confusion created when labeling a structure by floors some facilities utilize a grades above sea level approach. So, for example, if the ground floor of a facility is 411 feet above sea level the ground floor would be known as Grade 411. If you traveled 10' up to the next floor that would be Grade 421.

Compass directions are also used in facilities. This can be challenging for those of us who are directionally challenged when we are told to proceed to the East side of the structure. This can be further challenging because facilities will use an orientation known as Plant North which will be slightly off from the North, we are familiar with. Plant North assist in the day-to-day operations of the plant for orientation but does little for incoming responders as we are off by a couple of degrees.

It may take crews several minutes from arrival on the scene of the facility to arrival at the patient. Crews should give some consideration to notifying dispatch when they arrive at the patient. This notification will give a more appropriate documentation on when patient care began.

In the case of removing personnel from upper levels of a facility it may be beneficial to use a freight elevator vs a standard passenger elevator. Freight elevators are typically larger with a higher weight capacity, more contusive to transport a patient on a stretcher with a care team. When it comes to utilizing elevators is it possible for the facility to place the elevator into Fire Department Phase II operations. Phase II operations is what firefighters use to have total control of the elevator during a high-rise fire. The use of Phase II during an EMS responds will ensure EMS has complete control of the elevator and the elevator will ignore any other calls for service. This control will allow emergency responders to expedite their access to the level the patient is at

and insure the car will be at the level waiting when it comes time to remove the patient. Responders might find themselves walking on catwalks or elevated grating to access the patient. Rolling a stretcher on grated walkways can create a lot of vibration on the patient. Often times these walkways are narrow. These walkways can perform some psychological hazards to responders who are not used to working from heights as they walk on the walkway and can look through the grating and see how high they are. Consideration must be given to patient safety as we plan our route for patient removal to the ambulance. Industrial workers will typically think of the quickest route, EMS must identify the most appropriate route to remove the patient.

The need to build a relationship early

It is critical that responders build a relationship and a response plan with emergency responders long before a call for service comes. This relationship will pay off when we arrive on scene of what can be a very complex incident. Serious industrial accidents are rare but when they occur, they are often complicated and extremely life threatening. We as emergency providers always want to do our very best to improve a patient's outcome.

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Emergency Response to Industry for Municipal Firefighters
By Brian S. Gettemeier

The station is alerted to a fire in an industrial facility. As your crew rolls out of the station you can see a large black plume in the distance. You are familiar with the address and know it's a manufacture but do you truly understand the dangers ahead. For many fire departments in this Country industrial facilities are gated compounds on the edge of town that very few of us have had the opportunity to enter. These facilities can quickly overwhelm local resources especially if we are trying to learn about the hazards at the time of an emergency.

The typical firefighter in the United States is pretty well versed in automobile fires, residential structure fires, and emergency medical calls. We have seen in our recent history how tried and true residential tactics have challenged the fire service when it comes to commercial fires and unfortunately some of this incidents have resulted in the loss of firefighter's lives. Industrial incidents are at the pinnacle of high risk low frequency incidents. Industry presents a whole new set of circumstances, challenges, and rules of engagement that many firefighters have not trained for, much less thought about. The sheer size of industry facilities various from small manufactures in a building that is in the tens of thousands of square feet to large facilities that rival small cites. It is vital that the fire service reach out to partner with industry to at least learn about the facility before rolling through the gate during an incident.

The meeting before the planned tour

The partnership must start out with a meeting where the key players from the industrial facility and the fire service organization meet to discuss some rules of engagement. This meeting should occur before an engine company tour or training is scheduled. The purpose of an engine company tour or training at the facility must be about creating firefighter awareness about the unique aspects of the facility, not about code enforcement. The goal is to keep the firefighters safe during an emergency response while protecting the assets of the facility, including human life. Fire Department leadership must understand the expectations the industrial organization has of firefighters when onsite for a tour. The Fire Department leadership must clearly communicate these expectations to their members to make sure they understand. The facility has its own set of guidelines and rules they are going to want the firefighters to honor when they come on site. These rules are there to fulfill the company's commitment to safety. Additionally these maybe there as part of Homeland Security requirements or to protect against corporate espionage and sabotage. As firefighters we are used to making the rules, with industry we must honor those rules to build a solid working relationship. Firefighters may be required to attend a safety briefing prior to entering the site for tour. During non-emergency events firefighters may also need to provide a state issued photo id for security clearance.

Some general rules for industry:

1. No photography – typically all industries do not allow photography on site and if it is allowed it's under strict guidelines. This can be difficult at times because industrial operations and emergency response equipment is very impressive. Photo policies typically apply to employees and guest.

