HMCRP

REPORT 14

HAZARDOUS
MATERIALS
COOPERATIVE
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PROGRAM

Guide for Communicating Emergency Response Information for Natural Gas and Hazardous Liquids Pipelines

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HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

HMCRP REPORT 14

Guide for Communicating Emergency Response Information for Natural Gas and Hazardous Liquids Pipelines

Charles Jennings
Norman Groner
Chaim Roberts
Andrea Fatica
CHRISTIAN REGENHARD CENTER FOR EMERGENCY RESPONSE STUDIES
New York, NY

Michael Hildebrand
Greg Noll
HILDEBRAND AND NOLL ASSOCIATES
Lancaster, PA

Rae Zimmerman
RAE ZIMMERMAN, INC.
New York, NY

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HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

The safety, security, and environmental concerns associated with transportation of hazardous materials are growing in number and complexity. Hazardous materials are substances that are flammable, explosive, or toxic or that, if released, produce effects that would threaten human safety, health, the environment, or property. Hazardous materials are moved throughout the country by all modes of freight transportation, including ships, trucks, trains, airplanes, and pipelines.

The private sector and a diverse mix of government agencies at all levels are responsible for controlling the transport of hazardous materials and for ensuring that hazardous cargoes move without incident. This shared goal has spurred the creation of several venues for organizations with related interests to work together in preventing and responding to hazardous materials incidents. The freight transportation and chemical industries; government regulatory and enforcement agencies at the federal and state levels; and local emergency planners and responders routinely share information, resources, and expertise. Nevertheless, there has been a long-standing gap in the system for conducting hazardous materials safety and security research. Industry organizations and government agencies have their own research programs to support their mission needs. Collaborative research to address shared problems takes place occasionally, but mostly occurs on an ad hoc basis.

Acknowledging this gap in 2004, the U.S. DOT Office of Hazardous Materials Safety, the Federal Motor Carrier Safety Administration, the Federal Railroad Administration, and the U.S. Coast Guard pooled their resources for a study. Under the auspices of the Transportation Research Board (TRB), the National Research Council of the National Academies appointed a committee to examine the feasibility of creating a cooperative research program for hazardous materials transportation, similar in concept to the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP). The committee concluded, in *TRB Special Report 283: Cooperative Research for Hazardous Materials Transportation: Defining the Need, Converging on Solutions,* that the need for cooperative research in this field is significant and growing, and the committee recommended establishing an ongoing program of cooperative research. In 2005, based in part on the findings of that report, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) authorized the Pipeline and Hazardous Materials Safety Administration (PHMSA) to contract with the National Academy of Sciences to conduct the Hazardous Materials Cooperative Research Program (HMCRP). The HMCRP is intended to complement other U.S. DOT research programs as a stakeholder-driven, problem-solving program, researching real-world, day-to-day operational issues with near- to mid-term time frames.

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C O O P E R A T I V E   R E S E A R C H   P R O G R A M S

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In addition, a group of stakeholders met in the summer of 2013 to review a preliminary guide. The stakeholders represented major national public safety and local government organizations. This group contributed valuable insights to the development of this product.

FOREWORD

By William C. Rogers
Staff Officer
Transportation Research Board

HMCRP Report 14: Guide for Communicating Emergency Response Information for Natural Gas and Hazardous Liquids Pipelines provides pipeline operators and emergency responders with guidance on how to share appropriate information in advance of a pipeline emergency so that the response plan can be quickly and effectively put into operation with the assurance that the best steps are taken in correct sequence to bring optimum resolution to the pipeline emergency. The guide focuses on the appropriate emergency response content that pipeline operators should provide to emergency responders, effective means of disseminating this guidance by pipeline operators to recipient emergency response organizations and by those emergency response organizations to sub-units, and strategies for implementing and exercising emergency response plans.

Pipelines that transport hazardous materials are ubiquitous in the United States, crossing under water and over land from densely populated areas to the most remote uninhabited locations. Current federal regulations require pipeline operators to develop emergency response plans and implement public awareness programs. Under these regulations, pipeline operators must provide the affected public with information about how to recognize, respond to, and report pipeline emergencies. Emergency responders and local public officials must be provided information about the location of transmission pipelines to enhance emergency response and community growth planning. Affected municipalities, school districts, businesses, and residents must be advised of pipeline locations.

Under HMCRP Project 15, the Christian Regenhard Center for Emergency Response Studies was asked to (1) summarize current federal and state, and representative local and tribal regulations and ordinances governing emergency response plans for natural gas and hazardous liquids pipelines; (2) identify and describe lessons learned and best practices from recent significant U.S. pipeline emergencies with respect to communicating the emergency response plans and their effectiveness; (3) develop a failure mode and effect analysis of the process for disseminating, exercising, and implementing emergency response plans for natural gas and hazardous liquids pipeline incidents, including the roles and responsibilities of both pipeline operators and emergency responders; (4) and prepare a guide for pipeline operators and emergency responders to aid them in how to share appropriate content in advance of a pipeline emergency so that plans can be quickly and effectively put into operations with assurance that the best steps are taken in correct sequence to bring optimum resolution to the pipeline emergency.

CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

S U M M A R Y

Guide for Communicating Emergency Response Information for Natural Gas and Hazardous Liquids Pipelines

Analysis of major pipeline incidents suggests a recurring challenge in communication between emergency responders and pipeline operators. In some cases, critical information such as determining the presence of pipelines or identification of the pipeline owners took considerable time. These delays contributed to greater damage as a consequence of these incidents.

HMCRP Report 14: Guide for Communicating Emergency Response Information for Natural Gas and Hazardous Liquids Pipelines (the guide) is designed for use as a pre-incident planning tool for both pipeline operators and public safety agencies, such as fire departments, law enforcement, and emergency management agencies. It is intended to provide information to assist all parties in identifying information needs and the means for communicating this information. The reader should consider incorporating this information into emergency operations plans. The research team consulted researchers and practitioners with considerable experience pertaining to each element of the project including pipeline emergency response.

Findings in the guide are the result of several steps. The first was review of national and state regulation, industry best practices, and pipeline incident reports from the National Transportation Safety Board (NTSB). Next, there was a series of workshops held with diverse stakeholder participants representing pipeline operators, public safety, and environmental protection or regulatory officials at the state and federal levels. These workshops were designed to identify information needs of various stakeholders, and identify challenges to effective communication. Based on data obtained in the workshops, a group of experts, representing these same constituencies, completed a Failure Modes and Effects Analysis (FMEA). This analysis identified information needs in the early stages of a pipeline emergency as well as criticality of the information and likelihood that it would be transmitted effectively.

The guide uses a role-based approach for understanding information needs and flows. Functions are associated with specific roles. This approach recognizes the reality that multiple organizations collaborate in pipeline emergency response, and may fulfill multiple or differing functions at a pipeline emergency. The time of notification, magnitude of the incident, and cause of the incident can all affect the information flows and their specific requirements. The research team defined key roles and identified organizations that commonly fulfill those roles.

The vast geographic coverage of pipelines, and the complex nature of local emergency response organizations makes outreach and maintenance of contact difficult. Public safety 9-1-1 dispatch centers (known as Public Safety Answering Points ([PSAPs]) play a crucial

role that should not be overlooked. These centers can serve as institutional memory for critical communication procedures, and are often the first step in recognizing potential pipeline involvement in reports of unusual conditions from the public.

Both pipeline operators and local emergency responders must work together to ensure that communication is a primary component of pre-incident plans. Preparedness begins with the public emergency responder identifying pipeline operators with facilities in his/her service areas. With this information, and an understanding of common challenges and experience of past incidents, key parties can improve readiness for an incident, and improve the ability to respond in a timely and effective manner. This guide includes federal emergency planning guidance on integrating pipeline emergency communications into larger emergency operations plans and incident management frameworks.

The Hazardous Materials Cooperative Research Program (HMCRP) conducted the project with funding provided by the U.S. Department of Transportation's (DOT's) Pipeline and Hazardous Materials Safety Administration (PHMSA). This guide is one of four products of the project. The other three products are Appendix 1: Contractor's Final Report for HMCRP Project 15; Appendix 2: Summary of Current Federal, State, and Representative Local and Tribal Regulations and Ordinances Governing Emergency Response Plans for Natural Gas and Hazardous Liquids Pipelines; and Appendix 3: Review and Summary of Voluntary Consensus Standards for Best Practices Related to Communicating Emergency Response Plans and Their Effectiveness. These appendices can be found online at www.trb.org by searching for *HMCRP Report 14*.

CHAPTER 1

About the Guide

Purpose and Scope

Pipeline incidents can have negative consequences for life, property, and the environment. Analysis of previous incidents indicates that communication (the exchange of information) is crucial in the early stages of a pipeline emergency. Challenges may include recognition of the pipeline emergency, identification of the appropriate pipeline operator, and passing information back and forth from pipeline operators to emergency responders in the field. The need to focus on communication needs in pipeline emergencies is critical to produce a favorable outcome, and must be planned prior to an incident.

This guide's scope is limited to pre-incident planning for communication between local emergency responders and pipeline operators. It only addresses communications, and does not address operational aspects of pipeline response. The target audience is personnel tasked with developing plans for responding to pipeline emergencies, regardless of their affiliation, as well as those responsible for communicating applicable information in the plans to appropriate emergency responders and agencies. The focus is on lessons and observations from actual incidents and response scenarios to inform the need to identify communication procedures ***before*** *an incident.*

In this guide, the research team provides suggestions for a common basis of understanding and organizing communications necessary to respond to pipeline emergencies. It is intended to "bridge the gap" between the pipeline operators and the emergency response community, defined primarily as those local public safety agencies that make initial response to reported pipeline emergencies: fire, police, and emergency medical services.

The purpose of this guide is to

- Fill a gap between the emergency response literature for pipeline emergencies and the intent of regulation and good practice that encourages local public emergency response organizations to become familiar with the pipeline operators in their response areas.
- Assist pipeline operators in better understanding the needs of the emergency response community.
- Assist emergency responders in better understanding the needs of pipeline operators.
- Help form a common basis for local emergency services and pipeline operators to engage in a dialogue around the transfer of critical information both prior to and during a pipeline emergency.

Each agency or organization that responds to a pipeline emergency has information needs that are unique. Terminology differs between pipeline operators and emergency responders, and even between emergency response organizations. The ability to share critical information with the right organization at the right time is the key to a successful response. For pipeline operators, the guide provides a framework for understanding the complexity and variation in emergency responder information needs, as well as for understanding the tremendous variation in capacity and organization across the United States. For emergency responders, the guide provides a framework for understanding pipeline operator information needs.

Of course, communications for such a complex and specialized emergency requires considerable planning and preparation. This guide provides the information necessary to begin or improve the process in your community. Information needs elicited from both pipeline operators and emergency responders in response to actual pipeline emergencies and in planning activities associated with potential pipeline response scenarios are included. The guide also reflects lessons learned from an analysis of actual pipeline emergencies.

References to emergency response in the role-based scenarios are made to inform and motivate the need for pre-incident communications planning. The use of role-based information allows the reader to generalize across multiple contexts, and recognize the variation in responsibilities across different organizations, which can vary depending on the stage of the incident, and the circumstances particular to any individual event.

The research team recommends applying this process at a local level, to reflect variations in local operating conditions and hazards. Then, incorporate the findings of local planning efforts into local emergency operations plans. These finding will also become part of emergency planning training and exercises in your local jurisdiction.

Limitations

This guide is a pre-emergency guidance tool. It is only for use during the planning phase of an emergency response. Pipeline incidents may be complex and involve many organizations and individuals who do not routinely work together. The guide provides suggestions only for that purpose. While there is considerable difference in terminology within disciplines and even organizational responsibilities throughout the country, this guide portrays common roles and responsibilities.

Although federal pipeline regulation is common across the United States, state-level regulations may vary in the requirements placed on pipeline operators and emergency responders. Locally, different levels of resources may be available to assist in the event of a pipeline emergency. The guide intends to provide general guidance, and does not explicitly address these differences.

Finally, the guide attempts to deal with pipelines carrying multiple products and modes of operation. The guide, by necessity, generalizes in order to summarize and draw conclusions and develop guidance. The guide is not a substitute for knowledge of local pipeline operations or reliance on expertise of local, state, and federal organizations who serve your area.

How to Use the Guide

This guide is designed to facilitate the planning process for pipeline emergency response. It is designed to be a reference for emergency responders such as local police, fire, and emergency medical services, and public safety emergency communications (9-1-1) centers. The guide is also intended as a planning resource for pipeline operators to help them identify and work with local emergency responders to prepare for potential incidents.

