Response to Pipeline Incidents

By Craig H. Shelley

A PLOT WAS RECENTLY UNCOVERED IN NEW YORK City in which explosives would have been used to destroy a pipeline and possibly the fuel storage tanks at John F. Kennedy Airport. At the announcement concerning the arrests of the suspects, the United States Attorney stated it was "one of the most chilling plots imaginable." If this plot had succeeded and was located in your response district, would your department be prepared? Would it cause the mass destruction alluded to in the JFK incident above?

Pipelines can be found in most fire departments' response districts in one form or another and can be large aboveground pipes or smaller pipelines buried beneath the surface. They carry everything from home-heating oil to aviation jet fuel, as was the case in New York, and will differ in size, purpose, complexity, and operating environments.

Pipeline Systems

Gathering lines transport crude oil or natural gas from the wellhead to a processing facility where the oil/gas and water are separated and processed. The size required will vary based on the capacity of the well being served, the length of the line, and the pressure at the well. For crude oil lines, the pressure may be below 100 pounds per square inch (psi), but for gas lines the pressures will be much higher (up to 2,000 psi), though many operate at only several hundred psi. Transmission lines are pipelines used to transport natural gas to a customer from a gathering/storage facility to a processing/storage facility, large volume customer, or distribution system. When describing a hazardous liquid pipeline, a transmission pipeline transports crude oil from a gathering line to a refinery, and refined products from a refinery to a distribution center. Distribution lines are used to supply natural gas; they are located downstream of a natural gas transmission line. Pipeline gathering and distribution systems range from two to 60 inches in diameter. Natural gas pipelines range from two to 42 inches and are constructed of steel or plastic piping, depending on their location in the natural gas distribution system.

Compressors create the pressures needed to move natural gas through the system. Pressures in gas transmission lines may range from 500 to 1,000 psi. Compressor stations are spaced 50 to 100 miles apart along the pipeline. The distance between the stations varies based on gas volume, pipeline size, and other factors. The capacity of the system may be increased by adding compressors at existing stations or adding additional compressor stations.

Most pipeline systems in the United States are not visible, although pumping stations and other support facilities required for pipeline operations are. Although we normally associate oil and gas as the products contained and transported in pipelines, other liquids and solids may also be transported. Products transported in pipelines include the following:

- Gasoline.
- Diesel fuel.
- Kerosene.
- Natural gas.
- Heating oil.
- Propane.
- Aviation gasoline.
- Jet fuel.
- Carbon dioxide (CO₂).
- Ethane.
- Crude oil.
- Coal.
- Liquefied natural gas (LNG).
- Coal slurry.

Most of these pipeline products are familiar; some are not. It is essential for first responders to be aware of pipelines that traverse their response districts but, more importantly, how they operate and what products they carry. It is also important
to know that pipelines may carry more than one product in a single pipe. The process of transporting multiple products using one pipeline is known as "batching." Refined product pipelines can transport multiple products at the same time. These products can be separated with or without a physical barrier between products. Where no physical barrier is present, the difference in density between products maintains the product separation. Dozens of products or grades of a single product can be transported this way. If a rupture were to occur in a pipeline carrying batched liquids, first responders may encounter more than one product, flowing with differing properties and hazard characteristics.

Most pipelines are owned by companies whose sole function is to operate the pipeline system. Pipeline corridors may contain three or more pipelines running parallel to each other. These corridors are also known as pipeline rights-of-way and may be 25 to 150 feet wide, providing access to the pipeline for repairs or maintenance. There are also building restrictions near these rights-of-ways; they may be owned by the pipeline if acquired for use from the landowner. In addition to pipelines, other subsurface utilities such as communications lines may also use the pipeline corridor.

PIPELINE MARKINGS

Pipelines are required by law to be clearly identified using markers and warning signs in high-visibility colors, such as yellow or orange; such markers indicate the approximate route of the pipeline. They are placed at frequent intervals along the pipeline rights-of-way (Photo 1) and are located where a pipeline intersects a street, highway, railway, or waterway. Markers also are located at other prominent points, such as near buildings and structures. They are also found at locations where the pipeline is aboveground in areas of public access. The marker will identify the material being carried in the pipeline, the name of the company operating the pipeline, and a contact number where the operator can be reached in case of emergency. The markers also carry the words "warning," "danger," or "caution." The markers or signs only indicate the general location of the pipeline, because the pipelines do not always follow a straight course between markers. Also, markers do not give information on the depth of the pipelines. The absence of a marker is not an indication that a pipeline is not present. In urban high-density areas (possibly areas with hard surfaces and parking lots) where pipeline may be impractical, no pipeline markers may be present. In some instances, vandalism or damage by outside forces may have removed the pipeline markers.