2. Learn what the personal protective equipment requirements are. Hard hat, safety glasses, protective foot wear, hearing protection. Many facilities require long sleeve cotton shirts, if not, fire resistive clothing (FRCs). Other facilities many require static suits to prevent static electricity. Other facilities will require clean suits to prevent any contaminates from entering the facility.
3. The use of cell phones are strictly prohibited. Safe work practices guard against distracted workers, this includes walking while reading email and text messages. Other concerns is the phone could be an ignition source.
4. You maybe required to wear a personal air monitor. For example in the refinery industry Hydrogen Sulfide gas (H2S) is a common hazard. In fossil fuel power generation carbon monoxide (CO) is a common hazard in the coal handling areas.

During non-emergency entries:

5. You may be required to sign a non-disclosure form stating you will not disclose information about the facility, its operating systems, or its manufacturing process.
6. You may not be able to access all areas of a facility due to security reasons. These reasons may include critical infrastructures in operations of the facility or to protect trade secrets.
7. You may have to go through metal detectors and/or explosive sniffers.
8. You may be searched on the way in and out.
9. Will your membership be driving personal vehicles to the facility? Industrial facilities will control their entire property, including the visitor's parking lot. Many companies ban alcohol, drugs, and firearms for their premises for employees, contractors, and guest. This includes visitors parking in the visitors' lot.

Unified Command

It is imperative that command staff be part of this discussion and facility tour. The IC must have an idea the hazards and challenges firefighters may face while firefighting an industrial incident. In large scale incidents the command representative will be part of the unified command staff. In the case of facilities with emergency response teams we have to remember in a large scale incident we are not in charge, we are part of a larger command staff body. It is imperative that we understand they are a part of an integrated operating principal for the safety of the stakeholders and continued operations. During unified command all key players bring their knowledge and resource list to the table to develop a safe strategy and tactics plan for successful mitigation with a cooperative effort of all key stakeholders, which included the refinery emergency response personnel, the Philadelphia Fire Department, among others. The benefits of unified command and its success recently played out June 29th, 2019 in Philadelphia when a refinery fire was successfully mitigated. Less than 24 hours prior to that incident key players had met for an interagency meeting to discuss roles and responsibilities. There is no doubt the pre-incident meeting had reduced some of the confusion created by an incident of that magnitude. The decision making of the fire department incident commander must take into consideration the current plant operations and the plant's recovery from the incident. A breakdown between the command staff and the facility can have an unsafe reaction on the incident.

Incident commanders want to identify key subject matter experts on site. Industrial hygienist can be an excellent resource when it comes to hazardous substances. There may be process liaisons that might have advanced knowledge on key hazard information and mitigation methods for a particular area. The maintenance group has knowledge on how equipment works.

In a multi-agency, multi-discipline incident how will units communicate with each other? Great strides have been made since September 11, 2001 to create inter-operability between responders but there still are gaps. This gap is especially true between industrial and municipal responders. The time to create a communications plan is well before the incident.

Public information officers (PIO) must coordinate media releases with the facilities corporate communications group. Large scale incidents have all the key components for a media interest, multi-alarm, high hazards, dramatic smoke footage. We must respect the interest of the stakeholders on providing information to the media especially when it comes to life safety or environmental issues.

Continued Production During Emergencies

The complexity of manufacturing is not a simple on or off process. Halting production is a process that takes time to safely bring machinery off line and leave it in a state where production can occur again. This process can be as simple as a couple of minutes or a complex as a couple of hours. For example an aluminum manufacture in the mid-west had an explosion that prevented a typical shut down procedure. This resulted in molten aluminum cooling in molds. Ultimately the factory never recovered from the incident. While several economic factors went into the decision to halt production at the facility, this incident became the catalyst for the facility closure. This facility closure resulted in the loss of good manufacturing jobs which has an economic ripple effect through an entire community. Ultimately this ripple effect will include a loss of tax revenue for a community.

We as the fire service must understand that industry is there as a for profit organization to provide goods and services. It is not uncommon for large industrial facilities to continue with production during an emergency event, this includes a fire. If the facility can continue production without interfering with firefighting operations they will. This means firefighters may have to contend with the noise and moving machinery during firefighting operations. In fact it might be safer for the facility to operate versus shutting down. Production start-up and shut down can be some of the most vulnerable times for an industrial facility as equipment heats ups or cool downs, or as process units that normally operate above the upper explosive limits of a product have to travel through the explosive range during a shutdown process.

Incident Command staff and plant personnel must have an understanding well before an incident of what continued operations look like and what a safe shut down looks like. As firefighters are used to having control of a structure during operations, everyone has evacuated, and utilities are controlled. That is not the case in industry. It is imperative that Incident Commanders (IC) have an understanding of the importance of continued production and what that all entails. For example in power generation hydrogen is used as a cooling gas. During the proper shut down procedure there will become a time where the hydrogen will need to be vented.

This can become very unnerving for an IC if the first time they heard of this is during an actual fire incident. No IC wants highly flammable gas floating around their scene. There is a delicate balancing act for the IC to meet the needs of the customer while maintaining the life safety of the firefighters. A relationship and pre-understanding is paramount to meet the safety and needs of both organizations.