The guide consists of five chapters:

- Chapter 1: About the Guide
- Chapter 2: Introduction: Why Plan for Communications at Pipeline Incidents
- Chapter 3: Decisions, Roles, and Organization Affiliations: The Role Determines the Decisions and Information Needs
- Chapter 4: Developing and Exercising the Communications Plans
- Chapter 5: About the Project

It also includes a reference list and three appendices:

- Appendix 1: Contractor's Final Report for HMCRP Project 15
- Appendix 2: Summary of Current Federal, State, and Representative Local and Tribal Regulations and Ordinances Governing Emergency Response Plans for Natural Gas and Hazardous Liquids Pipelines
- Appendix 3: Review and Summary of Voluntary Consensus Standards for Best Practices Related to Communicating Emergency Response Plans and Their Effectiveness

These appendices are unpublished herein but can be found online at www.trb.org by searching for *HMCRP Report 14*.

Although the guide is written to be concise, the relevant chapters can be consulted directly for additional information. It is not necessary to read the entire guide before proceeding.

CHAPTER 2

Introduction: Why Plan for Communications at Pipeline Incidents

Selected Characteristics of Pipelines

Minor pipeline incidents occur frequently and are handled safely and effectively by pipeline operators and the emergency response community. However, there are also pipeline emergency scenarios, such as those involving transmission pipelines, which have the potential to quickly escalate into high consequence events. As low frequency/high consequence events, first responders and pipeline operators are sometimes not fully prepared or cognizant of the effort necessary or procedures needed to successfully respond to this type of incident (*1*). Pipeline emergencies can be inherently complex events, requiring the coordination of multiple response agencies and organizations, and having both short-term and long-term impacts that go well beyond the response phase of the incident.

Analysis of past pipeline incidents indicates that communication in the first critical minutes of an event—most often communication between emergency responders and pipeline operators—is critical to determining the outcome of an incident. Incomplete, inadequate, or unclear communication can result in a delayed response, and can contribute to human casualties, excess release of hazardous substances into the environment, and excess property damage.

Challenges to communications include failure to recognize the potential involvement of a pipeline in a release scenario, inability to identify the product(s) that are being released, and not knowing when or whom to notify to respond to the release.

About Pipelines

Pipelines are a highly efficient means for moving large quantities of both hazardous liquid and natural gas materials. An estimated 70 percent of petroleum products travel via pipeline (*2*). As such, pipelines are a crucial component of America's energy system. Although certain parts of the country have greater concentrations of pipelines, the overall mileage of pipelines is extensive and touches every state. Table 2.1 shows data on pipeline mileage by type of pipeline. The greatest mileage is found in natural gas distribution lines, which are used to deliver natural gas directly to consumers. Oil and hazardous liquids pipelines account for just over 185,000 miles of the 2.6 million miles of pipeline in the United States.

Types of Pipeline: Product and Function

While all pipelines have many commonalities, they can be classified by either function or by the product(s) they are designed to carry. In this section, the research team provides a high-level overview that can be useful for understanding pipeline differences.

Pipelines by Function

Pipelines can be classified according to their function. Regulatory definitions may be complex, and the reader should refer to the Code of Federal Regulations for complete definitions. Pipelines are classified as follows:

Gathering. Gathering *pipelines* transport gases and liquids such as oil or natural gas from the commodity's source—like rock formations located far below the drilling site—to a processing facility, refinery or a *transmission line* (49 CFR 195.2). Storage facilities exist that may receive shipments from multiple gathering pipelines. The shipments are then stored in tanks. Producers of the product may own gathering pipelines. Gathering pipelines can be found transporting product from multiple production sites to regional storage facilities.

Transmission. A transmission line is a pipeline used to transport natural gas from a gathering, processing, or storage facility to a processing or storage facility, large volume customer, or distribution system. A large volume customer may receive similar volumes of gas as a distribution center, and includes factories, power plants, and institutional users of gas. The term, transmission line, also refers to a pipeline used

Table 2-1. Types of pipeline and mileage (2012).

Type of Pipeline	Mileage
Hazardous Liquid	185,425
Natural Gas (Gathering)	16,288
Natural Gas (Transmission)	302,776
Natural Gas (Distribution Mains)	1,246,248
Natural Gas (Distribution Service Lines)	891,954
Grand Total	2,642,691

Source: Pipeline and Hazardous Materials Safety Administration. (http://phmsa.dot.gov/portal/site/PHMSA/menuitem.7c371785a639f2e55cf2031050248a0c/?vgnextoid=3b6c03347e4d8210VgnVCM1000001ecb7898RCRD&vgnextchannel=3b6c03347e4d8210VgnVCM1000001ecb7898RCRD&vgnextfmt=print).

to transport crude oil from a gathering line to a refinery and refined products from a refinery to a distribution center. The term is often used to describe hazardous liquids pipelines. (http://primis.phmsa.dot.gov/comm/glossary/index.htm?nocache=9525#TransmissionLine see also 49 CFR 192.3).

Indeed, some transmission pipelines traverse the entire continent. Transmission lines, especially those covering long distances, are often owned by specialized companies whose sole function is the operation of these specialized components of the pipeline infrastructure. Transmission pipelines are of larger diameter, and have greater flows and pressures than other types of pipelines. Because of this, they have the potential for greater consequences in the event of a release.

Distribution. Distribution pipelines are unique to natural gas systems. Distribution pipelines are used to deliver the product to end-users or customers. Storage facilities and transmission lines feed these lines. Distribution lines have the smallest diameter. While distribution lines are more frequently involved with leaks, the consequences are more limited, but because they tend to be in populated areas, they may be more likely to threaten structures and people.

The research team distinguishes between transmission and distribution pipelines in some places of this guide. The response scenario, the differing operating environments, and the characteristics of each pipeline can have an effect on communication needs and the entities involved in responding to a pipeline emergency.

Pipelines by Product Carried

Although pipelines have many common characteristics, an important distinction is based on the products they are designed to carry. Different products require different pipeline operating processes and characteristics. The physical characteristics of gases versus liquids will determine operating pressures and flow characteristics. These differences ultimately affect pipeline design and operations. That is, a pipeline designed to carry natural gas would not typically be able to carry a liquid such as crude oil or refined products. However, the same liquid pipeline may be used for multiple liquid products. For example, a pipeline from an oil refinery to a distant storage tank distribution facility can be used to send different grades of gasoline, diesel fuel, or heating oil.

Shipments through a liquid pipeline are sometimes referred to as "batch" systems because different grades or types of product may be shipped through the same pipeline at different times in so-called batches. The batch system is very common in liquid pipelines. The mixing that occurs between different grades of product is known as "transmix." Depending on the nature of the product and its end-use, the transmix may be subject to additional treatment before being sold or used (*3*).

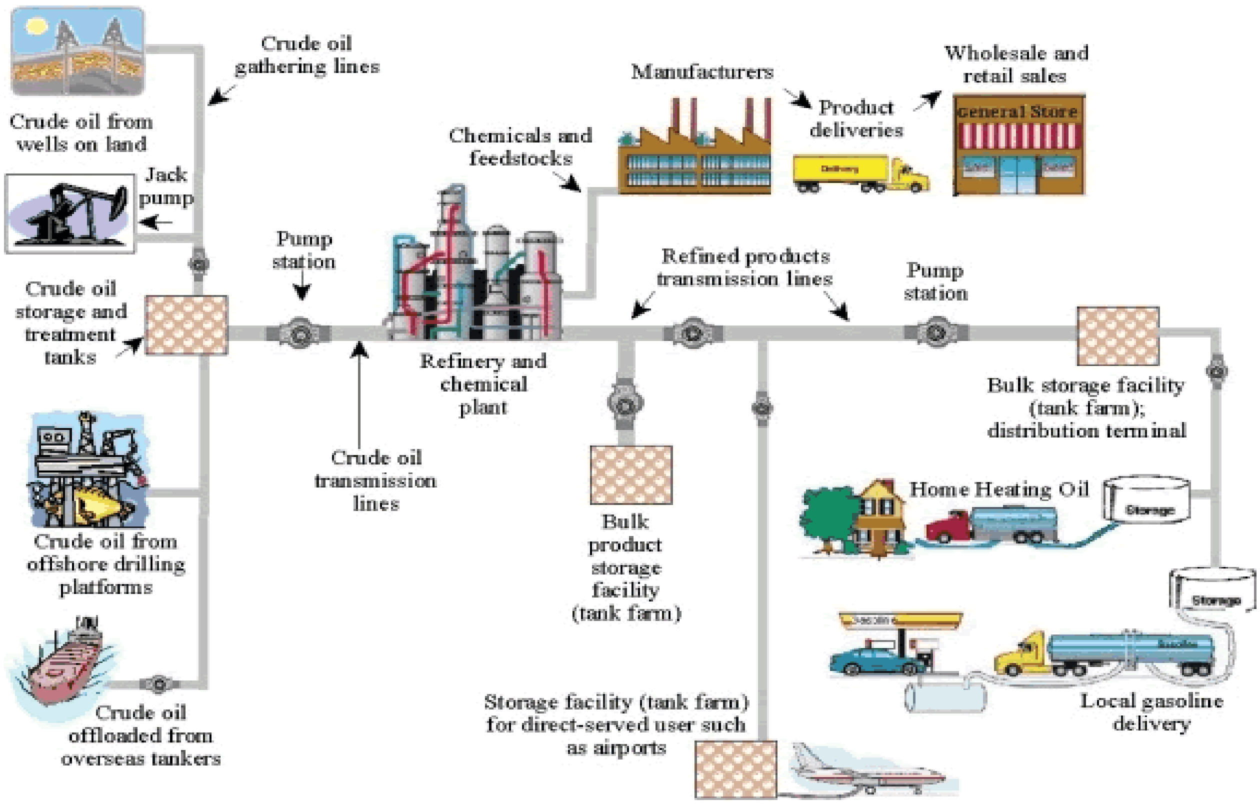
Characteristics of Pipeline Systems

Figures 2-1 and 2-2 provide the layout and overview of petroleum product and natural gas pipeline systems, respectively. Both diagrams move from production on the left to consumption on the right. The raw material is produced, either from wells or introduced to the system from a tanker or other external source. From there, the material is stored and may undergo some basic processing to remove contaminants. Next, the product enters the transmission line and goes either to a refinery or processing plant. The hazardous liquid or natural gas is transported from the refinery or processing plant through the transmission line. The product is kept moving along the line either through pumps (liquid lines) or compressors (natural gas) located along the route. Large liquid volume customers may access product directly from the transmission line, but most users receive the product from a storage tank distribution facility. Natural gas customers generally receive product through the local distribution pipeline system, which is usually operated by a local utility. Odorant can be added to natural gas at the city gate as shown, but is also required in some transmission pipelines in heavily populated areas. Please refer to regulations for specific details.

Pipeline Operations

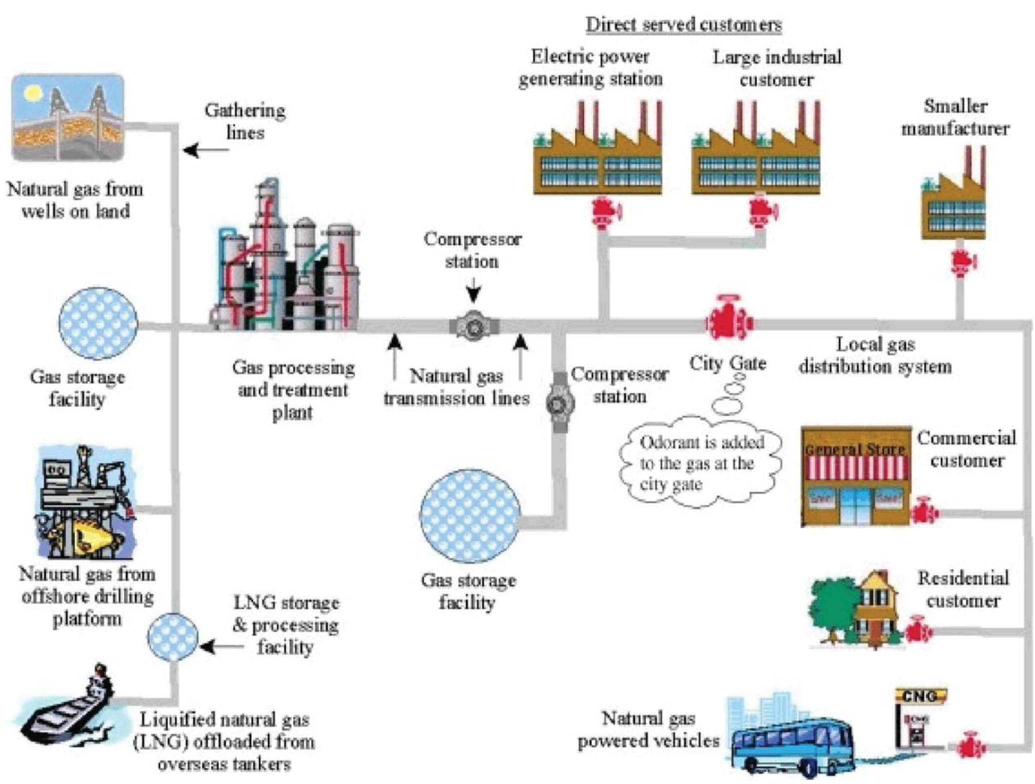
Pipeline operations are highly specialized and overseen by personnel working throughout the system. While maintenance personnel and limited operations staff work in the field, most control operations are centralized at the pipeline's "control room."