CAUSES OF PIPELINE ACCIDENTS AND INCIDENTS

Historically, pipelines are normally a safer method of transporting products than rail or truck transportation. However, pipeline ruptures do occur. The United States Department of Transportation, Office of Pipeline Safety, maintains data on the frequency, causes, and resulting consequences of pipeline failures. The Office of Pipeline Safety indicates that "outside force" damage contributes to more pipeline accidents and incidents than any other category when data from all accidents involving hazardous liquid, natural gas transmission, and natural gas distribution lines are considered together. Outside force damage can result from the following:

- Extreme temperatures.
- High winds.
- Heavy rains and flooding.
- Fires or explosions external to the pipeline, including terrorist acts.
- Vehicles striking the pipeline.
- Lightning.
- Earth movement.
- Vandalism.
- Excavation damage.

The largest portion of outside force damage is the result of excavation damage. Another leading cause of pipeline failure is pipeline corrosion, both internal and external.

Under normal operating conditions, there should be no pipeline hazards to first responders. However, if a rupture or leak occurs, various hazards may be present, including the flammability and high pressures of the product, explosion potential, fires, product toxicity, and skin irritation. Responders should treat a pipeline incident as a hazardous materials incident: protect against inhalation, absorption, and ingestion of the product and remove ignition sources when it is safe to do so.

Natural gas gathering pipelines leading from wells to processing facilities may contain hydrogen sulfide (H₂S), also known in the oil industry as "sour gas." Breathing sour gas can cause death. Sour gas is found in gathering pipeline systems that move the crude oil from the well to the field processing plant, where it is removed so the gas entering the transmission line for long distance movement does not contain toxic amounts of hydrogen sulfide. Associated sour gas may also be found in crude oil pipelines; be aware of this and plan accordingly.

PREINCIDENT RESPONSE PLANNING AND FIREFIGHTING TACTICS

As with other hazards in your jurisdiction, preplan pipelines, if present. Preincident response planning is essential for a safe and effective response. The response actually begins well before the department is notified of an emergency. Preincident response planning must involve the pipeline operating company and local emergency management officials. Pipeline incidents may be multijurisdictional if they span a large geographical area and may involve many agencies. Initiate a unified command structure.

Preincident response plans should contain the following information at a minimum:

- Location of the pipelines within your response area. Fire departments that may be called on mutual or automatic aid to a jurisdiction with pipelines should be familiar with those pipelines as well as any preincident response plans developed by the initial responding agency.
- Maps of the pipeline routes.
- Products transported in the pipeline and their hazards.
- Construction materials of the pipeline.
• Location of valves associated with the pipeline.
• Location of pumping and compressor stations.
• Direction of product flow.
• Emergency contact numbers.
• Amount of product carried in the pipeline daily, as well as the amount of product in the various sections of pipe, in case a leak occurs and a section of the pipeline needs to be isolated. Keep in mind that once the valves are closed, isolating a section, there still remains a considerable amount of flowing product in the line. You must be able to control this situation.
• Any specialized vapor control equipment, such as large-caliber portable monitors and specialized foam for spill coverage such as high-expansion foam for vapor control of liquefied natural gas. Large quantities of foam may be needed, depending on the amount of product spilled.
• Predesignated staging areas for pipeline sections. Pipelines should be separated into sections for response protocols. This allows annexes to the overall preincident response plans to identify specific hazards within a designated section. Select primary and secondary staging areas depending on weather and topography.
• Target hazards that require special handling, such as schools, hospitals, nursing homes, and places of assembly. Establish shelter-in-place or evacuation procedures for these facilities.
• Other exposures that could be affected, including the jurisdiction’s infrastructure (bridges, tunnels, major highways, and so on).
• General firefighting guidelines for responding units.
• Evacuation and isolation distances.
• Water supplies.
• Material safety data sheets (MSDSs) for the products.
• Prevailing wind direction.