Likewise as the emergency operations are wrapping up the facility will immediately begin on recovery operations to begin to restart if possible. Firefighters must remember industry is a vital part of our communities. Industry provides a good tax base for our communities and provides jobs for many of our community members. These facilities might provide critical resources, for example electricity. Incident commanders must work with facility operators to determine the best tactics to assist in the facility getting back on line. The fire service is great about customer service and property conservation but this level far exceeds what we are used to.

General Facility Layout:

When arriving at a facility is always beneficial to have someone there to escort emergency serves to the emergency area. Industrial facilities are complex and personnel can quickly find themselves lost or in a place where they should not be.

Are there streets within the facility? Do the streets have names? Often times you will find numbered streets run one direction and alphabet letters indicate the streets running the opposite direction. For example numbered street may run east and west and lettered streets may run north and south. Columns inside the structure can be labeled the same way. A row of columns are labeled with letters going one way across the structure and a row of numbers going the opposite way. So each column will have a letter and number designation.

Is the building and the process units laid out in floors, grades, or grades above sea level? Many industrial facilities are laid out in tiers based on equipment needs. Some times there may be a half floor located between two levels. Other times one may travel 20 feet or more vertically before the next elevation. To combat the confusion created when labeling a structure by floors some facilities utilize a grades above sea level approach. So for example, if the ground floor of a facility is 411 feet above sea level the ground floor would be known as Grade 411. If you traveled 10’ up to the next floor that would be Grade 421.

Compass directions are also used in facilities. This can be challenging for those of us who are directionally challenged when we are told to proceed to the East side of the structure. This can be further challenging because facilities will use an orientation known as Plant North which will be slightly off from the North we are familiar with. Plant North assist in the day to day operations of the plant for orientation but does little for incoming responders as we are off by a couple of degrees.

Industrial facilities are complex. Understanding how a facility is laid out can help responders to be able to identify where they are or where the incident is. Furthermore, it will help responders to understand some of the plant lingo as they are given assignments that the incident is on the plant North side of the structure or on Grade 562.

Fire Protection Systems:

Fire protection systems are larger and more complex than we typically encounter in a standard commercial occupancy. Fixed facility fire pumps can far exceed the pump capacities and pressures of our pumpers. Attaching a pumper into a hydrant of a fixed facility to supply a fire department connection will do nothing more than create friction loss. It is not uncommon to have multiple fire pumps at large industrial facilities to serve as back-ups in the event a primary pump is lost.

Fire detection systems are far different that we learned about in the Fire Academy. Some examples are:

1. Incipient Detectors – these are typically found in computer rooms and electrical rooms to detect the slightest hint of a break down in the insulation of a cable. This detection system consist of a ring of copper or PVC pipe looped around a room similar to a sprinkler system. Small ports located throughout the piping that draws in a small sampling of air. This air is analyzed by the system and creates an alarm if the slight indication of a thermal break down of a component. Responders enter the room with portable detectors to identify the potential equipment fault.

2. Linear Heat Detectors – this is a 2 wire system encased together that can be looped around the ceiling of a room or travel above the entire length of a conveyor belt. When heat is detected the wires melt together and signal that there is a fire. The system is sophisticated enough that it will indicate how many feet into the length of the detection wire the fire occurred.

Firefighters are used to seeing wet pipe sprinkler systems and occasionally run across a dry pipe system. A fire academy typically discusses deluge systems as protecting against high hazards with a series of sprinkler piping with open heads. A deluge system is tripped off by a detection system. Once the detector trips, the deluge valve opens, and water is sprayed out of every sprinkler head, similar to every TV show and movie we have ever watched. Very few of us have learned about pre-action systems. The system design is virtually the same as a deluge system with the exception that the sprinkler heads are equipped with fusible links. A detection system activates which opens the clapper valve on the sprinkler riser filling the sprinkler pipes with water. It still requires the fusible link of the sprinkler head to melt out before it activates and discharges water. The advantage is the facility has a dry pipe sprinkler in areas where freezing is a concern. The sprinkler system requires two actions to activate. We have all been to a warehouse where a forklift has sheered a sprinkler head. With a pre-action system if a fork lift sheers a head nothing will happen because the sprinkler valve is still held in place because the detection system not water or air. Pre-action systems and deluge systems can be manually activated at the sprinkler riser. Firefighters must be able to locate the riser location and the area of protection a riser goes to. Large facilities may have multiple risers in a single location that will branch out to protection different areas of the facility.

Firefighting fires in a sprinkler building can be challenging. Many firefighters are used to the hot, turbulent smoke, which is under pressure and wants to exit the structure. Smoke in a structure with a sprinkler activation will be cooled down and will become lazy. In the case of storage and warehouse spaces materials will begin to soak up water, this additional weight might exceed the weight rating of storage shelves resulting in failures. Fires maybe controlled by a sprinkler system but not extinguished. Firefighters may have to enter the structure to extinguish the fire.