Control rooms oversee routine and emergency operations of the pipeline. In the past, many functions relied on personnel located in the field to perform readings, monitor equipment, and open and close valves. Today, many of these functions are carried out remotely, from a centralized control room, using sophisticated monitoring and operation systems and software.



Source: PHMSA "Petroleum Pipeline Systems."
http://primis.phmsa.dot.gov/comm/PetroleumPipelineSystems.htm?nocache=6756

Figure 2-1. Petroleum pipeline systems overview.



Source: PHMSA "Natural Gas Pipeline Systems."
http://primis.phmsa.dot.gov/comm/NaturalGasPipelineSystems.htm?nocache=464

Figure 2-2. Natural gas pipeline systems overview.

Supervisory Control and Data Acquisition (SCADA) systems describe a distributed network of sensors and associated controls. These systems monitor the status of gates and valves, flow of product, pressures, and other operating characteristics. These SCADA systems for pipelines are extensive, and automate many functions of pipeline operation.

Computational pipeline monitoring (CPM) systems use sensors to monitor flow, mass balance, and other pipeline operating characteristics to detect leaks. These systems compare pipeline flows at various stages along the pipeline, and attempt to reconcile differences across these locations.

Control room personnel rely on SCADA and CPM systems to monitor the status of the pipeline and detect abnormal conditions. The highest priority is to identify a leak or unsafe condition as quickly as possible. In many cases, the control room operators must interpret multiple sources of information to infer that a leak has occurred. Reports from field personnel, the public, or emergency responders can help speed this process.

Even when a leak is detected, the proper valve or valves must be closed. All valves are not capable of being remotely operated which may require field personnel to drive to a location and manually operate valves. The flow of residual product may continue for some time even after valves are closed.

Although extensive technology is in place to monitor pipeline operations and identify leaks along the pipeline, depending on the pipeline size, location, and product involved, it may be difficult to initially detect a leak or its specific location. According to PHMSA data, public or emergency responders discover a significant percentage of pipeline leaks after a report from the public (*4*).

Please refer to *Pipeline Emergencies, Second Edition*, for a more complete introduction to pipelines and operational concerns of emergency response. This resource is available free of charge online and as a downloadable smart phone "app" via the National Association of State Fire Marshals and U.S. DOT at http://www.pipelineemergencies.com (*5*, *6*). For additional information on pipelines go to http://www.pipeline101.com and http://pipelineemergencies.com.

Review of Significant Pipeline Incidents: The Critical Role of Communication

Communication at pipeline emergency incidents is complex, and includes communication within pipeline companies, between pipeline companies and emergency responders, among emergency response organizations, and between the public and PSAP/Dispatch. This web of organizations and their communication flows illustrates the complexity of communications for pipeline emergency response. Each of the parties plays an important role, and the effectiveness of communication between and within the roles is crucial to the successful response to a pipeline emergency (Figure 2-3).

Emergency responders must quickly identify the product involved, which is a key piece of information particularly where multiple pipelines may be in the area or within a common pipeline right of way. Knowledge of the pipelines and products carried can greatly ease the process of determining that a call about an unknown odor, sound, or other physical manifestation of a release is a pipeline emergency. This knowledge can shorten the time to notify the pipeline operator and to dispatch appropriate public safety and industry resources.

Analysis of Major Incidents

By studying past incidents, one can learn about areas for improvement for emergency response. Relying on reports from regulatory agencies and oversight bodies, such as the

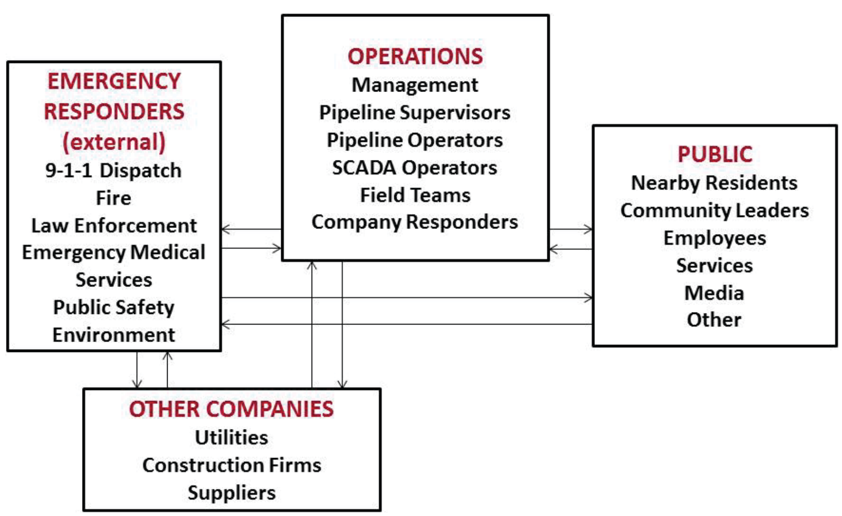


Figure 2-3. Roles, organizations, and communication flows.

NTSB, can drive improvements in safety through a mix of technological improvement, advancing industry practices, and regulatory actions. This guide relied primarily on post-incident investigative data from the PHMSA and the NTSB. The NTSB data was limited to major incidents. In addition to this data, the study involved interviews, surveys, and meetings with groups of professionals representing pipeline operators, state and federal regulators/emergency responders, public safety communications centers, and public emergency response organizations.

In examining NTSB reports for the 32 most recent major pipeline incidents (1994–2012), one can see a pattern of failures that contributed to excess losses. Fifty-nine percent of major incidents had one or more deficiencies identified in the NTSB reports that contributed to those outcomes.

The incidents are listed in Table 2-2. The incidents collectively resulted in 84 fatalities, 310 injuries, and losses in excess of $1.1 billion (2012 dollars). These incidents occurred in 25 states.

The research team analyzed the critical incidents identified in the previous discussion to determine contributing factors related to this study. The team selected the following categories to classify incident-related deficiencies. Multiple deficiencies were possible for a single incident. Table 2-3 summarizes

Table 2-2. Summary of losses from major pipeline incidents 1994–2012.

Incident Date and Location	Number of Fatalities	Number of Injuries	Total Cost of Damages ($M)	Total Cost Current Value (2012) $M
2012 Sissonville, WV	0	0	Not available	Not available
2010 Marshall, MI	0	320*	>$760	$760
2010 San Bruno, CA	8	15	$44.0	$46.0
2008 Rancho Cordova, CA	1	5	$0.27	$0.29
2008 Plum Borough, PA	1	1	$1.00	$1.1
2007 Carmichael, MS	2	7	$3.38	$3.8
2005 Bergenfield, NJ	3	4	$0.86	$1.03
2004 Kingman, KS	0	0	$0.68	$0.8
2004 DuBois, PA	2	0	$0.80	$0.98
2003 Wilmington, DE	0	14	$0.30	$0.37
2003 Glenpool, OK	0	0	$2.36	$2.9
2002 Cohasset, MN	0	0	$5.60	$7.2
2000 Winchester, KY	0	0	$7.10	$9.5
2000 Greenville, TX	0	0	$18.00	$24.1
2000 Chalk Point, MD	0	0	$71.00	$95.2
2000 Carlsbad, NM	12	0	$1.00	$1.34
1999 Knoxville, TN	0	0	$7.00	$9.64
1999 Bridgeport, AL	3	6	$1.40	$1.93
1999 Bellingham, WA	3	8	$45.00	$62.0
1998 South Riding, VA	1	3	$.025	$0.35
1998 Sandy Springs, GA	0	0	$3.20	$4.48
1998 Saint Cloud, MN	4	11	$0.40	$0.56
1997 Indianapolis, IN	1	1	$2.00	$2.85
1996 Tiger Pass, LA	0	0	Not available	Not available
1996 San Juan, PR	33	69	$8.50	$12.5
1996 Murfreesboro, TN	0	0	$5.70	$8.38
1996 Lively, TX	2	0	$0.22	$0.32
1996 Gramercy, LA	0	0	$7.00	$10.29
1996 Fork Shoals, SC	0	0	$20.50	$30.14
1994 Waterloo, IA	6	7	$0.25	$0.39
1994 Edison, NJ	1	93	$25.00	$38.70
1994 Allentown, PA	1	66	$5.00	$7.74

*Note: Includes people experiencing symptoms of exposure to oil.

Table 2-3. Common deficiencies identified in pipeline incidents 1994–2011.

Deficiency	Percent of Incidents (Number)
Delayed notification to pipeline operator	19 percent (6)
Delayed notification to emergency responders	25 percent (8)
On-scene coordination problem between pipeline operator and emergency services	6 percent (2)
Delayed action by pipeline operator	9 percent (3)
Emergency service on-scene problem	13 percent (4)
Pipeline operator on-scene problem	3 percent (1)
Other deficiencies not noted above	13 percent (4)

Note: Percentages are greater than 100 due to multiple contributing factors for some incidents.
Source: Analysis of NTSB reports.

the categories used and their frequency of occurrence in the 32 incidents. Nearly 60 percent of major incidents had some deficiencies in incident management.

In summary, the most common problems are failure to promptly notify emergency services or the pipeline operator, followed by delayed action by a pipeline operator. The findings from the pipeline incident reports showed that delays in the initial notification to both emergency responders and/or pipeline operators are dominant, but that on-scene issues of coordination or proper action on the part of pipeline operators or emergency services also occurred at over 20 percent of incidents. Improved communications, both during the planning and response phase of incidents, would influence nearly all of the deficiencies noted.

Communication Characteristics in Pipeline Emergencies

There are several ways to characterize communication issues during pipeline incidents. These are summarized as follows:

Timeliness. Timeliness is multi-dimensional and encompasses many functions. It pertains to the time it takes to recognize and identify a pipeline release, to determine its specific location, to isolate the product flow, and to control any release. It also refers to how quickly emergency responders are notified, arrive on the scene, and initiate response strategies and tactics to reduce the consequences and impacts of the incident. This could include isolation of the area, initiating public protective actions (evacuation or sheltering-in-place), leak and spill control, vapor suppression, and fire extinguishment.

Although pipeline operators maintain sophisticated systems for monitoring pipeline flows and pressures and detecting leaks, incident experience suggests that small leaks may not be initially detected through these control systems. Even in cases of significant releases, direct observation by the public, pipeline personnel or contractors, and public emergency responders accounts for well over one-half of all first reports of releases, according to a study commissioned by PHMSA (*4*). This means that information flow from the public and emergency responders, which is typically routed through public safety communications centers, often represents the initial notification. The timely ability to identify a pipeline emergency is the most important step in the incident management process.

Extent of The Release and Initial On-Scene Conditions. Information on the extent of the release may not be readily apparent to emergency responders or even pipeline control room operators. On-scene emergency personnel need to be able to visually confirm that a release has occurred and provide an initial estimate of the magnitude of the spill or leak. This critical information is also necessary for initiating public protective actions, including decisions to evacuate civilians and summon additional resources to the scene. For example, in the Bergenfield, New Jersey, incident, public safety units and the pipeline operator were on the scene of an outside leak from a gas distribution pipeline. However, they did not anticipate that the natural gas could migrate underground into nearby structures. No evacuation was undertaken, and as a consequence, three people were killed when an explosion resulted (*7*).

Contacting a local one-call center by dialing 8-1-1 before engaging in any digging activities helps avoid excavation damage to pipelines. When pipeline damage does occur, the responsible party must promptly report the emergency to 9-1-1. Several major incidents were identified where delays in notification led to increased incident damage and severity. First-hand observations of contractors, who may have detailed information on the location of a leak or site hazards, were often lost as workers reported the emergency to their supervisors or third parties rather than directly alerting public safety emergency responders using 9-1-1 (*8*).

Ideally, the public safety emergency communications center can ascertain that a pipeline is involved, begin making notifications early in the incident, and begin the coordination of multiple public emergency responder agencies. In some cases, other utilities may have underground infrastructure that crosses, or even shares right of way with a pipeline. Communication among different utility companies has been identified as a problem in some incidents, that is, a problem in one utility has affected the stability of an adjacent pipeline.

Human Behavior and Communication Failures

Behavioral factors can influence the flow of information and must be anticipated in the design and implementation of communications systems, especially during the initial assessment, alerting, and notification phases. For example, in the Marshall, Michigan, incident, the NTSB identified "confirmation bias" as a factor that inhibited communications between PSAP/Dispatch operators, the public, and emergency responders (*9*). Confirmation bias occurs when strongly held beliefs prevent people from paying attention to subsequent communications (*10*).