A major metropolitan fire department that has a pipeline running through the city has developed a comprehensive preincident response plan and standard operating procedure (SOP); the pipeline is actually two pipelines running together, one containing gasoline and the other a kerosene-based aviation fuel. The pipeline pressures range from 200 to 1,200 psig.

The preincident response plan contains a complete description of the pipeline and its associated facilities, including the failsafe systems designed to minimize damage in case of an incident. Control valves will shut down the system if any excessive pressure is detected. If these valves fail, then pressure switches will shut down the pumps. In the event of a pressure rise from excessive product heating, the pressure relief valves will operate. Automatic valves subdivide the system into sections for isolation. Each section can then be further isolated using manual valves.

This fire department has an SOP developed in conjunction with the pipeline operating company whereby the fire department closes the manually oper-
Pipeline Incidents

Ated valves located on each side of a leak. Normally, emergency response personnel should never isolate or close any pipeline valves on transmission or distribution lines unless directed by pipeline operations personnel. In this department's case, it has been agreed to in advance that the department will isolate the pipe section where the leak has been found. Included in the preincident response plan is the number of turns required to close a valve. The number of turns is considerable; with this information, the firefighter turning the wrench or valve wheel will not think the valve is broken or stop too soon if he meets resistance.

This department's preincident response plan also covers the roles of supporting agencies and other department divisions such as the communications division. It establishes drill frequencies and incorporates a mechanism for evaluation and modification.

It is essential with any SOP or preincident response plan to exercise these procedures on a preset schedule. Revolve those found to have become obsolete or unnecessary. Revise those that need updating because of changes in company or department philosophy, such as plant expansion, changes in plant processes, new techniques, new technology, or a change in a department's mission or scope. During review and exercise of procedures and plans, verify contact information contained in the plan.

When evaluating a plan's effectiveness in handling an incident, departments must look at the resources that may be necessary. As stated, in the case of a spill, large quantities of foam may be required for vapor suppression or extinguishment. Some departments have large quantities of foam stockpiled in a storehouse for such a situation. However, departments must also consider the logistics of getting the foam to the location, offloading it, and injecting it into the water stream to make a foam solution. Consider the hardware required such as nozzles, pickup tubes, and proportioners.

Operational security (OPSEC) regarding preincident response plans and SOPs is important. Keep all preincident response plans on department apparatus in a locked container or cabinet. If using an onboard computer to manage your preincident response plans, protect the password. During the review and revision process, shred all old, draft, or working copies of the documents before discarding them. Through careless OPSEC, a person up to no good can enter your apparatus or go through station trash to obtain information on facilities (including pipelines).

Notification of a Pipeline Incident

The response to a pipeline incident will usually be initiated in one of three ways.

1. Notification by the pipeline company to the local emergency response system—that is, 911. Pipeline companies monitor their pipelines using instrumentation and monitoring systems. These monitoring systems are known as SCADA (supervisory control and data) systems. These systems will provide pipeline operators at the control station with up-to-date readings on pressures, flows, volume, alarms, temperatures, and other conditions regarding the pipeline. Alarms are generated when preset levels are exceeded. Pipeline operators will be able to detect a leak by comparing total product being delivered by the system to total product being pumped into the system and activate emergency procedures to shut down the affected section of the pipeline or, in some cases, the entire pipeline. Pipeline operators also use aerial and surface inspection of their pipeline rights-of-way. When a leak is detected, emergency procedures will call for the notification of responders such as local fire departments.

2. Notification by nonpipeline employees is the second way a fire department can be notified of a pipeline incident. These persons may be present or nearby when the pipeline ruptures and may notice the effects of a pipeline leak, such as an oil spill or a strong odor, and report it to 911. In this case, the reason for the response may not be clear to the dispatcher or call receiver. In one case, civilians reported a strong odor in the area to the emergency call center from a pipeline leak. When the fire department responded, it assumed the odor was from an asphalt plant nearby. The resultant fire caused three deaths.

3. A verbal alarm from a passing fire department unit. There are times where firefighters out of the station on routine assignments spot pipeline or other emergencies.