Big Water:

The fire service is full of instructors talking about big water. In large industry a typical bread and butter operation water demand will greatly exceed the municipal big water operation. Municipal pumpers are equipped pump capacities of 1500gpm to 2000gpm. As we look at industrial pumpers at FDIC and you will see pumps capable of flowing 4000gpm plus from draft. Many of these industrial pumpers will carry foam only, no tank water. Supply lines may include 7¼" hose or greater. A 7¼" hose line is capable of flowing twice the capacity of 5" hose. In the refinery industry multiple small portable monitor nozzles with 500gpm or greater flow are the standard when it comes to fire attack on a process unit. Trailer mounted master stream devices feature multiple large diameter inlets and can have flows exceeding 6000gpm.

The refinery industry also use quick attack trucks. These are standard pick-up or utility trucks equipped with a monitor nozzle and supply line. Typically these trucks do not have a pump and are feed by a pumper from a remote position or directly from a fire hydrant. These trucks are disposable, they are driven into a hazard area, and the monitor is set-up and starts to flow, and the driver exits the area. The idea of a quick attack truck is to gain quick access to control a fire as the overall fire operations plan is developed.

Firefighters must train to challenge their pump operators to supply the needs of the industrial emergency response team. During a recent drill at a facility a municipal pumper was placed into relay pumping operation. The challenge was to pump 7¼" hose line greater than 1000' to an industrial pumper. This operation went to unconventional techniques including using a 5" to 2½" gated wye backwards, essentially taking a traditional gated wye and transforming it into a Siamese. Supplying the appliance with 2 – 3" hose lines with double females to feed a 5" supply line. The operation then took an industrial 7 ½" to 2 – 5" gated wye to make a Siamese to allow the pumper to pump a 7¼" line. After all the large diameter and 2½" outlets were exhausted the crew disconnected the deck gun nozzle to supply one more 3" hose line. Next to the large diameter discharge a deck gun outlet is typically one of the largest discharge rate on a municipal pumper. The municipal pump operator was forced to think beyond the typical pumping operation and utilize all the resources available on the apparatus. This drill was very successful and provided an excellent teaching tool for firefighters on how to maximize the apparatus. Reminder that your pumpers rating is based on drafting, when supplied from a pressurized source the pump capacity can greatly exceed the listed rated capacity of the pump.

A fire involving storage tanks will involve a complex set-up operation to insure complete tank coverage. This tank coverage may include hose lines on both side of the tank to achieve complete tank coverage. For example multiple master streams might be set-up on the Alpha side

of the tank, the arc of the hose streams will often create a gap in tank coverage on the Alpha side. A line has to be set-up on the Delta side to cover this gap. Flows will be greater than 10,000 gallons a minute. In a firefighting foam operation with 3% foam that would be a foam concentrate flow of 3000gpm. Flow calculation must include the ability to overcome the overall BTU's created by the fire. Some of the water will be converted to steam just trying to penetrate the flames. This tank coverage is for fire stream application to extinguish the fire and should not be confused with cooling streams. Bulk storage tank firefighting is an complex task and can differ based on roof design, the product in the container, and fixed systems to assist in firefighting.

Consideration must be given to supply line placement. Industrial incidents can last hours if not days. Road ways to apparatus must remain clear to allow for apparatus to be fueled and foam totes to be brought in to support extended foam operations. Fire departments must calculate their fuel consumption during extended pumping operations. How long will your pumper last before it needs to be fueled? The last thing we want is a pumper to run out of fuel. Any disruption during firefighting operations can greatly set back the entire operation.

Firefighters should ask about how the hydrant loop is feed. What is the typically water pressure on the fire protection water main. Older facilities may maintain a lower pressure on the fire protection loop to reduce the stress on the overall system. Other facilities might have their fire protection water as part of their service water system which can result in hydrants operating at 200psi. Fire protection water might not be the clean potable water we are used to from municipal hydrants. Water could be raw water taken directly from the river or lake or recycled water from plant run off.

Accounting For Your Water:

There are three additional things to consider when it comes to water in an industrial facility.

Fire Protection Water – facility may have a limited amount of fire protection water available. Required fire protection water is often based on the largest fire sprinkler system demand and 500 gpm for hand lines for 2 hours. The problem occurs when multiple sprinkler systems activate increasing the demand on the dedicated fire protection water. Another problem that can occur when the hand line demand is greater than 500gpm. For example if the fire department deploys a 1000gpm master stream the dedicate water supply is not going to last for 2 hours. Incident commanders must work with plant operators to determine the water supply and how long that supply will last. The facility may want the fire department to help develop an alternative water supply plan in the event fire protection water is exhausted. Back to the incident in Philadelphia firefighters used the fire boat to help supplement the plant's resources.