Combating confirmation bias is especially important when call takers and public safety emergency communications dispatchers may be accustomed to receiving calls for minor natural gas leaks or odors, and unintentionally rule out the possibility of a major pipeline emergency.

Other behavioral factors include what influences people to trust or defer to certain sources of information over others, as well as how people interpret high risk situations and response scenarios (*11*, *12*). People will sometimes underestimate or deny the presence of significant hazards and extreme risks (*13*).

People also tend to view emergencies from the perspective of their own roles. This can interfere with the likelihood that they will attend to the information needs of people in other roles who must respond to a pipeline emergency. Research about pipeline emergencies revealed that the two most likely ways in which information is not provided are (1) the information is not collected in the first place and (2) the information is sent too late. Both of these failure modes reflect preparedness problems among persons who are the sources of information. Persons who should transmit information may be unaware that someone else needs it, or they may simply be so caught up in their immediate responsibilities that the information is not sent early enough in an incident.

Public Safety Emergency Responders: Learning About Pipelines in Your Service Area

As described in the previous section, knowing the locations and products carried in pipelines in a community is the single most important step in preparing for a potential incident. Visual clues, such as markers, can also provide assistance in locating pipelines. However, distribution pipelines may or may not be marked, or are not marked as well as larger lines are marked.

An agency should begin with the PHMSA National Pipeline Mapping System (https://www.npms.phmsa.dot.gov/) to find out what hazardous liquid or gas transmission pipelines are running in a particular area. Representatives from public safety emergency response organizations can get an account that will permit access to the detailed maps for their respective county or jurisdiction. In addition to this tool, readers can search for organizations operating pipelines by state, county, or zip code using https://www.npms.phmsa.dot.gov/FindOperator/PublicSearch.aspx. This system allows public safety emergency responders to identify companies operating in their response area, enabling emergency response agencies to make contact with the pipeline operator and get additional information.

The PHMSA mapping system does not include distribution or gathering pipelines. Public safety emergency response agencies will need to contact their local gas utility for more information on these pipelines. In addition, networking with oil or gas producers should identify gathering pipelines, if such activities are ongoing in their area. Once this initial assessment is made, the pipeline operators should be contacted to verify the routing of pipelines and the products carried.

Pipeline Operators: Learning About Emergency Responders in Your Service Area

Pipeline systems traverse numerous political subdivisions and entities. An important, if not primary, piece of information for pipeline operators is to know how to contact the PSAP or dispatch facilities serving public emergency responders located along pipeline right of way. This requires knowing the 10-digit direct-dial number for each facility. Jurisdiction of law enforcement, emergency medical services, and fire services may not be the same, and some jurisdictions may even overlap. While the trend in many parts of the country is to consolidate emergency communications on a countywide basis, this practice is far from universal, and many variations exist. The National Emergency Number Association (NENA) offers a service to provide such contact information for pipeline operators.

Another key piece of information is to know the capabilities of public emergency responders protecting portions of pipeline. It is critical to establish personal relationships with representatives of key public safety agencies along the pipeline right of way. Depending on the product carried and capacity of the pipeline, specialized response equipment and resources may be necessary to respond in a safe manner. Resource demand for such an incident will commonly require the services of multiple agencies summoned under mutual aid agreements for all but the largest public safety agencies. The "Emergency Response Capability Database and Reporting Tool," operated by the Pipeline Association for Public Awareness (http://www.pipelineawareness.org/welcome-government-and-emergency-officials/response-capability-survey-reporting-tool/), is one measure that provides this information on a voluntary basis.

The Pipeline Regulatory Framework: How It Relates to Planning for Communications and Response

Federal, State, and Local Regulatory Roles

Federal, state, and tribal authorities share responsibility for pipeline safety and emergency planning oversight. Federal pipeline safety regulations require pipeline operators to carry out specific pipeline emergency planning activities, including written emergency response plans and requirements for communication of emergency plans to fire, police, and other government officials.

Nearly all states and the District of Columbia have elected to adopt by reference federal pipeline safety regulations. Through agreements with the U.S. DOT and the Office of Pipeline Safety (OPS), these states have an assigned pipeline inspection and enforcement entity.

More information on specific pipeline regulations is contained later in this guide. This guide summarized salient federal and state regulation; it is necessary for users to verify state and local regulation that may exist in their communities.

Several federal regulations require emergency plans and response procedures [Code of Federal Regulations (CFR) 2012, Titles 30, 40, and 49], including the following:

- Notification of appropriate fire, police, and other public officials and coordinating response
- Pipeline controller emergency procedures
- Evacuation plans for pipeline facilities must be coordinated with local public safety officials
- Disclosure of hazards, layout, facilities, and quantities of materials present at facilities

Thirteen states have additional emergency planning or response requirements in place. These range from filing federal plans with the appropriate state agency to more elaborate requirements including the following:

- Notification of appropriate local emergency response agencies
- Annual meetings with fire departments along the right of way
- Cooperation with training local responders
- Notification of schools located within 1,000 feet of a pipeline, providing information on the location of the pipeline, products transported, designated emergency number for the pipeline operator, and information on excavation notification, recognition, and procedures to follow in the event of a leak.

Although some states have additional regulatory requirements, only some of these requirements directly pertain to emergency response. For the most part, state notification requirements are not well defined, and are not standardized or specific with regard to how notifications shall occur. The PHMSA maintains links on its website to each state pipeline regulatory office.

Recent Regulatory Activity and Developments Concerning Communications

The PHMSA issued an Advisory Bulletin October 11, 2012 (Federal Register, Vol. 77, No. 197) directing pipeline operators to make direct contact with the appropriate PSAP for any indication of a pipeline emergency (*14*). This advisory is designed to help the pipeline operator confirm an emergency or to provide assistance and information to public safety personnel who may be responding to the event. Notification of the appropriate PSAP may be challenging due to the large number of PSAPs that may be responsible for portions of a pipeline. NTSB issued this advisory as a result of its investigation of the San Bruno, California, gas pipeline rupture and explosion on September 9, 2010 (*15*).

Shortly after this advisory was issued, NENA, a trade group for the public safety 9-1-1 centers, announced a service to provide contact information for PSAPs mapped to pipeline routes (http://nenapipedb.com/).

Among its many provisions, the federal law, Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, (CFR 49 Public Law 112-90 2012) requires that, within 18 months of the date of the legislation, the U.S. DOT establish time limits of 1 hour or less for telephone or electronic notification of the DOT and the U.S. Coast Guard's National Response Center (NRC) (*16*). This will impact owners and operators of gas and hazardous liquid pipeline systems and liquefied natural gas (LNG) facilities. The legislation reflects the following:

- Prompt, accurate communication about the estimated extent of damage for pipeline accidents or incidents to the National Response Center (NRC) is already required.
- PHMSA's new rule will establish specific time limits for telephone or electronic notification to the NRC about pipeline accidents or incidents.
- Notification will be established as being not later than 1 hour after confirmed discovery of an accident or incident, and information communicated must include:
  - Name of the operator
  - Name of the person making the report
  - Telephone number of the person making the report
  - Location of the incident
  - Number of fatalities and injuries
- Revision of initial telephonic or electronic notice to the NRC will still be required within 48 hours regarding the amount of product released, the number of fatalities and injuries and any other significant changes.

Finally, the U.S. Government Accountability Office recently provided testimony before the Senate suggesting the development of performance criteria for pipeline operators who arrive at incidents (*17*). These recent developments suggest that refinements to pipeline emergency response are recognized as a concern by both the legislative and executive branches of the federal government. Additionally, both the pipeline and emergency response communities are working to improve pipeline emergency response.

CHAPTER 3

Decisions, Roles, and Organization Affiliations: The Role Determines the Decisions and Information Needs

Common Decisions

Safe and effective response to a pipeline emergency requires timely and clear communication. Communication is defined as the exchange of information among people. The information and the method of communication during a pipeline emergency depend upon the response and mitigation role played by individual people within their respective organizations. Roles determine decisions and information needs. It is important to distinguish between *role* and *organization*. Table 3-1 shows key roles and organizations that typically perform these roles.

Common decisions that need to be made at a possible pipeline incident include the following:

- Do we have a pipeline emergency?
- Where is the leak or release?
- Whom do we notify?
- Is there an immediate life or property threat?
- What specialized resources are needed; where will we get them?
- Should we shut down the pipeline?
- Do we need to start an evacuation or other public protective action?
- Will state or federal resources be required?

Each of these decisions must be made for each incident. Critical information is required to make these decisions. Often this critical information will be mediated through public safety communications (PSAP/Dispatch) centers. The management of a pipeline emergency depends on knowing what information is needed, who needs it, when they need it, and how they can obtain it. Failure to plan these aspects of communications, before an incident, can cause delays in getting the appropriate resources to the scene, increase risks to both emergency responders and the public, and increase the severity and resultant impacts of the incident.

Key Roles in Pipeline Emergencies

Roles Refer to Specific Operational Responsibilities Or Functions. The use of roles is contrasted with organizational identity. There are two primary reasons for using a role-based approach within this document. First, organizational roles differ across the United States. Second, in spite of their primary or perceived functions, organizations may be involved in multiple roles at an incident. Likewise, multiple organizations may share responsibility or functional activity in a single role.

For example, evacuation is often considered primarily a fire or law enforcement role. However, depending on the nature of the incident and when assistance arrives, evacuation may be coordinated through the local emergency management agency and performed by occupants of buildings near the emergency, pipeline operators, emergency medical services, or almost any other responsible party.

The role determines the information needed at each particular point in the progression of an incident. Organizations may have a set of information as their primary interest, but their information needs may vary depending on the particular role they fulfill. For example, if evacuation is a priority in the initial stages of an incident, law enforcement may be deeply involved in alerting and removing occupants of nearby structures from the hazardous area. Once sufficient fire service resources arrive, their attention may shift to issues of traffic control or expediting access to the scene for certain resources, such as pipeline crews. All personnel performing a singular function or responsibility generally have similar needs for information, regardless of their organizational affiliation.

The roles in a pipeline emergency are listed below. These roles were used to define information needs and flows required to successfully manage a pipeline emergency. Well-defined

Table 3-1. Roles and organizations that typically perform these roles.

Role	Organizations
Initial Receipt of Notification by Pipeline Operator	-Pipeline Operator -Public Emergency Communications (PSAP)
Control of Pipeline Release	-Pipeline Operator -Fire Department
First Arriving Responder	-Law Enforcement Agency -Fire Department -Emergency Medical Service -Pipeline Operator
Public Safety Call Taking and Dispatch	-Public Emergency Communications
Public Protective and Response Actions	-Fire Department -Law Enforcement -Emergency Management -Pipeline Operator
Federal and State Support for Environmental Protection	-State pipeline regulatory agency -State environmental agency -U.S. Environmental Protection Agency -U.S. Coast Guard

roles enable entities to plan for communications by anticipating the information needed in an actual emergency.

Initial Receipt of Notification by Pipeline Operator

Although pipeline operators maintain sophisticated systems to monitor pipeline flows/pressures and to detect leaks or ruptures in their pipelines, research into previous incidents has shown first reports of an incident often come from the public, emergency responders, contractors, or field-based employees of the pipeline operator.

Control of Pipeline Release

Control of the pipeline release involves personnel charged with closing valves to isolate the release, or mitigate the effects of the release. These personnel may be pipeline control center personnel, field-based pipeline employees, or emergency responders on the scene of an incident.

First Arriving Responders

Emergency responders (operator personnel on-site or public agency) are generally the first trained personnel to arrive on scene during the initial stages of a reported incident. Personnel assigned to public safety response organizations, such as fire departments, police departments or, in the case of coastal water-based incidents, the U.S. Coast Guard, usually fill the role of first responder.

Public Safety Answering Point Call Taking and Dispatch (PSAP/Dispatch)

PSAP call taking and dispatch refers to the organization receiving and transferring 9-1-1 calls for a particular geographic area. These geographic areas usually coincide with political subdivisions such as counties, cities, towns, or other governing areas.

The call taking role may be shared among one or more organizations. The PSAP receiving the initial call may transfer the caller and information to a specialized call taking facility where additional details are obtained.

Dispatch is the last stage of this role. Information collected in the first phase of this process is used to determine the number and type of resources (personnel and equipment) required to respond to a reported incident. The dispatch process is ordinarily governed by locally determined protocols and procedures.

Notification of supporting agencies and organizations is another key function of this role and is usually undertaken at the point of dispatch. Supporting agencies can include the pipeline operator, specialized response resources, and state or federal agencies. Such notifications may also occur at the federal level through the NRC.

Incident Commander/Dispatch Resource Response Request

The Incident Commander/dispatch resource response request role refers to the interaction and coordination between the on-scene Incident Commander and the supporting PSAP/Dispatch center. In the early stages of the incident, the Incident Commander will likely be the local ranking senior fire officer. Both entities are charged with identifying the need for and source of additional resources and support for the management of the reported incident. Communication between the Incident Commander and dispatcher is critical to develop a common understanding of the incident (common operating picture), and is dependent on the flow of information between the Dispatch center and Incident Commander.