As already described, the response to a pipeline incident may have been initiated by a caller stating a little defined problem, such as an unknown hazardous material spill or unknown odor. Therefore, when responding to such vague reports, the crew must consider and recognize certain clues for a safe and effective response. When receiving reports such as the one above, you must be familiar with the district and determine if there are any pipelines in the area that could give such indicators if there were a leak or rupture. The units must
respond with full personal protective equipment. How you respond to the small or unknown incident is how you will respond to the major incidents. Are you disciplined, prepared to work, and in the correct frame of mind? When you approach the area, be cognizant of the surroundings. Is there dead or discolored vegetation? Is there a strong odor present? What sounds do you hear? Is there a hissing noise? On a hot day, you may see the vapors from a spilled product. If you are near a body of water, do you see evidence of product spillage, such as sheen on the surface or pooling or discoloration of the shoreline? With some gases, a vapor cloud may be present. Dirt being blown into the air may indicate a buried pipeline leak. The pooling of liquid may also be an indication of a leak. (4, 79-80) These signs may not be clearly visible during the day, but they are even less visible at night.

Pipelines and their supporting facilities might be targets for terrorists. It is possible that an explosion at one of these remote locations might be a practice run for a much larger explosion and attack at a more populated area or facility. To hold explosives in place at pipelines, heavy objects such as sandbags may be used. Fire departments responding to fires at these locations should be aware of this fact and be alert for their presence, indicating the possibility of explosives—either unexploded initial or secondary devices.

If you are responding to a reported pipeline leak, treat it just as you would a hazardous materials incident, and respond with caution. Use combustible gas-indicating equipment, and establish hot zones. Another consideration when responding is that there may be more involved than a leak or spill. A pipeline response may be instituted for a confined space or other technical rescue scenario. Position the apparatus from the upwind and uphill side of the incident. Refer to your preincident response plan for the product information and evacuation and isolation distances. Never place your apparatus closer than the recommended evacuation distances so the apparatus does not become an ignition source. I know of instances where this happened. In one case, a natural gas leak resulted in a fire that destroyed a number of city blocks; another industrial incident resulted in the shutdown of a plant for an extended time. Try to place the apparatus facing the direction of evacuation in case you need to make a hasty retreat. Practice evacuation and accountability procedures during incident response drills.

Apparatus operators should locate and test their water source but should not connect the pumper until the incident commander (IC) determines the incident objectives and strategies. The position of the apparatus may change when the strategies are defined. Ensure that apparatus and hoselines do not block evacuation routes.

The fire department shall establish isolation distances and prevent entry by unauthorized persons. Persons allowed into the hot zone should be equipped with the proper personal protective equipment including self-contained.
breathing apparatus (SCBA) and should monitor for flammable, toxic, and oxygen-deficient atmospheres. SCBA is required for all pipeline firefighting and control operations. Accountability protocols are a must for everyone entering the hot zone. This includes pipeline personnel who may be called to effect repairs.

The IC should establish command and open lines of communications with the pipeline company. The IC must verify the product and its hazards and attempt to verify the quantity of the product leaked. Liquids leaking under pressure may give the appearance of a harmless geyser of water, but it should not be assumed that it is not a hazardous material. The ignition of the product will be easier when it is in vapor or leaking under pressure. In addition, the IC must notify other response and support agencies. Because this is a pipeline incident, it will involve more than one agency and may involve more than one jurisdiction, so establish a unified command system. Some of the key players will be pipeline company representatives, the Environmental Protection Agency (EPA), environmental cleanup contractors, support agencies, the U.S. Coast Guard (if the spill is located near a waterway), the National Transportation Safety Board, the U.S. Department of Transportation, law enforcement agencies, and other fire departments.

As with any response, the life hazard must be the first priority. This includes the lives of firefighters. Perform a risk-benefit analysis before committing personnel to a rescue. There may be times when casualties must be left in place until the area is deemed safe to enter. In addition to any life hazard in the hazard zone, you must address the life hazard of those persons in the surrounding area. Is evacuation necessary, or will shelter in place be appropriate? Address those in the area most likely to be affected first; this would normally be the downwind direction. When addressing the life hazard, note that during these times when terrorism is a threat to society, always consider that the incident you have responded to may be the result of a terrorist act because of the limited security and remote locations of pipelines. The IC should ensure that the area is secure for fire department operations. Be alert for unexploded improvised explosive devices (IEDs) that may be in the area. Heavy sandbags or other objects may be used to hold such devices to the pipeline for maximum effect. Be observant of all suspicious objects, and take the necessary precautions. Establish staging areas so that nonessential vehicles, equipment, and personnel are staged at a safe distance, ready for assignment and deployment as ordered by the IC.