Firefighters must be aware of where hose streams can and cannot be applied. Water reactive chemicals and solids are some of the obvious considerations but firefighters must be aware these hazards exist prior to arriving at a fire. In December 2009 a firefighter was killed and 8 firefighters were killed in a dumpster fire at a foundry. High pressure steam lines are found in many industrial facilities. The cold water of a fire stream can result in the catastrophic failure of a high pressure steam line. In addition to the scalding temperatures of steam, high

pressure steam will also displace the oxygen in the area. In June of 2018 in Kansas 2 power plant workers were killed as they stepped off an elevator to investigate a steam leak.

Firefighters must account for run off from hose lines, especially when working at upper levels of the facility. Water run off can trickle down through the facility and create other problems at lower levels as critical equipment gets wet from run off. This problem can result in larger problems especially as critical equipment begins to trip off line. Firefighters must be aware if the runoff contains oils or other hazardous materials that will need to be collected.

Water application in industrial incidents becomes a more precision application. Spotters must be placed at a sight advantage to guide master streams in place for maximum steam application. At times firefighters must apply a precise stream with minimal water. For example in coal power plants spontaneous combustion of coal in in plant coal storage systems does occasionally occur. Many times theses smoldering incidents can be safely mitigated by plant personnel. In most power plants coal travels from the bunkers and silos into the mill which pulverizes the coal. These mills will operate above the upper explosive limit of coal. Any introduction of hot coal in a mill can have catastrophic results. There is a balance of water application in bunker and silo fires. Enough water has to be applied to the coal to extinguish the fire. On the other hand over application of water to coal silos and bunkers will result in the coal to be too wet to burn. In this case operators have to allow the coal to dry in the silo/bunker. Heat is created during this drying process which will often result in smoldering coal. Firefighters must not treat coal bunker and silos fires like a dumpster fire and fill it up until the fire goes out. Firefighters must also realize that rekindles will occur if the plant is unable to unload coal from the bunker/silo.

Emergencies

When emergencies happen at an industrial facility it's typically the beginning of a series of cascading events. The initial emergency occurs and plant operators are divided on safe continued operations or safe shut down of the machinery, while dealing with the emergency situation at the same time. As the fire occurs additional equipment is often effected and at times that is adversely. This adverse reaction can result in additional fires or equipment failures. The fire department's operations can also result in these cascading as fire protection water gets into critical systems. Incident Commanders must be ready with ample resources and contingency plans in the event additional emergencies arise.

Emergency Response Teams:

Ask the facility if they have an emergency response team on site. If they do have a team try and make an assessment of their skills and equipment. The caliber of emergency response teams will vary. It's unfortunate that some teams will exist in title and nothing more. Equipment and training will put members at more risk that good. Yet other industrial response teams will rival the best fire departments in the county when it comes to equipment and training. Industrial pumpers will dwarf the size of the largest municipal pumpers.

The make-up of the team and how people join the emergency response team will vary also. Some larger facilities will employee personnel whose full time job is emergency response. These full time emergency response personnel maybe employed by the company or they may be a contractor. In many cases emergency response teams (ERT) will staffed by facility employees whose primary job is not emergency response. In some cases being a member is a highly coveted opportunity. In other cases employees volunteer to be part of the ERT and in some incidents employees are assigned to the ERT. Often industrial workers are assigned to the ERT as part of their regular job duties.

It is important that as an outside organization we understand the level plant personnel maybe committed to prior to our arrival. When it comes to fire response are they incipient trained which is responding in standard work clothes with an extinguisher or small hand line. Incipient employees are not supposed to take evasive to avoid heat, smoke, or toxic gases. Do they have an exterior fire brigade? Exterior fire brigades maybe equipped with SCBA's and structural PPE. In the case of an outside fire brigade they maybe in an immediately dangerous to life and health (IDLH) zone but will not be inside a structure. Do they have an interior structural fire brigade? In the case of an interior structural fire brigade municipal firefighters may arrive to find industrial firefighters conducting interior operations upon their arrival. OSHA requires interior fire brigade members to attend a training or education session at least quarterly. The local fire department may want to see if they can participate in one of these training sessions. During an emergency interior fire brigade members should be paired with a fire company to lead them to the location and identify hazards and resources in the area.

Emergency response teams are typically not limited to firefighting operations. Hazardous materials and confined space emergency response teams are not uncommon in industrial facilities. These teams are found on site based on the sheer number of hazardous materials and confined spaces that can be found on site. For example in additional to process chemicals the facility might have water treatment, sewage treatment, and/or emissions scrubbing equipment on site. Confined space entries might be a daily activity. Municipal firefighters will find that many industrial facilities training and equipment will exceed that of the local fire departments. These responders can be a tremendous asset when it comes to identifying the hazards of a confined space or hazardous materials incident but still may need outside responders to supplement personnel needs to complete the operation.