Interagency Coordination

Interagency coordination refers to the process of exchanging necessary information to ensure a coordinated response after multiple organizations are notified of a reported emergency. This coordination includes criteria such as (1) establishing a common operating picture; (2) comprehending the incident's magnitude, severity, and potential for escalation;

(3) understanding the resources required and where to obtain them; (4) having knowledge of an incident's likely progress (i.e., control of the release, quantity of materials released, threats to people, property, and the environment); and (5) awareness of regulatory requirements and informed decision making. The Incident Commander, PSAP personnel, and the pipeline operator often fulfill this coordination role. In significant incidents, this role may be fulfilled by the local emergency management agency working with the pipeline operator and other governmental agencies.

Public Protective and Response Actions

First arriving responders implement public protective and response actions to safeguard life, property, and the environment. Depending on the nature of a spill or release, the role may include (1) evacuation, (2) sheltering-in-place, (3) environmental assessment, (4) confinement of runoff, or (5) firefighting.

Federal and State Support for Environmental Protection

Environmental agencies at the state and federal levels play an important role in terms of (1) reporting of releases, (2) provision of expertise and support for mitigation of incidents, and (3) environmental restoration. On-scene support may be provided for large releases, or release of materials harmful to human health or the environment. Such support ranges from provision of technical specialist guidance to perform air monitoring, delivering specialized equipment.

The research team has described the roles necessary for the successful resolution of pipeline emergencies. The following subsections describe the roles of agency or organizational affiliations. Although agencies may typically fulfill a particular role at an incident, this does not mean they may not perform other roles depending on the circumstances of an incident. Knowing the agencies involved and the role or roles they are fulfilling is critical to understanding their information needs.

Types of Organizations

The organization of emergency services and the associated legal frameworks will vary across locales. The process of identifying the necessary roles and which organizations perform them is carried out locally during the planning phase.

Pipeline Operator. Pipeline operators are usually either private corporations or municipal governments. Organizational differences between pipeline companies depend on the type of pipeline operated. Pipeline categories are defined by their operating characteristics and purpose.

Pipeline operators are responsible for maintenance and operation of pipelines and related facilities, which may include pumping stations, valve locations, and storage and distribution facilities. In emergencies, they are responsible for isolating the product flow, providing emergency on-scene responders with pipeline expertise, resources, equipment, and support. Pipeline operators should be part of the unified command structure or have a liaison at the Incident Command Post (ICP).

Pipeline operations are coordinated from pipeline control rooms, which are typically distant from the incident location. Control room staff are responsible for pipeline operation, monitoring and controlling the flow of product through the lines and any associated storage and distribution facilities, as well as for responding to and correcting abnormal conditions (*3*).

Fire Service. Fire service refers to the provision of fire and rescue services by public fire departments. Fire departments provide different types and levels of specialized emergency services and this varies widely across the nation. While most departments provide basic fire and rescue services, others may provide emergency medical services, medical transport (ambulance) service, technical rescue, and hazardous materials (hazmat) response. Firefighting equipment also varies. Fire services may range from rural, all-volunteer organizations with minimal capabilities, to large, metropolitan fire services staffed with career personnel that provide a wide range of specialized emergency planning and response services. Hazardous materials capabilities may range from First Responder Operations-level responders, with minimal protective equipment and minimal detection capabilities, to a Hazardous Materials Response Team staffed at the HazMat Technician level.

Hazardous materials services provided can include fire suppression, standby for hazardous conditions, hazardous materials response, and initial evacuation or sheltering decisions carried out with the support of law enforcement and emergency management agencies.

Law Enforcement. Law enforcement refers to the local agency charged with answering criminal complaints and enforcing the local criminal code. Often, multiple agencies have overlapping jurisdictions. For example, a municipal police agency and a Sheriff's office or State Police may share the same enforcement area. Depending on the location and local organization and agreements among jurisdictions, any of these agencies may be the first responding law enforcement agency on the scene of a pipeline emergency.

Law enforcement agencies at a pipeline emergency are typically responsible for scene control and public protective actions. Their capabilities may be limited as they self-protect and identify materials or directly deal with the product released.

PSAP Call Taker. The PSAP call taker is the information entry point into the 9-1-1 system. These services are commonly provided at the county, parish, or major city level and, sometimes, are also provided in even smaller political jurisdictions. The call taker may be a representative of an independent public safety communications organization, emergency management, or public safety agency. The function of the call taker is to determine the nature of the problem (police, fire, or EMS), the jurisdiction involved, and then to transfer the call or information to the respective public safety dispatcher.

PSAP/Dispatch. Dispatchers may serve one function (police), reside in a combination center serving more than one service (fire, police, EMS), or have multiple dispatch centers that serve each service. The critical distinction of multiple dispatch centers is the need to recognize that (1) the call taker is probably not in direct communication with on-scene resources or the Incident Commander and (2) multiple dispatch centers may serve both police and fire, which means that information must be relayed to both services thereby introducing additional coordination challenges. In small agencies, a single person may fulfill both the role of call taker and the role of dispatcher.

Incident Command. Incident command refers to the on-scene responder in charge of the field response. This person is usually affiliated with a traditional public safety emergency response organization, and command may be transferred based on the size and nature of the incident. However, in certain circumstances, the initial on-scene Incident Commander may be a representative of the pipeline operator, or a state or federal response agency (e.g., U.S. Coast Guard). In this structure, pipeline operators may serve as a liaison to the Incident Commander.

Unified Command. Unified command will likely be employed at large or long duration incidents and entail key agencies collaboratively managing the incident. Under unified command of an incident, multiple agencies with different legal, geographic, and functional responsibilities interact effectively to manage, coordinate, and plan. Participants and procedures are usually identified in advance. Unified command would be ideal in a pipeline emergency because of the complex nature of these incidents.

Unified command is characterized by the following:

- A shared understanding of priorities and restrictions
- A single set of incident objectives
- Collaborative strategies
- Improved internal and external information flow
- Less duplication of efforts
- Better resource utilization (*18*)

The Incident Commanders within the unified command make joint decisions and speak as one voice. Incident Commanders work out differences before taking action. Unified command would customarily incorporate pipeline operator representatives.

Emergency Management Agency. The Emergency Management Agency is usually an "All Hazards" coordinating agency responsible for establishing and staffing the jurisdiction's Emergency Operations Center (EOC). The EOC serves as an off-site location for management of an incident to facilitate resource requests and to enable the formation of strategic objectives. Emergency Management Agencies are established at the state level and have a working relationship with the Federal Emergency Management Agency (FEMA) through its regional offices.

Locally, emergency management is usually organized at the county or city level. Smaller political entities may have emergency management functions assigned to fire or police departments and/or operate the EOC. Depending on the size or scope of the incident, multiple EOC's may be activated at the local, county, and state levels. Under principles of the incident command system, these centers would support the on-scene Incident Commander and pass resource requests from the lowest to highest levels.

State Pipeline or Environmental Agency. States retain authority over some aspects of pipeline operations and control environmental quality in areas not regulated by the federal government. Responsibility for pipeline safety varies widely given that each state has an environmental agency to lead environmental aspects of a pipeline spill or release.

Each state (except Alaska and Hawaii) has its own governmental entity responsible for oversight of pipeline operations and safety within that state. Some of these offices are administrative in nature while others have a field response or investigative role during or after an incident. Some states divide responsibility between two or more agencies, such as a Fire Marshal and Public Utilities Commission. Requirements for notification in the event of a pipeline release exist in almost all cases. For additional information, refer to the National Association of Pipeline Safety Representatives' 2013 publication, *Compendium of State Pipeline Safety Requirements and Initiatives Providing Increased Public Safety Levels Compared to the Code of Federal Regulations* (*19*).

Emergency responders should know their state's requirements and the procedure for notification of the state pipeline agency in the event of an emergency.

Principal Federal Agencies. The federal government has an important overarching role in pipeline incidents that result in release of oil or hazardous substances. While the on-scene role may be limited for smaller events, it has a critical role for reporting incidents and providing technical support. It is important to be aware of the federal structure, which is designed to support emergency response at the state and local levels. Two primary entities have a functional role in mitigation of, or support for, pipeline emergency response: the PHMSA and the National Response Team (NRT). Many other federal agencies contribute expertise.

PHMSA. PHMSA, within the U.S. DOT, is the principal federal agency regulating pipeline safety. It supports the response efforts of other agencies; however, its response role is limited. PHMSA's responsibilities include efforts to improve pipeline integrity; regulation of pipeline safety and risk; administration of a national pipeline inspection program, including operator requirements; and provision of technical assistance to state pipeline safety programs.

The NRT is the principal federal entity managing pipeline emergency response. The team structure comprises 15 agencies designed to harness the expertise and resources of federal agencies in support of local and state responders working to mitigate a pipeline emergency when there is an environmental threat. The team is authorized by federal legislation including the Clean Water Act (subsequently modified by the Oil Pollution Act of 1990), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the National Contingency Plan) (*20*). The first response would come from one of 13 Regional Response Teams (RRT) that are based throughout the continental United States, Alaska, Hawaii (and Pacific Islands), and Puerto Rico (and U.S. Virgin Islands).

The NRT is activated for incidents where major spills or releases overwhelm regional resources, pose a threat to the environment or property, or occur in an incident affecting multiple states. The lead federal official representing the NRT or RRT is known as the Federal On-Scene Coordinator (FOSC). These response teams are planning, policy-coordinating bodies whose primary role is to provide assistance to the FOSC during an event.

Separate reporting requirements exist for oil and hazardous substances. Federal guidance requirements are detailed under the CERCLA (CFR 2012, Title 40, Chapter 1, Environmental Protection Agency) (*21*) and the Clean Water Act. The Emergency Planning and Community Right-to-Know Act includes a list of hazardous substances and reporting quantities (*22*).

The NRC is the federal government's federal notification point for oil or hazardous substance spills or releases. Notification to the NRC begins the process of bringing federal resources to bear in emergencies through a FOSC who serves as the federal government's focal point for assessing the incident. Depending on the severity of the incident, actions can range from notification, monitoring, on-site assessment, or activation of the RRT or NRT.

U.S. Environmental Protection Agency. The Environmental Protection Agency (EPA) is also responsible for protecting human health and the environment from pollutants and chemical exposure resulting from industrial activity or other sources. The EPA is the lead agency for enforcement and regulation in several key areas related to consequence management in the event of a pipeline emergency.

The EPA participates in the federally organized RRTs and the NRT. The EPA administers numerous legal and regulatory programs for emergency response to oil or hazardous substance releases, including those resulting from pipeline incidents.

U.S. Coast Guard. The U.S. Coast Guard reports to the Department of Homeland Security during peacetime. It has a broad and diverse mission encompassing search and rescue, military support, border security and inspection, drug interdiction, investigation of maritime accidents, and response to environmental emergencies occurring in or adjacent to navigable waterways. It is organized into nine geographic districts, and has facilities located throughout these areas.

The U.S. Coast Guard's role as a federal agency is unique. It acts as a first responder for events that occur on or near waterways and, through the NRT, provides expert advice and assistance to state and local Incident Commanders for incidents resulting in release of oil or hazardous materials from a pipeline or other source that may impact a navigable waterway. The U.S. Coast Guard has special expertise in responding to such incidents because pipeline facilities often traverse waterways, and many terminals or petroleum processing facilities are located on or adjacent to waterways.

Key Information Needs

As the previous section indicated, it is important to plan for communication well before a pipeline emergency occurs.

The lists presented in Tables 3-2 through 3-11 are not exhaustive, but rather are designed to identify those pieces of information that are both critical AND likely missing or poorly communicated in the initial stages of an incident. The research team presents the source and destination for each of these critical information elements, and summarizes the information needs by major role, the "most important information you need" in that role and the "most important information you need to provide to others." Common sources for information are also provided.

Readers should view these tables as the basic information needs that the respective organizations need to receive and supply to others. The last column, "Decisions Where Information Needed," provides context for why the information needs are important to the management of the incident. These tables are a good way to define the information needs to initiate the pre-emergency planning process for pipeline emergency communication.

For example, in Table 3-2, it is known that pipeline operators need to rely on public safety dispatch to identify the locations of incidents. This means that pipeline operators must identify the dispatch centers serving their operating areas, and review the content and means for how to report information about the location of an incident.

Please refer to Appendix 2 for a complete enumeration of information needs.

Pipeline Operator

Table 3-2. Most important information you need.