If no life hazard is present, the next priority will be incident stabilization. Incident stabilization may require the following:

- Coordination with the pipeline company to verify that the pipeline has been shut down, the flow has been redirected, or the section has been isolated.
- Containment of the spilled product. Damming or diking may be required to control the product runoff.

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- Elimination of ignition sources.
- Vapor dispersal using steam. In this instance, it is desirable to use unattended monitors to avoid placing personnel in the hazard zone. When using a steam stream to disperse vapors, monitor water runoff. It is possible that the water runoff will weaken the trench walls, if present, collapsing the trench onto the pipeline.
- Control of flammable vapors using fog patterns or a foam blanket application. Control the vapors of an LNG spill using high-expansion foam. You may need additional foam supplies other than what you carry on responding apparatus. Note this and identify resources in the preincident response plan.
- Extinguishment of secondary fires. Secondary fires may have been started by the primary fire or explosion.
- Protection of exposures. In a pipeline fire, it may be appropriate to let the product continue burning until the fuel can be shut down. This is essential when a flammable gas is involved. Cool exposures, including other pipeline or support facilities, where fire is affecting them directly or by radiant heat.
- Fire extinguishment where applicable. Do not extinguish gas-fed fires unless the fuel source has been isolated and the pipeline operator advises you to do so. When a pool of LNG is on fire, the use of water on the fire will increase the vaporization rate of the LNG and intensify the fire. Dry chemical would be the preferred extinguishing agent for LNG fires. For large LNG fires, use high-expansion foam. High-expansion foam, although it will not completely extinguish the fire, will provide a controlled burn and significantly reduce the radiant heat. When a high-expansion foam blanket is applied to the surface of a burning LNG pool, it reduces the vaporization rate, resulting in the fire's reaching a steady-state condition. You can then use dry chemical to extinguish the remaining fire. The use of foams for hydrocarbon fires may require additional foam supplies to be delivered on-site. Identify this in the preincident response plan.
- Establishment of water supplies. Because the incident may be in a remote area, water supply may be scarce or nonexistent. You will need a water resource officer and plans to establish water supplies. This may include water tanker shuttles or long hoses with pumper relays. Practice these relays during drills and exercises.

During or after the incident, decontamination of personnel as well as tools and equipment may be required. Because of the hazardous properties of many of the products being transported by the pipeline system, a careful analysis of the product and determination of the decontamination required should be performed at all pipeline incidents.

As with all incidents, you must protect the environment. Close liaison with EPA representatives during the incident will allow discussion concerning your actions and their effect on the environment. At times your actions may actually hurt the environment, and you should be aware of this and prevent it as much as possible. Control water runoff from cooling and extinguishment streams as much as you can. Documentation of all actions taken at the incident is an essential part of the recordkeeping and subsequent incident investigation.

Responses to pipeline incidents may be rare for most fire departments, but statistics show they do occur. Fire departments must be prepared to respond to these incidents when called on just as they are prepared to respond to the bread-and-butter calls of structural fires and emergencies. Although the case in New York may not have resulted in the destruction of the airport and surrounding community as planned, it would have been a fire that caused residents to take notice. Pipelines may be targeted for a variety of reasons—to injure nearby persons, to create fear and panic in a community, or to use the physical and chemical properties of their products to cause an environmental impact. A large incident may also disrupt supplies, which could affect the economy locally or nationally.

As with all responses, preincident response planning and drills are the keys to success. Remember that pipelines may contain almost any substance. Do not assume that a pipeline that has provided reliable service for 20 years does not pose a potential threat to your community.

A final note for consideration: Because of recent events, pipeline security in your area may have (or should have) been heightened. Areas previously accessible during emergencies may now be inaccessible. Coordinate with the pipeline companies to evaluate how increased security may affect your preincident response planning and, if so, adjust it accordingly. Follow up any adjustments with the education of your response personnel and exercise any changes as necessary.

ENDNOTES
3 DOT, Office of Pipeline Safety.
5 Texas A & M University, Emergency Services Training Institute. Liquefied Natural Gas (LNG) Spill Control and Fire Suppression Training, Student Notebook. (College Station, TX: Texas A & M, n.d.), 85.

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