Medical services may be performed by a plant nurse or paramedic that is on site to handle minor medical emergencies to reduce the frequency employees have to seek care off-site from job related emergencies. Furthermore, many facilities have medical emergency response teams made up of first responders, EMT's, and in some cases paramedics. The equipment maybe as simple as a medical jump bag or advanced as Advanced Life Support. Some facilities even have ambulances on site and depending on their protocols these medical units may include transporting off site. It is important that local EMS providers are aware of the treatment levels and protocols of an industrial facility to avoid potential conflicts at the scene of an emergency.

Outside responders should ask to see what emergency response equipment a facility has. The overall quality and care of the equipment can speak volumes to the abilities of a team. If members of the fire department enter a brigade room to find equipment in a haphazard pile this

could be an indication to the abilities of the team. Look at equipment for inter-operability especially when it comes to SCBAs of an interior fire brigade.

When it comes to personnel and equipment we must be cautious to not get into company politics. Conversations can start unassuming but can result in you unknowingly supporting someone' cause. As some facilities struggle to fund an emergency response team it can be very easy for outside response organizations to fall into an internal conflict when it comes to equipment, training, and staffing of an emergency response team. Many of us in the fire service are far too familiar with the struggles when it comes to determine the wants and the needs of equipment, training, and staffing within our own organizations. We must be very careful when engaging in conversations involving equipment, training, and staffing.

Security:

Security at large industry is typically very tight as organizations are protecting their facilities. Security guards can range from an unarmed guard to heavily armed personnel. Firefighters must identify what facility gates they should enter at. Once on site how will firefighters access an area? It's obvious in a non-hazardous emergency plant personnel will most likely escort firefighters to the area of the emergency. In a fire incident how will firefighters have access to all areas of the facility? Magnetic locks requiring employees to use ID badges to access are very common for secured facilities. During an emergency can security provide an all access ID? Fire departments must identify barriers to response ahead of an incident.

Plant Evacuation & Accountability:

Identify what the evacuation and accountability practice is in the event the facility would need to be evacuated. In the event of an evacuation where to personnel go? Is there a plan to account for all employees? A common practice in industry is taken right from the playbook of school evacuations. Employees are assigned to work groups. Those work groups report to a designated area of the facility for accountability. A single employee, typically a supervisor, is responsible to insure all members are present. That supervisor then reports the status of his/her work group to a designate individual who will in turn report the overall accountability to plant management and outside responders. While this is a very efficient system to perform a primary accountability there is still a slight risk a small percentage of employees maybe overlooked and unaccounted for based on this method. Secondary accountability must be performed based on the gate activity logs that should account for personnel on site. Identify how many personnel are on site or in a specific work area during the day, during the night, during the weekends and holiday. Identify how many contractors will be on site during a maintenance turnaround or outage. Periodically facilities conduct major preventative maintenance projects. During these projects the census of the facility can exponentially grow.

Personal Protection:

Firefighters must be aware of their surroundings within an industrial facility. Moving equipment and self-starting equipment can find a firefighter in a bad place. The noise level and

general temperature of the facility are typically greater than firefighters are used to. Communications will be more difficult. Crews will need to be rotated more often due to the stress of the ambient heat of the facility coupled with the heat of the fire. Crews need to be very aware of their surrounding and the hazards that exist. If you do not know about the hazards, ask. Crews must also be aware of their location within the facility and the location of the nearest exits.

Combustible Dust:

Very little is written in the fire service on how dangerous dust is. Dust is explosive. Dust is a common by product in many manufacture processes and despite the best housekeeping efforts there an ever present risk. Firefighters must take steps to minimize the risk of stirring up dust with hose lines. Interior crews should use wide fog lines initially to suppress and wash down the dust. Once dust suppression has been completed the firefighters can narrow down the hose lines and attack the fire.

Electrical Hazards:

The demand for power is huge in industry. It is not uncommon to find both AC & DC power within a facility. Facilities might have a small power plant located on site. Responders will often encounter dry and oil filled transformers, large breaker buses, battery banks, and emergency generators to just name a few hazards that maybe encountered. Critical systems within a facility are often backed up through one or two redundant systems. Older facilities may have wiring that contains asbestos. Fair warning that low voltage in industry means anything under 600volts. To put this in perspective the orange high voltage wiring in a hybrid vehicle is 480 volts.

Hazardous Substances:

The amount of substances that are used in an industrial process can be an eye opening experience. Facilities may have water treatment or sewage treatment facilities on site. Hydrogen is used as a cooling gas.

Regulatory Agencies:

In large scale incidents regulatory agencies may arrive to begin to gather information on the incident. Is there injuries or fatalities that might require an OSHA investigation? Is there an environmental release that may require department of natural resources (DNR) or the environmental protection agency (EPA) to investigate? The incident commander may need to appoint a liaison officer to assist these agencies in gathering the information they are seeking.