Information	Sources	Role Where Information Needed	Decision(s) Where Information Needed
Location of incident	Public safety dispatch	Initial receipt of notification	Do we need to respond?
			Who do we send?
			What public safety agencies do we ask to respond?
Scene conditions (investigation by local responders); impact of hazard on environment, life safety and infrastructure	Investigation by local public safety responders via public safety dispatch	Initial receipt of notification	Do we need to respond?
			Do we shut down the pipeline?
			Where and how do we shut down the pipeline?
Amount of release	Investigation by local public safety responders via public safety dispatch	Control pipeline release	Do we shut down the pipeline?
	Pipeline employees	Control pipeline release	Where and how do we shut down the pipeline?

Table 3-3. Most important information you need to provide to others.

Information	Recipient	Function Where Information Needed	Decision(s) Where Information Needed
Material released, rate of release (diameter of pipeline)	Public safety dispatch	Dispatch/Incident Command resource request	What types of resources and how many should I request?
Scope, quantity & location of event (public affected, time to shut down)	Public safety dispatch	Interagency coordination	How do we establish coordination? What agencies will be involved?
State/federal agency notifications	State/federal regulatory agencies (e.g., National Response Center)	Interagency coordination	How do we establish coordination? What agencies will be involved?
		Federal and state support for environmental protection	

Public Safety Emergency Responder (Police, Fire, EMS)

Table 3-4. Most important information you need.

<table>
<tr><th>Information</th><th>Sources</th><th>Function Where Information Needed</th><th>Decision(s) Where Information Needed</th></tr>
<tr><td rowspan="2">Product identification and associated hazards</td><td rowspan="2">Physical observation
Public safety communications
Pipeline operator</td><td rowspan="2">First arriving responder</td><td>What are my initial actions?</td></tr>
<tr><td>Is this a pipeline incident?</td></tr>
<tr><td>Physical damage (Is excavation in progress?)</td><td>Physical observation</td><td>First arriving responder</td><td>Is this a pipeline incident?</td></tr>
<tr><td>Responder resource available (Personal Protection Equipment [PPE]/training)</td><td>Public safety communications</td><td>First arriving responder</td><td>Is this a pipeline incident?
Do I need additional public safety resources?</td></tr>
<tr><td>Consequences of non-entry to life safety, property, and environment</td><td>Physical observation</td><td>First arriving responder</td><td>What are my initial actions?</td></tr>
</table>

Table 3-5. Most important information you need to provide to others.

<table>
<tr><th>Information</th><th>Recipient</th><th>Function Where Information Needed</th><th>Decision(s) Where Information Needed</th></tr>
<tr><td rowspan="3">Scene conditions (investigation by local responders); impact of hazard on environment, life safety and infrastructure</td><td rowspan="3">Investigation by local public safety responders via public safety dispatch</td><td rowspan="3">Initial receipt of notification</td><td>Do we need to respond?</td></tr>
<tr><td>Do we shut down the pipeline?</td></tr>
<tr><td>Where and how do we shut down the pipeline?</td></tr>
<tr><td rowspan="2">Amount of release</td><td>Investigation by local public safety responders via public safety dispatch</td><td>Control pipeline release</td><td>Where and how do we shut down the pipeline?</td></tr>
<tr><td>Pipeline employees</td><td>Control pipeline release</td><td>Where and how do we shut down the pipeline?</td></tr>
<tr><td>Scope, quantity, type, location of release</td><td>Pipeline operator, On-scene responders via public safety communications</td><td>Environmental protection</td><td>Will Environmental protection agencies respond?</td></tr>
</table>

Environmental Protection

Table 3-6. Most important information you need.

Information	Sources	Function Where Information Needed	Decision(s) Where Information Needed
Scope, quantity, type, location of release	Pipeline operator, On-scene responders via public safety communications	Environmental protection	Will Environmental protection agencies respond?
Are oil or hazardous chemicals released?	On-scene responders via public safety communications	Environmental protection	Need to assess health effects/air monitoring?
	Pipeline operator, on-scene responders via public safety communications		Will state or federal environmental protection assets respond?

Table 3-7. Most important information you need to provide to others.

Information	Recipient	Function Where Information Needed	Decision(s) Where Information Needed
Will state or federal environmental agencies respond?	Public safety communications	Environmental protection	Need to assess health effects/air monitoring?

Public Safety Communications (PSAP/Dispatch)

Table 3-8. Most important information you need.

Information	Sources	Function Where Information Needed	Decision(s) Where Information Needed
Location	Public via 9-1-1 Pipeline operator	Public safety dispatch/call taking	What questions do I ask caller?
Severity of incident	Public via 9-1-1 Pipeline operator On-scene public emergency responder	Public safety dispatch/call taking	What resources do I dispatch?
			What questions do I ask caller?
Presence of possible ignition sources?	Public via 9-1-1 Pipeline operator On-scene emergency responder	Public safety dispatch/call taking	What resources do I dispatch?
			What questions do I ask caller?
Are there any injuries?	Public via 9-1-1 Pipeline operator On-scene public emergency responder	Public safety dispatch/call taking	What questions do I ask caller?
			What resources do I dispatch?

Table 3-9. Most important information you need to provide to others.

Information	Recipient	Function Where Information Needed	Decision(s) Where Information Needed
Location	On-scene public emergency responders Public or pipeline operator	Initial Incident Command	If pipeline incident confirmed, what type of resources and how many should I request?
	Pipeline operator	Public safety dispatch/call taking	What questions do I ask caller?
Material released	On-scene emergency responders	Dispatch/Incident Command resource request	What types of resources and how many should I request?

Incident Command/Interagency Coordination

Table 3-10. Most important information you need.

Information	Sources	Function Where Information Needed	Decision(s) Where Information Needed
Location	On-scene public emergency responders Public or pipeline operator via Public safety communications	Initial Incident Command	If pipeline incident confirmed, what type of resources and how many should I request?
Exposures/population density	On-scene emergency responders Public safety communications	Initial Incident Command	If pipeline incident confirmed, what type of resources and how many should I request?
Identification of material released	On-scene emergency responder Pipeline operator or public via public safety communications	Initial incident command	If pipeline incident confirmed, what type of resources and how many should I request?
Consequences of not evacuating on life safety	On-scene emergency responder Pipeline operator or public via public safety dispatch	Public protective action	Do we need to start public protective actions?
Number, physical condition, and locations of people affected	On-scene emergency responder Public safety communications	Interagency coordination	Do we need to start public protective actions?
			Can we and do we need to remove people from the hazardous area?

Table 3-11. Most important information you need to provide to others.

Information	Recipient	Function Where Information Needed	Decision(s) Where Information Needed
Scene Conditions (investigation by local responders); impact of hazard on environment, life safety, and infrastructure	Pipeline operator	Initial receipt of notification	Do we need to respond?
			Where and how do we shut down the pipeline?
	Media/Public warning	Public protective actions	Do we need to start public protective actions?
Amount of Release	Pipeline operator via public safety dispatch	Control pipeline release	Do we shut down the pipeline?

CHAPTER 4

Developing and Exercising the Communications Plans

Developing an emergency response plan, acquiring the necessary resources and equipment, training responders to perform their expected tasks and skills, and conducting exercises to test the desired operational capability are the cornerstones of an effective emergency response program. Underlying all of these elements is the need for a communications system that integrates the key players who will be involved in a pipeline emergency, including emergency responders, the pipeline operators, and the PSAP and communications centers. Networking and relationships developed during the planning process will help develop a level of trust that will be critical during the response phase.

A key player during the planning process will be the local or county emergency management agency, because its role is to facilitate the coordination of the planning and response processes, especially when the use of mutual aid resources is anticipated. The general approach to planning for pipeline emergency communications is drawn from FEMA doctrine, and supplemented with information gathering techniques developed as part of this research.

Given the risks involved in a pipeline emergency and the relative infrequency with which major incidents occur, a collaborative effort is essential to integrate emergency responders, the pipeline operators, and the PSAP and communications centers. This collaborative effort will ensure the development and delivery of an effective emergency preparedness capability. A successful incident outcome will not be achieved in the absence of addressing critical information needs and communications processes.

The Critical Role of Public Safety Emergency Communications (PSAP/Dispatch) Centers

One of the most important functions that must be performed in a pipeline emergency is to coordinate the flow of information at an incident. Most commonly, in the early stages of an incident, this will involve transmitting information from responders in the field to pipeline operators. In most cases, the information flow is mediated by the public safety dispatch facility. This critical linkage between pipeline operators and the emergency response community is not always recognized and acknowledged. The role of the public safety dispatcher or call taker is thus crucial to the communications process.

There are a number of technologies that may be used to facilitate the exchange of information among organizations responding to a reported pipeline emergency. The following are the most common technologies:

- Telephone
- Radio
- Computer/Electronic Data Exchange

The technologies used to exchange information between emergency responders and pipeline operators should be identified in advance. In most cases, pipeline operators must rely on telephone communication to speak to first responders; however, other technologies may be usable with prior training. Advances in 9-1-1 system technology, the widespread use of computer aided dispatch systems by public emergency responders, and greater availability of computers with wireless connectivity in the field will all offer opportunities for greater connectivity in the future. Regardless of the technologies used, they should be in good working order, which is critically important for the communication function. Alternative technologies and redundant modes of communication should be available as well in the event that the most commonly used mode is not available.

Guidance Documents for Public Safety Communications Centers and Pipelines

Model Protocol for 9-1-1 Centers and Pipeline Emergencies

NENA publishes a model procedure known as the "Pipeline Emergency Operations Standard/Model Recommendation.

Document 56-007" (*23*). This document provides a structured protocol for handling pipeline emergencies. The protocol requires that dispatch personnel be provided with information about physical signs of a pipeline release so they can recognize a potential pipeline emergency based on equivocal or incomplete information. Lay personnel may provide this information when reporting an unusual situation to PSAP.

While the protocol advises PSAPs to be aware of pipeline companies and contact information in their service areas, the centers may need to rely on identifying pipeline markers or calling 8-1-1 to reach the local "one call center." The centers may also need to identify emergency contact information for the pipeline operator(s) in question. In addition, the procedure includes a listing of common pipeline leak indicators as described by 9-1-1 callers. These indicators include smells, sounds, and visual indicators such as liquid pooling, dead vegetation, and frozen ground in the summer or a melted patch of snow in the winter. Also included in the protocol is information to determine if the caller is in danger and instructions to provide guidance under common scenarios depending on the nature of the hazard, distance from the leak, and physical indicators.

Immediate notification of the pipeline operator is indicated and the dispatcher is directed to obtain additional information on hazards near the location of the leak or spill as well as determine the response time and any actions to be taken by the pipeline operator.

Pipeline operators, the American Petroleum Institute (API), and PSAP personnel jointly designed NENA's Document 56-007 (*23*). The document is available at NENA's website, http://www.nena.org.

NENA Pipeline Database

In response to PHMSA Advisory Bulletin ADB 12-09, NENA established a pipeline database designed for use by pipeline operators to determine the appropriate PSAP along the route of a pipeline (*24*). The database provides a 10-digit direct-dial number to each of the PSAPs along a pipeline route, and can also be used for identifying the appropriate PSAP for a given location.

Released in October 2012, the PHMSA Advisory Bulletin reinforces PHMSA's intent that operators of gas, hazardous liquid, and liquefied natural gas pipelines should have the ability to make immediate contact with the appropriate PSAP located at any point along the pipeline route. The purpose of this communication is not only to advise emergency responders of a possible hazardous condition, but also to assist the pipeline operator in gathering first-hand observations made by callers to 9-1-1 centers or by on-scene emergency responders. Such information can be crucial in verifying a leak and reducing the amount of time before taking action to close valves or otherwise isolate the problem.

NENA has maintained the U.S. database of all 9-1-1 centers for a long time. This database, which was initially developed for interconnection between 9-1-1 centers and cell sector call routing, has been expanded to include 10-digit numbers for the call centers. These services are available on an annual license, with data updated quarterly (http://nenapipedb.com).

Pipeline operators or other users provide a list of counties in which they have facilities, and the NENA database cross-references the list and creates a tabular database list of PSAPs based on locations along the pipeline route. This service is particularly valuable because many counties are served by multiple PSAPs, and the service area boundaries are not always apparent.

The use of an authoritative service, such as that provided by NENA, can be an efficient way for pipeline operators to maintain emergency reporting capabilities for local authorities.

Planning Process

Pre-incident planning for pipeline emergency communications can follow the same approach used in developing emergency operations plans. The research team briefly describes the planning process, identifies key information sources and flows necessary to manage an incident, and suggests approaches to effectively carry out the planning process. As previously noted, the local emergency management agency can be a key player in coordinating and collaborating with multiple organizations and disciplines.

Characteristics of Effective Emergency Plans

The planning effort should involve all stakeholders to ensure that key players are represented. Minimum participation includes the pipeline operator, public emergency responders, and public safety emergency communications agencies that serve the response agencies. A representative of each center should participate in cases where multiple communications centers serve the agencies that would respond. This should include (a) the agency dispatch center(s), (b) the PSAP, and (c) any communications center that receives wireless 9-1-1 calls. This ensures all centers that may handle any portion of the critical communication are involved.