For many of us in the fire service a large industrial incident will be a once in a career event and if we are not careful they could be a career ending event. These incidents will challenge local responders based on its size and complexity. The key to building an efficient operation is to develop a relationship with the key stake holders long before the incident occurs.

This relationship must be continuous. The key to industrial emergencies is integrated preparedness.

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Fire Protection Water Supply in the Industrial Environment

Brian S. Gettemeier

When it comes to pre-planning for an incident, we typically take an assessment of the facility and its related hazards. We are very aware that industrial facilities are often large and contain many hazards. Pre-plans must extend into considering the required fire flows and the industrial fire protection system that will assist in achieving that goal. In this article we will look at fire protection water beyond the traditional municipal water supply and hydrants. When it comes to supply how much are we going to need and where do we get it from? How do we find out the answer to this question? Pre-planning and training well before the incident occurs. As an organization with the responsibility to respond to an industrial facility we must pre-plan. We must learn about the unique aspects of the facilities. We must learn about the challenges we may face.

Mega Water

The fire service likes the mantra of big fire big water. As firefighters we can typically meet the big water flows of a residential structure. In an industrial incident are we prepared for a fire flow rate greater than 5000gpm?

When the fire service arrives on the scene of a large-scale industrial incident, we must quickly establish a water supply officer. The reality of many suburban and urban departments is a water supply officer is not part of a typical arsenal. Establishing water supplies beyond hydrants is outside our comfort zone.

Fire Protection Water Supply

We will begin with water supply. Are there dedicated fire protection water tanks? There are several questions involved in fire protection water tanks. Are they dedicated tanks or is the water in the tank used for another purpose? Example the facility may need 500,000 gallon of dedicated fire protection water. A common practice would be to build a 750,000-gallon tank with the top 250,000 gallons being available for plant service water to support the operations of the facility. In this case there would be 2 suction lines in the tank one at the top to access the service water and one at the bottom of the tank to supply the fire protection loop. The advantage of this system is if the tank is all the way full there will be an additional 50% of water available because we will have access to the service water and the fire protection water. The disadvantage is as fire protection systems are using the water out of the tank naturally the service water will be used first. The service water maybe used for critical systems prompting a shut down of the systems due to lack of water. Facility operators are challenged with managing the fire and managing the safe continued operations or shut down of the facility.

The fire service must take in consideration that a dedicated fire protection water tank is designed off a fire flow. For example, the largest demand sprinkler system and 500gpm for handlines for 2 hours. In this example if the largest demand sprinkler is 1500gpm with an additional 500gpm for handlines the total flow 2000gpm, this flow would need to be sustained for 2 hours. The dedicated fire protection water supply would be 240,000 gallons. This

calculation is based off a single sprinkler activation. The unfortunate reality is typically industrial events escalate to becoming multiple events with in a facility. The activation of multiple sprinkler systems or the implementation of fire service master stream devices will result in depletion of the water supply at an accelerated rate. In these cases, the incident command team must quickly identify alternative means for water supply.

Alternative water supplies maybe taking water out of other water tanks on site. These tanks maybe raw water. Raw water will be untreated and dirty the equivalate of drafting out of a lake or river. The water maybe treated potable water. In extreme cases we may have to take water from tanks that supply industrial processes. In this case the water maybe ultra-pure. Process water will affect the facilities ability to remain on line requiring a shut down. Note most industrial facilities will continue production even during a fire because shut downs and start ups are time consuming and costly. In pre-incident planning we must identify how we will gain access to the water in non-fire protection water tanks. The facility may have tanks connected together using cross tie valving. In this case we need to identify what valves have to be opened to allow the tanks to cross tie. In other cases, the fire service might be able to connect the tank directly to the apparatus. When connecting an apparatus to a tank we must identify what connections and adapters are needed to make the connection. We must use hard suction hose to make the connection.

In industry tank capacity is typically measured in feet. For example, if the tank was 36' tall in the interior the tank gauge would read 36' not 100% capacity or capacity in gallons. Operators can quickly do the math to calculate how many gallons are in a foot based on tank size. To illustrate our previous example in the case of our 750,000 gallon tank that contains 250,000 gallons of service water and 500,000 gallons of fire protection water the suction for the service water would be at the approximate 24' mark. This would only allow the top 12' of the tank to be used for service water. The suction line for the fire protection water would be close to the bottom allowing for the entire tank capacity to be used for fire protection.

Fire Protection Water Pumps

The next component of the fire protection water system is fire pumps. There needs to be a method of pushing the water through the fire protection grid. Typically, this is handled through one or more fire pumps. The fire service must work with the facility to identify where the pump houses are. How are the fire pumps activated? Typically, activation is accomplished with a pressure drop but in the event the pumps do not start how do we manually start them? Manual start maybe accomplished through remote starting, example through a computer screen in the control room or directly at the machine itself. Are the fire pumps electric or fuel supplied? In the event of electric pumps is there a back-up system to supply the pumps in the loss of power? In the early 2000s I was part of a firefighting crew at an electric generating facility that caught fire. The fire protection system was electric powered. Unfortunately, during this incident, the facility lost all power and consequently lost its hydrant grid and sprinkler systems because the electric fire pumps were non-operational. This utility now utilizes a combination of electric and diesel fire pumps for continuity and redundances of fire protection systems. In the case of a fuel supplied fire pump how long is the pump designed to operate before it needs to be refueled. An example with diesel fire pumps we may find a day tank in the pump house that is designed to

operate the fire pump for 8 hours before refueling. In the event the incident last over 8 hours the incident command team must identify how to refuel the tank before the pump runs out of fuel.

Fire pumps can be remotely operated but can only be turned off at the control panel located at the fire pump. Fire pumps also do not recognize and interruption in water supply. In the event water supply is lost to the pump the pump will continue to operate until manual shut down or pump failure. When fire pumps are fed by a fire protection tank the water supply officer must be cognizant of the tank level to avoid the pumps running dry.

Fire Protection Water Distribution

Once the water has left the pumps it is now distributed through the fire protection grid. This grid can include hydrants, large diameter manifolds, fixed monitor nozzles, standpipes, and sprinkler systems. During the pre-planning process the fire service must identify what is on the fire protection system grid and the operating pressure of the fire protection grid.

The day-to-day operating pressure of the industrial hydrant loop maybe relatively low. This will be especially true of aging industrial facilities where the underground piping is reaching the end of its life span and needs maintenance. The fire service must identify how to increase the pressures on these systems during an emergency. Furthermore, we must identify what the operating pressures will be during an emergency. For example, a power plant that I have experience with the hydrant loop is part of the service water system. On any typical day the hydrants will have greater than 200psi of pressure in the system. Firefighters must have this knowledge and a plan to overcome the pressure in the event of an emergency.

Many industrial facilities do not use potable water in their fire protection loop. In other words, do not allow your firefighters to ingest the water. In the typical municipal system, the hydrants are part of the drinking water system so it's not uncommon to see a firefighter to cup their hands under a leaking hose connection to splash some water on themselves or get a drink. An example would be a refinery that collects water run off and uses that untreated run off as part of the utility water system. It would not be uncommon to see the water have a less than clear appearance and have a slight petroleum smell.

Just as we pre-plan the location of hydrants in the municipal setting we must identify where the closest hydrants are in the industrial setting. Are they all on the same loop or are there separate loops? Are all the hydrants part of the facilities systems or is there also municipal system hydrants on site or in the nearby vicinity? How many hydrants will we need to meet the intended fire flow? A large diameter manifold is essentially a water main that comes out of the ground and has a series of large diameter connections. This manifold is essential when supplying multiple large diameter hose lines.

On Site Apparatus and Hose

Large facilities may have a fire brigade including fire apparatus. Get to know the capacities of the apparatus. Industrial fire apparatus as designed to pump as much as 5000gpm

from draft, dwarfing the pump capacities of our municipal apparatus. When it comes to supply line what type of couplings is it equipped with? In the case of incompatible couplings do we have the appropriate adapters? What size supply lines do they operate? It is not uncommon to see 7¼" to 12" supply lines. A 7 ¼" hose line has approximately twice the water delivery of 5" supply line.

Ask the industrial facility if your organization can participate in a training or exercise with their response members. Most facilities will gladly welcome the local response organizations in to help pre-plan for an incident because they recognize the value of unified response system to mitigate the emergency.

Water Supply Lay Out

In many suburban and urban communities, a water supply is as simple and as attaching a large diameter hose to a hydrant and taking what you get. Consideration maybe given to keeping the supply line out of the middle of the street to allow vehicle access in and out. When establishing water supplies time must be taken to establish a system that is going to sustain the operation. Consideration must be given to the number of pumps and hoses required to establish the proper fire flow requirements. Access must be left to move foam totes in an out for a sustained foam operation. For example, if the required fire flow is 5000gpm with 3% foam we would be using 150gpm of foam concentrate a minute. This would mean a standard 330-gallon foam tote will need to be switched out every 2 minutes. Space will be needed to stage foam totes. Fuel consumption must also be taken in consideration. Many industrial fire brigades know their gallons per hour consumption rate on their apparatus. Industrial fires are often long sustained pumping operations that will require apparatus to be periodically fueled during the firefighting operation.

In Conclusion

The water supply operation of an industrial facility fire can be a complicated one. In order to be successful, the fire service and the industrial facility must identify the key components and identify the fire flow needs. A water supply plan must be more than a plan, it must be practiced to identify gaps. The day the incident occur is not the time to try and figure out how everything works.

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