A systematic process should be used to address uncertainty around potential hazards and threats. For example, FEMA already requires states and many local jurisdictions to develop a Threat and Hazard Identification and Risk Assessment (THIRA) as part of its "all hazards" planning process. In the case of pipelines, responders should consider variables such as the type and products carried by pipelines, and their presence in sensitive locations. The pipeline operator's expertise and familiarity with previous incidents can help the operator anticipate possible outcomes.

Public emergency responders routinely plan and practice for a number of hazards, often under their jurisdiction's

Emergency Operations Plan (EOP). Planning for pipeline emergency communications should follow the same general steps, but the research team suggests some refinements in this area. The benefit of incorporating pipeline emergencies into the jurisdiction's EOP is that it has the support of the entire political jurisdiction and engages other agencies beyond public emergency responders, who would play a role in responding to and mitigating a major pipeline emergency. Further, this approach is consistent with FEMA's notion of "whole community" planning (*25*).

The mission and supporting goals of each entity in the plan should be clearly specified. This stage of the planning process enables identification and clarification of resource constraints and roles.

The planning process should have active participation of senior personnel from all participating agencies. Involvement of participants with the ability to speak for their organizations, make commitments, and resolve uncertainties is critical to the process.

FEMA identifies three levels of planning: strategic, operational, and tactical. Strategic planning sets overall policy objectives. Operational planning addresses roles, responsibilities, tasks, and action. The tactical level planning addresses personnel functions, equipment needs, and resource management. To be effective, the planning of emergency communications must reach down to the tactical level. It is important to establish specific technologies for exchange of information, means of sharing information among all parties, and contacts for key individuals and offices.

An objective of this planning effort is to support the development of a "common operating picture," whereby all entities involved have a shared and consistent understanding of not only where things are, but also where they are expected to go in the near term. A common operating picture describes having a situation awareness among those agencies and organizations involved in the response to a pipeline emergency. The goal of the planning effort is to be able to achieve this common operating picture or situation awareness as quickly as possible after an incident is reported to any party.

To summarize, the planning for pipeline emergency communications should be consistent with emergency planning already practiced and embedded in the agency's larger process of developing emergency operations plans. The planning effort is a process. It should be integrated into training exercises and evaluations. Once completed, revisit the process to ensure that it remains current and effective (Figure 4-1).

Source: Federal Emergency Management Agency.

Figure 4-1. The preparedness cycle.

Managing the Incident: Unified Command and the EOC

Efforts to plan for communications and incorporate that information into EOPs should be consistent with federal guidance in the National Incident Management System (NIMS) and the National Response Framework (NRF). The use of terminology and resource descriptions should be consistent with NIMS guidance. The reader is referred to the national planning frameworks published by the U.S. Department of Homeland Security because they are critical to understanding the need for planning communications for pipeline emergency response. The national planning frameworks provide an overarching vision for the relationship between pre-event mitigation, emergency response, and recovery. The activities associated with planning for communications in pipeline emergency response would fall under the planning function of the National Mitigation Framework (*26*).

The National Infrastructure Protection Plan (NIPP) is another resource designed to protect the nation's critical infrastructure and key resources (CIKR). See http://www.dhs.gov/nipp for additional information. The CIKR Support Annex and Private-Sector Coordination Support Annex provide detailed guidance regarding implementation of the NIPP, including roles and responsibilities, concept of operations, and incident-related actions.

Incident and Unified Command

In the incident command function, a local public emergency responder, usually the ranking officer on scene from the most relevant public safety agency will assume the role of Incident Commander. The incident command system (ICS) has the capability to integrate pipeline operator representatives as liaisons, where they can efficiently share information with the Incident Commander. This level of integration may be sufficient for smaller incidents of limited duration and commitment of resources.

However, for larger or more complex incidents, the concept of unified command brings together all critical agencies that play a crucial role in managing the incident. Organizations or agencies may be defined as candidates for participation in unified command based on provision of expertise, resources, jurisdiction, or legal responsibility.

Unified command, in which on-scene command is shared by multiple agencies, is a method to recognize the multidisciplinary nature of pipeline events, and the important role played by other agencies, such as law enforcement, human services, environmental protection, hazardous materials response teams, and the specialized expertise of pipeline operator responders. Implementing a unified command structure enables development of a single integrated incident organization.

In the early stages of an incident, communication between the pipeline operator and emergency responders is likely to be mediated by the public safety dispatcher, with such communications typically taking place over radio. When a pipeline company representative arrives at the scene of an incident, the primary means of communication shifts so that it is direct, usually face-to-face between the Incident Commander, or a member of his/her staff, and the pipeline company representative. Assuming an ongoing incident, implement a unified command at this stage.

Generally speaking, distribution pipelines, such as those operated by natural gas utilities, will have pipeline representatives on the scene of an incident sooner than transmission pipeline operators. This is due primarily to the more urban nature of distribution pipeline systems, and the long distances that must be covered by transmission pipeline operators. Furthermore, local emergency services are likely to have a closer and better established relationship with local pipeline operators because of their proximity and the higher frequency of incidents occurring on local natural gas distribution systems.

The Role of the Public EOC

Pipeline incidents can be complex events, requiring the response of multiple agencies from different disciplines and different levels of government. Often, such incidents may affect multiple jurisdictions as well. Diverse agencies require multi-agency planning, which presents a coordination challenge.

As an incident escalates in terms of its scope or duration, a decision will likely be made to activate the local EOC. The local EOC may be activated on larger or longer duration incidents to assist in coordination, resource management, and fulfillment of functions. Functions may include tracking resources, ordering specialized resources, and providing legal and financial support, such as executing contracts, and accounting for funds.

As multi-agency coordination centers, EOCs are designed to serve as a means to coordinate the flow of information between the incident scene and other agencies and support entities. EOCs bring together key decision makers to provide guidance and direction to support the on-scene incident management activities.

Putting Plans into Practice: Exercises

Exercises enable organizations to evaluate plans in a risk free environment. The purpose of exercises is to clarify roles and responsibilities and to identify areas where the need for improvement may exist. Exercises are designed to take place before an incident to help the participants and their organizations improve their capacity to respond to an actual event. Exercises are important because they help ensure that the effort and information developed in the plan will actually translate into action. The discussion of exercises is limited to planning pipeline emergency communications. In addition to FEMA, *TCRP Report 86/NCHRP Report 525: Transportation Security, Volume 9: Guidelines for Transportation Emergency Training Exercises* may serve as a useful reference (*27*).

Exercises exist in a hierarchy. They range from a simple review of key plan components with critical players, to elaborate full-scale exercises that may involve hundreds of personnel from dozens of organizations. Figure 4-2 shows the hierarchy of exercises in terms of their sophistication.

The research team advocates developing communications plans at least at the operational level. Identify and test communication methods and links among all critical parties as identified in the plan. Any pipeline-related exercises should also include tests of communications procedures among all the primary entities previously identified.

Situation Awareness Information Requirements Analysis

The Situation Awareness Information Requirements Analysis (SAIRA) was designed to be effective in particular contexts of identifying role-based information needs based on real-world decision making. This technique, described briefly in

Source: Federal Emergency Management Agency IS-120a Course.

Figure 4-2. Hierarchy of exercises.

Chapter 5, lends itself to identifying information needs in an emergency communications context.

Interoperability and Controlling Communications Traffic

Communication during a pipeline emergency requires coordination with numerous government agencies and private companies. A mixture of technologies will undoubtedly be used by the various organizations that must interact to successfully resolve a pipeline emergency. Before an incident, identify contact information and methods for communicating with pipeline operators in the community. Important steps to prepare for this task include the following:

- Document intra-agency communication technologies and procedures.
- Identify relevant organizations and agencies for notification and coordination.
- Identify preferred communication technologies and procedures for notification and coordination.

Identify in advance pipeline operators with facilities in the response area. State or federal agencies that would respond to a significant event, along with their contact information, should also be identified in advance.

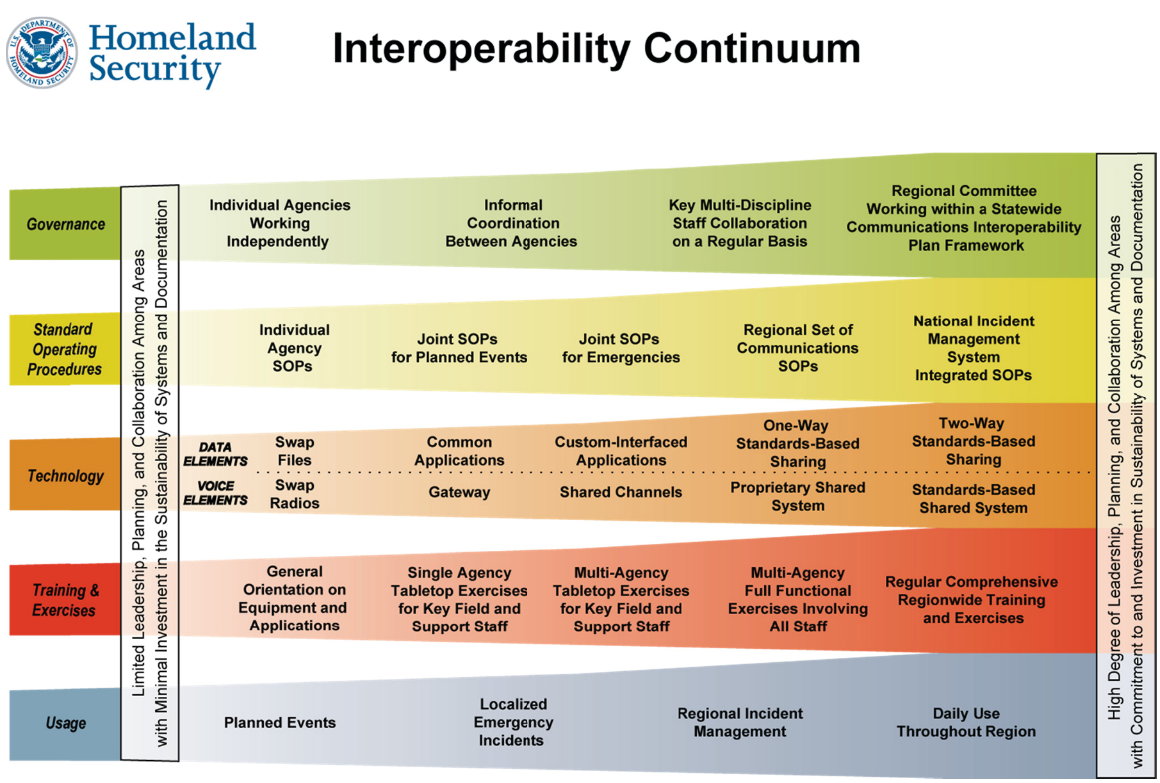
Interoperability

Interoperability is a concept that has received considerable attention in recent years. While interoperability can extend beyond communication, the research team uses it to refer to the ability of different organizations to communicate directly through some technology accessible to all necessary participating organizations.

Interoperability is defined as "the ability of emergency responders to work seamlessly with other systems or products without any special effort. Wireless communications interoperability specifically refers to the ability of emergency response officials to share information via voice and data signals on demand, in real time, when needed, and as authorized" (*28*).

The concept of interoperability is important to pipeline emergency response because the dispatch center or EOC will fulfill a critical role and facilitate communication among personnel and equipment located at the scene of the incident and specialized resources, including state, federal, and industry assets.

While interoperability is commonly thought of as involving voice radio communication, the concept also applies to the ability to communicate with data across disparate agencies. Figure 4-3 shows the interoperability continuum. The U.S. Department of Homeland Security's SAFECOM Office developed this figure. While the diagram is elaborate, it aids in understanding interoperability and its components given the needs of emergency communications in pipeline events.



Source: U.S. Department of Homeland Security.

Figure 4-3. Interoperability continuum.

Examine the continuum by starting at the left side, which represents the lowest level of integration and interoperability, and move progressively toward the right side of the presentation where there are higher levels of integration and interoperability. Interoperability as a concept is divided into five distinct components:

- Governance
- Standard operating procedures
- Technology
- Training and Exercises
- Usage

The continuum is a useful guide when envisioning communication strategies used during a prospective pipeline emergency. The far right column is not necessary in this application, but shows useful concepts to stress the importance of coordinating joint procedures and exercises to practice communication.

Elements of a Good Communications System

FEMA defines the elements of a desirable communications system. It is important to keep these elements in mind when designing plans and exercising communications procedures for pipeline emergency communications.

Communications systems need to have the following characteristics:

- Interoperable—able to communicate within and across agencies and jurisdictions.
- Reliable—able to function in the context of any kind of emergency.
- Portable—built on standardized radio technologies, protocols, and frequencies.
- Scalable—suitable for use on a small or large scale as the needs of the incident dictate.
- Resilient—able to perform despite damaged or lost infrastructure.
- Redundant—able to use alternate communications methods when primary systems go out (*29*).

Again, while these requirements are designed for public safety communications systems, procedures and technology should be in place to develop some level of redundancy. Redundancy provides for an alternate means of communication, between the pipeline operator and the public safety first responders. If a primary means of communication is disrupted in operational terms, this burden would fall primarily on the pipeline operator, because public safety communications systems are designed with redundancy and resilience in mind (see Figure 4-3).

CHAPTER 5

About the Project

The information in Chapter 3 came from research conducted through HMCRP Project 15. The research had three parts: (1) cataloging the current federal and state regulations governing pipelines, (2) examining NTSB investigations of pipeline incidents, and (3) writing this guide for improving communications during pipeline incidents.

Chapter 3 provides the information about decisions and roles obtained from two workshops with representatives from public safety agencies (fire and police departments), pipeline operators (both utilities and large-scale operators), and federal agencies (the U.S. EPA, the U.S. Coast Guard, and the U.S. Department of Homeland Security). The workshops used a method called a SAIRA. Workshop participants helped the project team define the roles, decisions, and information required for pipeline emergencies. The SAIRA uses a goal hierarchy approach that reveals the relationships among roles, goals, decisions, and information requirements. For every role, there are goals to pursue, and for every goal, there are actionable decisions to make to respond appropriately to a pipeline incident. Also, for every decision, there are types of information required by the decision maker. Figure 5-1 displays the logic of the analysis. The SAIRA method clarifies the specific types of information needed to make the key actionable decisions associated with each role. It also clarifies who needs each type of information and why that information is needed. Effective communication is often difficult during emergencies, and the SAIRA reveals both (1) what information people need to request to fulfill their roles and (2) what information people should be prepared to provide, in an accurate and timely manner, to other individuals in roles other than their own.

The various responding public agencies and pipeline operators should plan for how to obtain each type of required information once they determine the situation awareness information requirements. This "information flow" analysis simply involves figuring out who has the information, who needs the information, and how to convey it early enough in an incident to improve the likely outcome. Tabletop exercises are well suited to conducting information flow analyses.

Another part of the research examined the types of communication problems that can occur during pipeline emergencies. The method used for this part of the study was a failure modes and effects analysis (FMEA), a method often used by systems safety engineers. The method examines the various ways that a system's components can fail (i.e., the failure modes), along with the likelihood that such failure modes will occur and the effects on the system's ability to fulfill its functions when components do fail.

The "system" examined in the FMEA was derived from the SAIRA. The system is a generic pipeline emergency communications system. In this context "generic" means that the system is general enough to apply to communications during all types of pipeline emergencies. The components of the system were the types of information required to make key actionable decisions, as identified in the SAIRA. Data for the FMEA were collected using a panel of 15 technical specialists. The panel rated (1) the likelihood that failure modes would prevent each type of information from reaching the people who need it and (2) the consequences for recipients being able to make decisions if the information is not received. Table 5-1 displays the failure modes the panel used.

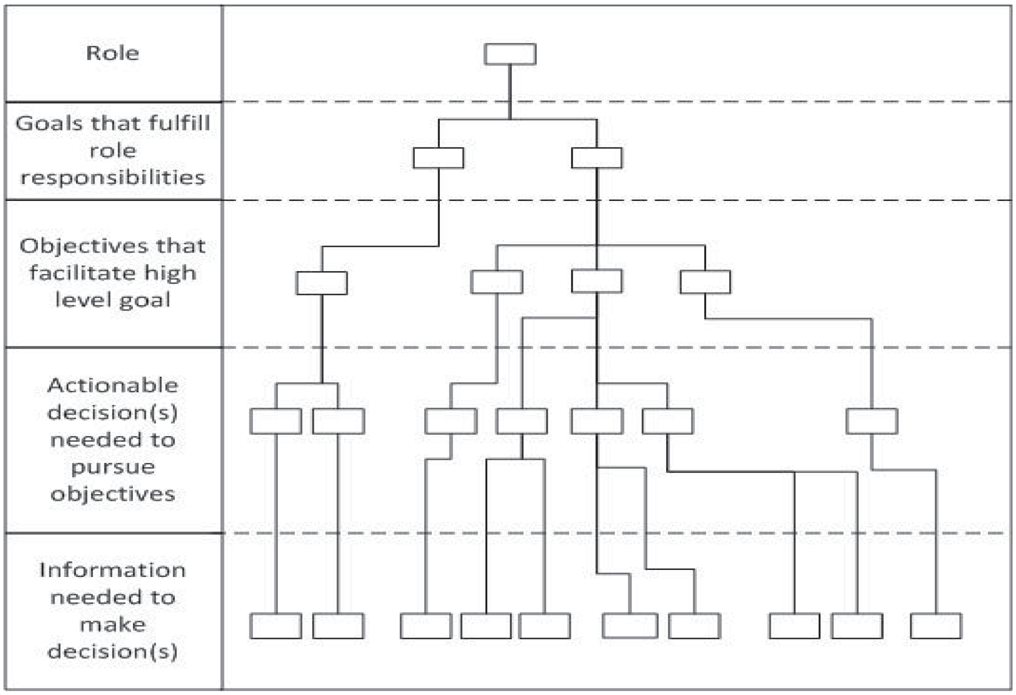


Figure 5-1. Situation Awareness Information Requirements Analysis.

Table 5-1. Failure modes and effects analysis.

Failure mode	Definition
Information not collected	The information does not exist, or the potential source of the information does not collect, assemble, or observe the needed information.
Recipient unknown	The original source of the information, or whoever is supposed to forward the information, does not know to whom the information should be sent.
Source unknown	Whoever needs the information does not know from whom to request it.
Request poorly communicated	The request from the recipient is unclear; the expectations of the requesting party are not clear to the source.
Information not sent or poorly expressed	The source does not convey the information to the user/requesting party in a clear manner, only part of the information is transmitted, the information is inaccurate, equipment or communication issues may distort the message.
Value of information unclear	The recipient does not understand the importance or value of the information, the source of the information is unclear, the source of the information is not trusted.
Information sent too late	The source does not collect and send the information soon enough to be useful in making the decision.
Technology unavailable or fails	Information cannot be sent because the source or the recipient does not have the available technology, the equipment lacks interoperability, or the means of transmitting the information is unreliable.

References

1. Hall, Sam, T. Butters, and L. Armstrong. A Hidden Threat: Pipeline Emergency Planning and Response Tools for the Emergency Response Community. *Fire Rescue Magazine*, January 2012, pp. 40–45.
2. Association of Oil Pipe Lines. Pipelines Retain Leading Role Transporting American Crude Oil and Petroleum Products. February 7, 2012. http://www.aopl.org/pdf/AOPL_Shift_Report_Press_Release_Feb_7_2012.pdf.
3. Miesner, Thomas, and W. Leffler. Oil and Gas Pipelines in Nontechnical Language. PennWell Corporation, Tulsa, OK, 2006, pp. 63–64, 71–72, 101.
4. U.S. Department of Transportation. Pipeline and Hazardous Materials Safety Administration. *Leak Detection Study—DTPH56-11-D-000001. Final Report 12-173.* Government Printing Office, Washington, DC, December 10, 2012, pp. 2–10.
5. Noll, Gregory, and Michael Hildebrand. Pipeline Emergencies. First Edition, Red Hat Publishing, Chester, MD, January 1, 2004.
6. Noll, Gregory, and Michael Hildebrand. Pipeline Emergencies. Second Edition, National Association of State Fire Marshalls. Cheyenne, WY, July 14, 2011.
7. National Transportation Safety Board. *Natural Gas Service Line Break and Subsequent Explosion and Fire Bergenfield, NJ, 12/13/2005.* NTSB/PAB-07/01. United States Government Printing Office, Washington, DC, May 1, 2007, pp. 4–6, 11.
8. National Transportation Safety Board. *Natural Gas Pipeline Rupture and Fire Carlsbad, NM, 8/19/2000.* NTSB/PAR-03/01. United States Government Printing Office, Washington, DC, February 11, 2003, p. 9. http://www.ntsb.gov/doclib/reports/2003/PAR0301.pdf.
9. National Transportation Safety Board. *Enbridge Incorporated Hazardous Liquid Pipeline Rupture and Release, Marshall, MI, 7/25/2010.* NTSB/PAR-12/01. United States Government Printing Office, Washington, DC, July 10, 2012, p. 103.
10. Nickerson, R. S. Confirmation Bias: A Ubiquitous Phenomenon in Many Guises. *Review of General Psychology*, Vol. 2, no. 2, 1998, pp. 175–220.
11. Slovic, P. Perceived Risk, Trust and Democracy. *Risk Analysis*, 13 (6), 1993, pp. 675–682.
12. Fischhoff, B., P. Slovic, S. Lichtenstein, S. Read, and B. Combs. How Safe is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits. Earthscan Publications, London, England and Sterling, VA, 2000.
13. Slovic, P. The Perception of Risk. Earthscan Publications, London, England, and Sterling, VA, 2000, p. 99.
14. U.S. National Archives and Records Administration. Pipeline and Hazardous Materials Safety Administration. Advisory Bulletin Docket No. PHMSA-2012-0201. 2012. *Federal Register* 77, no. 197, October 11, 2012.
15. National Transportation Safety Board. *Pipeline Accident Report. Pacific Gas and Electric Company Natural Gas Transmission Pipeline Rupture and Fire, San Bruno, CA, 9/9/2010.* NTSB/PAR-11/01. United States Government Printing Office, Washington, DC, August 30, 2011. http://www.ntsb.gov/doclib/reports/2011/PAR1101.pdf.
16. U.S. National Archives and Records Administration. *Code of Federal Regulations.* Title 49. Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011. Public Law 112-90. January 3, 2012.
17. Fleming, Susan A. Pipeline Safety: Better Data and Guidance Could Improve Operators' Responses to Incidents. *Testimony before the Committee on Commerce, Science, and Transportation*, U.S. Senate. January 28, 2013.
18. Federal Emergency Management Agency. IS-100.HE: Introduction to Incident Command System, ICS for Higher Education. November 2008, pp. 6–8. http://training.fema.gov/EMIWeb/IS/IS100HE/IG_PDF/L6_ICS100HigherED_IG.pdf.
19. National Association of Pipeline Safety Representatives. Compendium of State Pipeline Safety Requirements and Initiatives Providing Increased Public Safety Levels Compared to the Code of Federal Regulations. Second Edition, September 30, 2011. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Pipeline/Compendium.pdf.
20. U.S. National Archives and Records Administration. *Code of Federal Regulations.* Title 40. Protection of Environment. Part 300. National Oil and Hazardous Substances Pollution Contingency Plan. October 11, 2013.
21. U.S. National Archives and Records Administration. *Code of Federal Regulations.* Title 40. Protection of Environment. Part 112. Oil Pollution Prevention. July 1, 2012.
22. U.S. Environmental Protection Agency. 2013. Reporting Requirements—Oil Spills and Hazardous Substance Releases. http://www.epa.gov/oem/content/reporting/#oil. Accessed September 16, 2013.
23. National Emergency Number Association (NENA). Pipeline Emergency Operations Standard/Model Recommendation. Document 56-007, November 11, 2010.
24. U.S. Department of Transportation. Pipeline and Hazardous Materials Safety Administration. *ADB-12-09: Communications During Emergency Situations.* Government Printing Office, Washington, DC, October 11, 2012.
25. Federal Emergency Management Agency. Developing and Maintaining Emergency Operations Plans: Comprehensive Preparedness Guide, CPG 101. Version 2.0. November 2010.

26. U.S. Department of Homeland Security. Overview of the National Planning Frameworks. May 2013.
27. McCormick Taylor, Inc. *TCRP Report 86/NCHRP Report 525 Transportation Security, Volume 9: Guidelines for Transportation Emergency Training Exercises*. Transportation Research Board of the National Academies, Washington, DC, 2006.
28. U.S. Department of Homeland Security. Welcome to SAFECOM. 2013. http://www.safecomprogram.gov/interoperability/Default.aspx. Accessed November 5, 2013.
29. Federal Emergency Management Agency. IS-700. A: National Incident Management System, An Introduction, Student Manual. January 2009, pp. 4.3–4.4.

APPENDICES 1–3

The following appendices are unpublished herein but can be found online at www.trb.org by searching for *HMCRP Report 14*:

Appendix 1: Contractor's Final Report for HMCRP Project 15

Appendix 2: Summary of Current Federal, State, and Representative Local and Tribal Regulations and Ordinances Governing Emergency Response Plans for Natural Gas and Hazardous Liquids Pipelines

Appendix 3: Review and Summary of Voluntary Consensus Standards for Best Practices Related to Communicating Emergency Response Plans and Their Effectiveness

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation