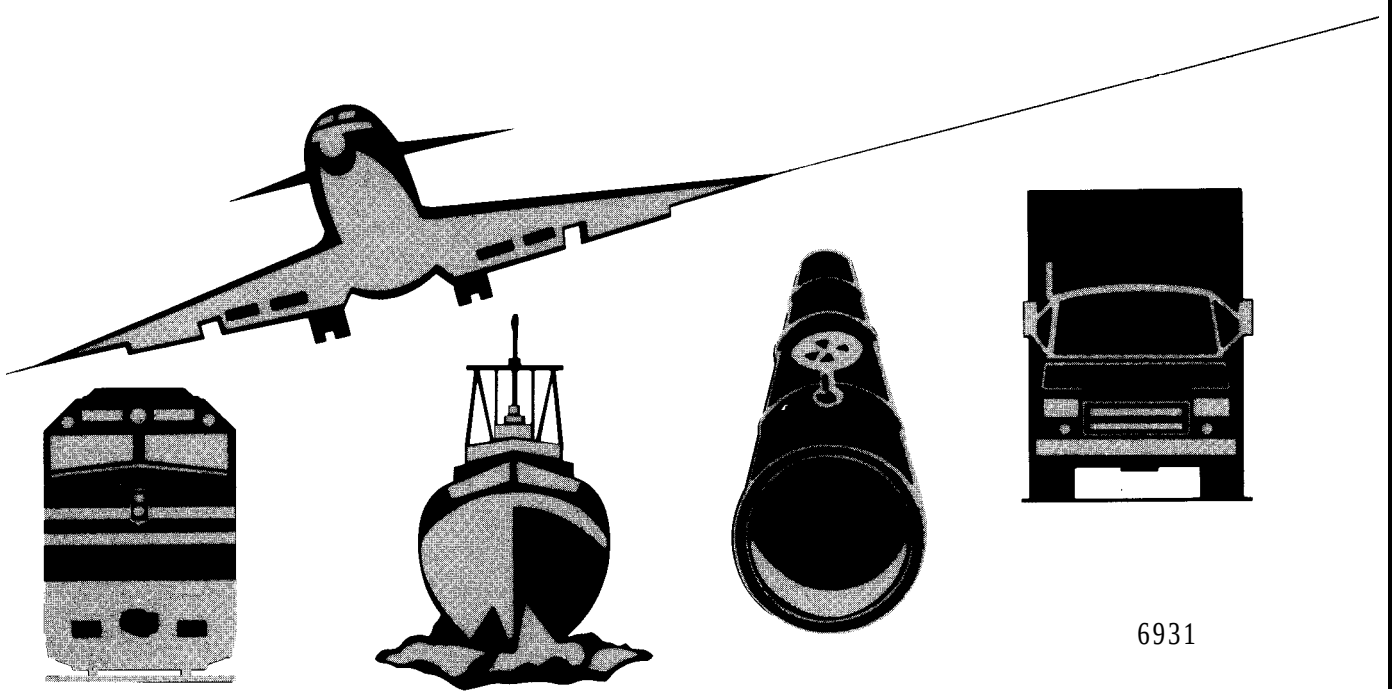
PB97-917003
NTSB/SS-97/01

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY STUDY

PROTECTING PUBLIC SAFETY THROUGH EXCAVATION DAMAGE PREVENTION



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National Transportation Safety Board. 1997. Protecting Public Safety Through Excavation Damage Prevention. Safety Study NTSB/SS-97/01. Washington, DC. 106 p.

Pipeline accidents result in fewer fatalities annually than accidents in the other modes of transportation; however, a single pipeline accident has the potential to cause a catastrophic disaster that can injure hundreds of persons, affect thousands more, and cost millions of dollars in terms of property damage, loss of work opportunity, community disruption, ecological damage, and insurance liability. Excavation and construction activities are the largest single cause of accidents to pipelines. In 1994, the Safety Board and the Research and Special Programs Administration jointly sponsored a workshop that brought together industry representatives to identify and recommend ways to improve State excavation damage prevention programs. The Board conducted the current safety study to analyze the findings of the 1994 workshop, to discuss industry and government actions undertaken since the workshop, and to formalize recommendations aimed at further advancing improvements in excavation damage prevention programs. The safety issues discussed in the report include (a) the essential elements of an effective excavation damage prevention program; (b) the accuracy of information regarding buried facilities; and (c) system measures, reporting requirements, and data collection. Safety recommendations concerning these issues were made to the Research and Special Programs Administration, the Federal Highway Administration, the American Public Works Association, the Association of American Railroads, the American Short Line Railroad Association, the American Society of Civil Engineers, and the Associated General Contractors of America.

Protecting Public Safety Through Excavation Damage Prevention

Safety Study

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Contents

Acronyms Used in the Report

AGA	American Gas Association
AGCA	Associated General Contractors of America
AOPL	Association of Oil Pipe Lines
APGA	American Public Gas Association
API	American Petroleum Institute
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASLRA	American Short Line Railroad Association
CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
DPU	Department of Public Utilities
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
GPS	global positioning system
GRI	Gas Research Institute
INGAA	Interstate Natural Gas Association of America
MnOPS	Minnesota Office of Pipeline Safety
NARUC	National Association of Regulatory Utility Commissioners
NPRM	Notice of Proposed Rulemaking
NRSC	Network Reliability Steering Committee
NULCA	National Utility Locating Contractors Association
OCSI	One-Call Systems International
OPS	Office of Pipeline Safety
OPSO	Office of Pipeline Safety Operations
OSHA	Occupational Safety and Health Administration
RSPA	Research and Special Programs Administration
SUE	Subsurface utility engineering
TIGER	topographically integrated geographic encoding and referencing
ULCC	Utility Location and Coordinating Council

Executive Summary

Pipeline accidents result in fewer fatalities annually than accidents in the other modes of transportation; however, a single pipeline accident has the potential to cause a catastrophic disaster that can injure hundreds of persons, affect thousands more, and cost millions of dollars in terms of property damage, loss of work opportunity, community disruption, ecological damage, and insurance liability. Excavation and construction activities are the largest single cause of accidents to pipelines. Data maintained by the U.S. Department of Transportation, Research and Special Programs Administration (RSPA), Office of Pipeline Safety, indicate that damage from outside force is the leading cause of leaks and ruptures to pipeline systems, accounting for more than 40 percent of the reported failures. According to the data, two-thirds of these failures are the result of third-party damage; that is, damage caused by someone other than the pipeline operator. Reports from the 20th World Gas Congress confirm that excavator damage is also the leading cause of accidents in other countries.

According to the Network Reliability Steering Committee (NRSC), an industry group appointed by the Federal Communications Commission, excavation damage is also the single largest cause of interruptions to fiber cable service. Network reliability data, compiled since 1993 by the NRSC, show that more than half of all facility outages are the result of excavation damage (53 percent). The Safety Board's review of NRSC first quarter data for 1997 indicates that this relationship has not changed. In addition to being expensive and inconvenient, disruption of the telecommunications network can have significant safety implications, such as impact on traffic control systems, health services, and emergency response activities. The Federal Aviation Administration's (FAA) study of cable cuts in 1993 documented 1,444 equipment outages or communications service disruptions resulting from 590 cable cuts nationwide over a 2-year period. The majority of cable cuts were related to construction and excavation activities. For 1995, the FAA's National Maintenance Control Center documented cable cuts that affected 32 air traffic control facilities, including 5 en route control centers. Cable cuts for the first 8 months of 1997 affected air traffic control operations for a total of 158 hours.

The U.S. underground infrastructure comprises about 20 million miles (32.2 million kilometers) of pipe, cable, and wire. The term "underground facilities" generally refers to the buried pipelines and cables that transport petroleum, natural gas, electricity, communications, cable television, steam, water, and sewer. In addition to being categorized by product type and structural component, underground networks are further grouped according to function (gathering, transmission, distribution, service lines); owner (public utility or private industry); or jurisdiction (municipalities, State, and Federal agencies). The diverse and segmented nature of underground facilities is evident from the variety of organizational interests that work with the subsurface infrastructure: facility

owners; construction crews, government authorities, insurance companies, locating contractors, and notification communication specialists.

The Safety Board has long been concerned about the number of excavation-caused pipeline accidents. In response to six serious pipeline accidents during 1993 and 1994 that were caused by excavation damage and to foster improvements in State excavation damage prevention programs, the Safety Board and RSPA jointly sponsored a workshop in September 1994. This workshop brought together about 400 representatives from pipeline operators, excavators, trade associations, and local, State, and Federal government agencies to identify and recommend ways to improve prevention programs.

This safety study was initiated to analyze the findings of the 1994 workshop, to discuss industry and government actions undertaken since the workshop, and to formalize recommendations aimed at further advancing improvements in excavation damage prevention programs. Safety issues discussed in the study include the following:

- essential elements of an effective excavation damage prevention program;
- accuracy of information regarding buried facilities; and
- system measures, reporting requirements, and data collection.

As a result of this study, safety recommendations were issued to the Research and Special Programs Administration, the American Public Works Association, the Federal Highway Administration, the Association of American Railroads, the American Short Line Railroad Association, the American Society of Civil Engineers, and the Associated General Contractors of America.

Chapter 1

Introduction

Pipeline accidents result in fewer fatalities annually than accidents in the other modes of transportation; however, a single pipeline accident has the potential to cause a catastrophic disaster that can injure hundreds of persons, affect thousands more, and cost millions of dollars in terms of property damage, loss of work opportunity, community disruption, ecological damage, and insurance liability. In March 1994, a pipeline accident in Edison, New Jersey, injured 112 persons, destroyed eight buildings, and resulted in the evacuation of 1,500 apartment residents.[1] Accident damage exceeded $25 million. The National Transportation Safety Board's investigation determined that the probable cause of the accident was excavation damage to the exterior of a 36-inch gas pipe. Less than 3 months later, a gas explosion in Allentown, Pennsylvania, resulted in 1 fatality, 66 injuries, and more than $5 million in property damage.[2] The Safety Board concluded that the accident was caused by a service line that had been exposed during excavation and had subsequently separated at a compression coupling.

A propane gas explosion on November 21, 1996, in the Rio Piedras shopping district of San Juan, Puerto Rico, resulted in 33 fatalities and 69 injuries. This accident, one of the deadliest in pipeline history, made 1996 a record year for pipeline fatalities. The San Juan accident accounted for more fatalities than occurred the entire previous year, and it vividly illustrates the tragic potential of a single excavation-damaged pipe.

The Safety Board determined that the probable cause of the propane gas explosion, fueled by an excavation-caused gas leak in the basement of the Humberto Vidal, Inc., office building, was the failure of San Juan Gas Company, Inc., to oversee its employees' actions to ensure timely identification and correction of unsafe conditions and strict adherence to operating practices; and to provide adequate training to employees.[3] Also contributing to the explosion was the failure of the Research and Special Programs Administration/Office of Pipeline Safety to effectively oversee the pipeline safety program in Puerto Rico; the failure of the Puerto Rico Public Service Commission to

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[1] National Transportation Safety Board. 1995. Texas Eastern Transmission Corporation Natural Gas Pipeline Explosion and Fire; Edison, New Jersey; March 23, 1994. Pipeline Accident Report NTSB/PAR-95/01. Washington, DC. 104 p.

[2] National Transportation Safety Board. 1996. UGI Utilities, Inc., Natural Gas Distribution Pipeline Explosion and Fire; Allentown, Pennsylvania; June 9, 1994. Pipeline Accident Report NTSB/PAR-96/01. Washington, DC. 94 p.

[3] National Transportation Safety Board. 1997. San Juan Gas Company, Inc./Enron Corp. Propane Gas Explosion in San Juan, Puerto Rico, on November 21, 1996. Pipeline Accident Report NTSB/PAR-97/01. Washington, DC.

require San Juan Gas Company, Inc., to correct identified safety deficiencies; and the failure of Enron Corporation to adequately oversee the operation of San Juan Gas Company, Inc. Contributing to the loss of life was the failure of San Juan Gas Company, Inc., to adequately inform citizens and businesses of the dangers of propane gas and the safety steps to take when a gas leak is suspected or detected.

In 1994, a tragic pipeline accident occurred in Caracas, Venezuela. A 22-ton trenching device, working on a road construction project, struck a 10-inch gas transmission line. An occupied bus and cars stopped by the road construction were engulfed in flames. Fifty-one persons were killed and 34 injured. The next year, in April 1995, construction work on a subway system in Taegu, Korea, ruptured a gas line, killing 103 persons. These accidents occurred in systems that do not operate under U.S. regulations, but they illustrate the catastrophic consequences that can result from excavation damage to underground facilities.[4]

Excavation and construction activities are the largest single cause of accidents to pipelines. Data maintained by the U.S. Department of Transportation (DOT), Research and Special Programs Administration (RSPA), Office of Pipeline Safety (OPS), indicate that damage from outside force is the leading cause of leaks and ruptures to pipeline systems, accounting for more than 40 percent of the reported failures.[5] According to the data, two-thirds of these failures are the result of third-party damage; that is, damage caused by someone other than the pipeline operator. Reports from the 20th World Gas Congress confirm that excavator damage is also the leading cause of pipeline accidents in other countries.[6]

According to the Network Reliability Steering Committee (NRSC), an industry group appointed by the Federal Communications Commission, excavation damage is also the single largest cause of interruptions to fiber cable service. Network reliability data, compiled since 1993 by NRSC, show that more than half of all facility outages are the result of excavation damage (53 percent), and in more than half of those cases (51 percent), the excavator failed to notify the facility owner or provided inadequate notification.[7] The Safety Board's review of NRSC first quarter data for 1997 indicates that this relationship has not changed. In addition to being expensive and inconvenient, disruption of the telecommunications network can have significant safety implications, such as impact on traffic control systems, health services, and emergency response

[4] The National Transportation Safety Board does not have the authority to investigate pipeline accidents in other countries.

[5] Transportation Research Board, National Research Council. 1988. Pipelines and Public Safety. Special Report 219. Washington, DC.

[6] Dipl.-Ing, Klees Alfred; Wasserfaches, e.V. 1997. The Safety Concept of Public Gas Supply in Germany. In: Proceedings, 20th IGU World Gas Conference; Copenhagen.

[7] Alliance for Telecommunications Industry Solutions/Network Reliability Steering Committee. 1996. Results and Recommendations Pertaining to Facilities Reliability. Facilities Solutions Report. Washington, DC. February.

activities. The Federal Aviation Administration's (FAA) study of cable cuts in 1993 documented 1,444 equipment outages or communications service disruptions resulting from 590 cable cuts nationwide over a 2-year period. The majority of cable cuts were related to construction and excavation activities.[8] For 1995, the FAA's National Maintenance Control Center documented cable cuts that affected 32 air traffic control facilities, including five en route control centers. Cable cuts for the first 8 months of 1997 affected air traffic control operations for a total of 158 hours.[9]

The Safety Board has long been concerned about the number of excavation-caused pipeline accidents. Because of several excavation-caused pipeline accidents that occurred between 1968 and 1972,[10] the Safety Board sponsored a symposium on pipeline damage prevention. Many of the proposals developed at that April 1972 symposium led to a Safety Board special study on damage prevention[11] and recommendations that resulted in many of the concepts and systems that have now been implemented to minimize excavation-caused damage to pipelines; for example, the local utility location and coordinating councils (ULCCs) established by the American Public Works Association (APWA). Since that symposium, the Safety Board has continued to support the initiatives of the APWA, the States, and the national organizations to reduce excavation damage to pipelines. The Safety Board has been an advocate of strong damage prevention programs through its recommendation process and through testimony before Congress and State legislatures, and before groups and trade associations interested in pipeline safety, such as the Interstate Natural Gas Association of America (INGAA), the American Public Gas Association (APGA), the Association of Oil Pipe Lines (AOPL), the American Gas Association (AGA), and the American Petroleum Institute (API).

The combined efforts of industry, the States, the Safety Board, and other Federal agencies led to a decrease in the number of accidents during the 1980s. Nevertheless, excavation-caused damage remains the largest single cause of pipeline accidents. Appendix A lists excavation-caused accidents investigated by the Safety Board since 1985. The Board is currently investigating three other accidents that involved excavation: Gramercy, Louisiana; Tiger Pass, Louisiana; and Indianapolis, Indiana.[12]

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[8] Federal Aviation Administration, Safety and Quality Assurance Division, Associate Administrator for Aviation Safety. 1993. Cable Cuts: Causes, Impacts, and Preventive Measures. Special Review. Washington, DC. 30 p.

[9] Federal Aviation Administration, National Maintenance Control Center AOP-100. 1997. Adhoc Report of facility/service outages associated with cable cuts, 7/1/95–8/22/97.

[10] A gas explosion in Annandale, Virginia, on March 24, 1972, occurred just 1 month before the symposium.

[11] National Transportation Safety Board. 1973. Prevention of Damage to Pipelines. Special Study NTSB/PSS-73/01. Washington, DC.

[12] NTSB accident Nos. DCA96FP004 (Gramercy, Louisiana; May 24, 1996); DCA97FP001 (Tiger Pass, Louisiana; October 23, 1996); and DCA97FP005 (Indianapolis, Indiana; July 21, 1997).

In response to six serious pipeline accidents during 1993 and 1994 that were caused by excavation damage[13] and to foster improvements in State excavation damage prevention programs, the Safety Board and RSPA jointly sponsored a workshop in September 1994.[14] This workshop brought together about 400 representatives from pipeline operators, excavators, trade associations, and local, State, and Federal government agencies to identify and recommend ways to improve prevention programs.

On May 20, 1997, the Safety Board updated its "Most Wanted" list of safety improvements to include excavation damage prevention.[15] The Board's recommendations on this issue address requirements for excavation damage prevention programs; comprehensive education and training for operators of buried facilities and the public; and effective government monitoring and enforcement.

This safety study, "Protecting Public Safety Through Excavation Damage Prevention," was initiated to analyze the findings of the 1994 workshop, to discuss industry and government actions undertaken since the workshop, and to formalize recommendations aimed at further advancing improvements in excavation damage prevention programs. Chapter 2 of the study provides some background information on the subsurface infrastructure and an overview of pertinent regulatory and legislative initiatives. Chapter 3 discusses the various components of a damage prevention program, Chapter 4 discusses the accuracy of information regarding buried facilities, Chapter 5 addresses system performance measures, and the last sections contain the Safety Board's conclusions and recommendations.

[13] The accidents occurred at Allentown, Pennsylvania; Edison, New Jersey; Green River, Wyoming; St. Paul, Minnesota; Cliffwood Beach, New Jersey; and Reston, Virginia.

[14] National Transportation Safety Board. 1995. Proceedings of the Excavation Damage Prevention Workshop; September 8–9, 1994; Washington, DC. Report of Proceedings NTSB/RP-95/01. Washington, DC.

[15] In October 1990, the Safety Board adopted a program to identify the "Most Wanted" safety improvements. The purpose of the Board's "Most Wanted" list, which is drawn up from safety recommendations previously issued, is to bring special emphasis to the safety issues the Board deems most critical.

Chapter 2

Overview of Subsurface Infrastructure and Regulatory and Legislative Initiatives

Subsurface Infrastructure

The term "underground facilities" generally refers to the buried pipelines and cables that transport petroleum, natural gas, electricity, communications, cable television, steam, water, and sewer. These subsurface networks are constructed of cast iron, steel, fiberglass, copper wire, concrete, clay, plastic, or optical fiber depending on the age of the system and its product content. In addition to being categorized by product type and structural components, underground networks are further grouped according to function (gathering, transmission, distribution, service lines); owner (public utility or private industry); or jurisdiction (municipalities, State, and Federal agencies). The U.S. underground infrastructure comprises about 20 million miles (32.2 million kilometers) of pipe, cable, and wire.[16]

Pipeline regulation and oversight by DOT distinguishes between the transport of carbon dioxide, hazardous liquids, and gas. Hazardous liquid lines carry petroleum, petroleum products, or anhydrous ammonia. Their functions include gathering lines that transport petroleum from a field production facility to the primary pumping stations. Trunk lines differentiate a line-haul function for the transport of crude oil to refineries and product from the refineries. Gas lines are categorized as gathering, transmission, or distribution. Gathering lines transport gas from a current production facility to a transmission line or processing facility; transmission lines transport gas to distribution centers, storage facilities, or large volume customers; and distribution service lines transport gas to end users.[17]

[16] Estimates of the total infrastructure size are difficult to verify. Bell Communications Research used 20 million miles during the Safety Board's 1994 excavation damage prevention workshop.

[17] Wright, P.H.; Ashford, N.J. 1989. Transportation Engineering: Planning and Design. 3d ed. New York: Wiley & Sons (p. 25). 776 p.

The diverse and segmented nature of underground facilities is evident from the variety of organizational interests that work with the subsurface infrastructure:

- Facility owners design, install, and maintain the underground network. Owners are a diverse group with varied interests; they include private corporations, municipal public works systems, private and public utility companies, telecommunication providers, and State transportation traffic control systems.
- Construction crews engage in excavation activities for a variety of reasons, and they use an assortment of government permits. Excavation activities are carried out by building trades, farmers, homeowners, State and local transportation departments, and others.
- States regulate actions to protect safety.
- Insurance companies insure the underground facilities, property, and construction business activities.
- Locators work at excavation sites to identify and mark underground facilities. This work may be conducted by the operators of the underground facility or by locating contractors who specialize in providing underground locating services.
- One-call communication centers coordinate notifications about digging activities. These centers may be an operating unit of a facility owner or they may be independent entities that provide notification service to several facility owners.

The number of times people dig into the underground infrastructure illustrates the sheer frequency of excavation: there were an estimated 13 million excavation notices issued to utility operators across the United States in 1996, though the actual number is higher because some excavators do not use one-call notification services.[18]

Urbanization of lands through which utility lines are routed, combined with an increase in the number of users of the underground, has created competition for the underground space. A recent study by the American Farmland Trust states that the rate of farmland lost to development is 2 acres per minute, or 1 million acres per year (0.81 hectare per minute, or 405 000 hectares per year).[19] Increased construction activity, which results in increased excavation, is directly related to population growth, demographic shifts, and a growing national economy. New building construction requires that additional services—more utility lines and communication services—be placed in the

[18] The estimated number of excavations is based on the number of notifications received in 1996 by member organizations of One-Call Systems International.

[19] American Farmland Trust. 1997. Farming on the Edge. Washington, DC.

underground. There is also a trend in current suburban development to remove aboveground utilities to reduce clutter and storm damage. Additions to the underground infrastructure are installed within the underground space occupied by the existing systems. Thus, increased construction can be considered a corollary of increased excavation. This relationship affects the approach to excavation damage prevention because the desire to avoid damage is a genuine interest of everyone, but the success of damage prevention depends on systematic safeguards.

Regulatory and Legislative Initiatives

Underground facilities and pipelines are addressed by various Federal regulations. The Federal regulations issued by RSPA are contained in Title 49 Code of Federal Regulations (49 CFR) Parts 190-199. Parts 191 and 192 address natural gas regulations; Part 195 covers hazardous liquids and carbon dioxide; and Part 198 prescribes regulations for grants to aid State safety programs. Federal regulations establishing minimum standards for excavation damage prevention programs for gas pipeline operators (49 CFR 192.614)[20] were extended to the operators of hazardous liquid pipelines (49 CFR 195.442) effective April 1995.[21] (Excerpts from these regulations are reproduced in appendix B.)

Federal regulations mandate companies to develop and participate in damage prevention programs when those companies transport gas and hazardous liquids subject to DOT jurisdiction.[22] Participation in a one-call notification system satisfies parts of this requirement; consequently, one-call centers have become a key element in damage prevention programs. As the Safety Board's accident investigations and 1994 workshop have pointed out, however, one-call notification programs do not ensure damage prevention. Protection from excavation damage will occur only when facility owners, excavators, locators, and one-call operators—people working with the underground facilities—share responsibilities to protect underground facilities from excavation damage. (These responsibilities are discussed in the next two chapters.)

[20] In September 1988, RSPA's Technical Pipeline Safety Standards Committee unanimously supported extending Section 192.614 to cover onshore gas pipelines in Class 1 and 2 locations.

[21] RSPA published the final rule, "Excavation Damage Prevention Programs for Gas and Hazardous Liquid and Carbon Dioxide Pipelines," in the *Federal Register* on March 20, 1995.

[22] 49 CFR Parts 192.614 and 195.442.

Both government and industry have, in the past, prepared model statutes that would serve as a framework for individual State legislation of damage prevention programs. The Office of Pipeline Safety Operations (OPSO) prepared model statutes in 1974 and 1977 and encouraged State and local governments to enact model legislation.[23] The APWA prepared guidelines for damage prevention laws that were not substantially different from the OPSO model. The AGA also developed elements for damage prevention legislation; these elements were documented in a 1988 report issued by the Transportation Research Board.[24] Several features of the OPSO model statute overlapped with features in regulations issued by the Occupational Safety and Health Administration (OSHA) of the Department of Labor.

OSHA regulations require excavators to notify utility owners of planned excavation and to request that the estimated location of underground facilities be marked prior to the start of excavation (29 CFR 1926.651(b)). The regulations also require excavators to determine the exact location "by safe and acceptable means" when they approach the estimated location during excavation.[25] (Excerpts of the OSHA regulations are included in appendix B of this report.)

Model legislation was introduced in the 103^{d} Congress following the 1994 accident in Edison, New Jersey.[26] That bill, which strongly recommended rather than mandated State participation in one-call systems, passed the House of Representatives but not the U.S. Senate. A different version of the bill (HR431/S164) was introduced in, but not adopted by the 104th Congress. Industry representatives worked with the 105th Congress to again develop legislation. The Comprehensive One-Call Notification Act of 1997 (S1115) was introduced into the Senate in July 1997, and the Surface Transportation Safety Act of 1997 (HR1720) was introduced into the House in May 1997. The Senate Committee on Commerce, Science, and Transportation held a public hearing on S1115 in September 1997; the Senate passed the measure on November 9, 1997. The issues related to the currently proposed legislation are not substantially different from earlier versions; a comparison of the features indicates the following:

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[23] Courtney, W.J.; Kalkbrenner, D.; Yie, G. 1977. Effectiveness of Programs for Prevention of Damage to Pipelines by Outside Forces. Final Report DOT/NTB/OPSO-77/12. Washington, DC: U.S. Department of Transportation, Materials Transportation Bureau, Office of Pipeline Safety Operations; contract DOT-OS-60521. 290 p. (The Office of Pipeline Safety Operations later became the Office of Pipeline Safety within the DOT's Research and Special Programs Administration.)

[24] Transportation Research Board, National Research Council. 1988. Pipelines and Public Safety. Special Report 219. Washington, DC.

[25] The Safety Board's 1973 review of OSHA regulations is contained in its special report entitled "Prevention of Damage to Pipelines" (NTSB/PSS-73/01).

[26] National Transportation Safety Board. 1995. Texas Eastern Transmission Corporation Natural Gas Pipeline Explosion and Fire; Edison, New Jersey; March 23, 1994. Pipeline Accident Report NTSB/PAR-95/01. Washington, DC. 104 p.

- The current bills are advisory in nature rather than prescriptive.
- The House bill recommends participation by all facility owners and excavators; the Senate bill recommends appropriate participation by underground facility operators and excavators. Both contain incentives for compliance based on providing grant monies for State use.
- Both bills recommend general components to be included in the State programs; the House bill calls these elements, the Senate bill calls them minimum standards. There is no specific guidance for States concerning the organizational structure and funding mechanisms of one-call centers, or the administration of enforcement provisions.
- Both bills include a mechanism for recommending effective damage prevention practices; specifically, the Secretary of Transportation shall study existing one-call systems to determine practices that are most effective in preventing excavation damage.

The recently introduced legislation makes no specific requirements on the States because the Federal government has not exercised jurisdiction over one-call operations, and because States cannot be required to pass legislation. This has led one industry trade publication to characterize both bills as "toothless in terms of being able to require states, excavators, facility operators, or one-call centers" to modify existing practices to achieve the objectives set forth in the legislation.[27] Table 2–1 shows a comparison of the two bills that appeared in a recent trade association newsletter. The Safety Board's position regarding certain provisions of the proposed legislation is discussed in the next chapter.

[27] The Conduit 3(4): 1, 4. August 1997. Spooner, WI: National Utility Locating Contractors Association.

Table 2–1. Comparison by a trade association newsletter of the currently proposed Federal legislation for one-call systems.

House Bill HR1720	Senate Bill S1115[(a)]
1. Shall consider the establishment of a nationwide toll-free telephone number system. 2. Elements of a State program shall include: (a) All excavators and facility operators; (b) 24-hour coverage for emergency notice; (c) Public education about the program; (d) Proper excavation procedures training; (e) Excavators must contact the One-Call Center; (f) Facility operators must mark their facilites; (g) Effective enforcement; (h) Fair free schedule for operating the State program. 3. Funding of $1M in fiscal year 1998, "as necessary" in FY 1999, and 2000 to be used for improving damage prevention. Money to come from fees collected from pipeline operators. 4. Secretary of Transportation to develop a model program in consultation with all affected parties, conduct workshops and public education.	1. (Telephone number language deleted because OCSI already has a system in operation.) 2. Minimum standards of a State program to include: (a) appropriate participation by excavators and facility operators considering risks, cost: benefit ratios, and allowing voluntary participation where risk is low; (b) Administrative system of variable penalties. 3. Funding of: (a) grants of $1M in FY 1999 and $5 M in FY 2000 to be available until expended; (b) funds "as necessary" in FY 1998–2000 for administration. Money to come from general revenues. States would get money when the Secretary of Transportation has determined, from a grant application, that the State is in compliance with the minimum program standards. 4. Secretary to review the one-call system "best practices" and issue a report.

[(a)] The U.S. Senate passed S1115 on November 9, 1997.

Source: The Conduit 3(4): 1, 4. August 1997. Spooner, WI: National Utility Locating Contractors Association. (The full text of the bills is available on the Internet at www.underspace.com.)

Chapter 3

Damage Prevention Practices

In its report of the accident in Allentown, Pennsylvania, on June 9, 1994,[28] the Safety Board highlighted the common elements of effective State excavation damage prevention programs that have been recognized in the industry and that were discussed in detail at the Safety Board's 1994 workshop. The elements include (1) mandatory participation by all affected parties, whether private or public; (2) a true one-call notification system in which excavators can alert all operators of buried systems; (3) swift, effective sanctions against violators of State damage prevention laws; and (4) an effective education program for the public, contractors, excavation machine operators, and operators of underground systems that stresses the importance of notifying before excavating, accurately marking buried facilities, and protecting marked facilities when excavating. Other elements that have been deemed critical to an effective damage prevention program and that have been the subject of past Safety Board recommendations include accurate mapping, employee training, and emergency response planning. This chapter discusses the various aspects of these elements and summarizes the reports and conclusions of the 1994 workshop participants as they relate to these elements.

Mandatory Participation

Every State except Hawaii and the District of Columbia has a damage prevention law to govern the activities of operators and excavators of most buried facilities. Texas, the most recent State to enact legislation, passed the Underground Facility Damage Prevention and Safety Act in June 1997 to establish a non-profit corporation to oversee the State's three one-call systems. The Governor of Puerto Rico is preparing damage prevention legislation for introduction in the Legislative Assembly. In the interim, he has issued an Executive Order that establishes an excavations notice center, requires government facility operators to use the center, and encourages its use by private entities.

Individual States have developed a variety of program approaches to handling the problem of excavation damage of underground facilities. A key finding in a 1995 OPS study was that there were "significant variations among state statutes, among excavators,

[28] National Transportation Safety Board. 1996. UGI Utilities, Inc., Natural Gas Distribution Pipeline Explosion and Fire; Allentown, Pennsylvania; June 9, 1994. Pipeline Accident Report NTSB/PAR-96/01 (Appendix E, "Gas Piping Technical Committee Excavation Damage Prevention Guidelines"). 94 p.

and among facility operators in the ways that excavation around underground facilities is done."[29] Table 3–1 provides an overview of the variations among State programs; appendix C provides a broader look at aspects of the States' programs.

More than half the States (30) have mandatory one-call participation programs and most (39) are intended to protect all utilities. However, all but seven States (Connecticut, Iowa, Massachusetts, Maryland, Maine, New Hampshire, and Vermont) have granted exemptions to a variety of organizations. State laws specifically qualify their exemptions, but, in general, exempt organizations are not required to participate in the State's excavation damage prevention program. Exemptions have been granted to State transportation departments, railroads, mining operations, city/State/Federal governments, cemeteries, water utilities, military bases, and Native American Lands. Although underground facilities frequently follow road rights-of-way, nine States have current damage prevention legislation that specifically exempts State transportation departments; another dozen States exempt substantial State highway maintenance activities. State highway administrators have argued that they do not have the resources for participating in notification and marking. Several States (Arizona, Arkansas, Delaware, Oregon, Mississippi, and Washington) exempt agricultural activities, home owners, and tilling operations less than 12 inches (30.5 centimeters) deep. By receiving exemptions, these entities are not required to inform utilities or underground facility owners of their digging activities, nor are the underground facilities operated by these exempt entities marked or protected in advance of scheduled excavations.

In the 1994 Green River, Wyoming, accident investigated by the Safety Board, a highway contractor operating excavation equipment struck a 10-inch-diameter natural gas gathering line.[30] The accident resulted in three fatalities. The pipeline operator did not participate in the local excavation notification one-call program, though the operator was required by the State of Wyoming to belong to the one-call system. The highway contractor notified the one-call center prior to excavation but did not notify one-call concerning project modifications that expanded the geographic area of work. Neither the Wyoming Department of Transportation nor its contractor made telephone notification directly to the pipeline operator. Had these parties participated in the one-call notification program, the gas line would have been marked and the accident likely would not have happened.

[29] U.S. Department of Transportation, Office of Pipeline Safety. 1995. Exemplary Practices and Success Stories In One-Call Systems. Washington, DC. May.

[30] National Transportation Safety Board Accident Brief DCA94MP002; Green River, Wyoming; May 3, 1994.

Table 3–1. Overview of the characteristics of State programs to prevent excavation damage.

Program characteristic	Alabama	Alaska	Arizona	Arkansas	California	Colorado	Con-necticut	Delaware	District of Columbia	Florida	Georgia	Hawaii	Idaho
Protects all utilities[a]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Mandatory participation for facility owners			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
No exemptions for excavation notification							✓						
24-hour access[b]						✓	✓						
Emergency response procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Permits issued		✓			✓				✓				
Penalty clause	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Notification time 2 days or less		✓				✓				✓			
Positive response			✓	✓	✓		✓	✓	✓	✓			✓
Standard marking color code	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Tolerance zone within 24 inches	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Year of State legislation	1994	1987	1995	1995	1984	1993	1987	1979	1979	1997	1986		1991
Legislative activity in 1997						✓				✓	✓		
Number of one-call service centers	1	1	1	1	2	1	1	1	1	1	1		6

Table 3–1. Overview of the characteristics of State programs to prevent excavation damage.

Program characteristic	Illinois	Indiana	Iowa	Kansas	Kentucky	Louisiana	Maine	Maryland	Massa-chusetts	Michigan	Minne-sota	Missis-sippi	Missouri
Protects all utilities[a]	✓		✓		✓	✓		✓		✓	✓	✓	✓
Mandatory participation for facility owners	✓		✓	✓		✓	✓	✓	✓	✓	✓		
No exemptions for excavation notification			✓				✓	✓	✓			✓	
24-hour access[b]	✓	✓	✓	✓			✓		✓	✓	✓		✓
Emergency response procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Permits issued							✓		✓				
Penalty clause	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notification time 2 days or less	✓	✓	✓		✓		✓	✓			✓	✓	✓
Positive response	✓	✓	✓	✓		✓		✓		✓		✓	✓
Standard marking color code	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Tolerance zone within 24 inches	✓	✓	✓	✓	✓	✓		✓		✓	✓		
Year of State legislation	1991	1990	1993	1993	1995	1995	1991	1974	1980	1989	1987	1985	1992
Legislative activity in 1997	✓		✓								✓	✓	
Number of one-call service centers	2	1	1	1	1	1	1	2	1	1	1	1	1

Table 3–1. Overview of the characteristics of State programs to prevent excavation damage.

Program characteristic	Montana	Nebraska	Nevada	New Hampshire	New Jersey	New Mexico	New York	North Carolina	North Dakota	Ohio	Oklahoma	Oregon	Pennsylvania
Protects all utilities[a]	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
Mandatory participation for facility owners	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓
No exemptions for excavation notification	✓			✓		✓		✓					
24-hour access[b]	✓	✓	✓	✓					✓	✓	✓	✓	✓
Emergency response procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Permits issued				✓					✓				✓
Penalty clause	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
Notification time 2 days or less	✓					✓			✓				
Positive response	✓	✓	✓		✓		✓		✓		✓	✓	✓
Standard marking color code	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tolerance zone within 24 inches	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Year of State legislation	1991	1995	1987	1983	1994	1991	1997	1986	1995	1990	1982	1997	1996
Legislative activity in 1997				✓		✓		✓		✓			
Number of one-call service centers	2	1	1	1	1	2	2	1	1	2	1	1	1

Table 3–1. Overview of the characteristics of State programs to prevent excavation damage.

Program characteristic	Rhode Island	South Carolina	South Dakota	Tennes-see	Texas	Utah	Vermont	Virginia	Wash-ington	West Virginia	Wis-consin	Wyoming
Protects all utilities[a]		✓	✓	✓		✓		✓	✓	✓	✓	✓
Mandatory participation for facility owners	✓		✓			✓	✓	✓	✓		✓	✓
No exemptions for excavation notification				✓			✓					
24-hour access[b]	✓		✓	✓	✓		✓			✓		
Emergency response procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Permits issued	✓						✓					✓
Penalty clause	✓	✓		✓		✓	✓	✓	✓		✓	✓
Notification time 2 days or less	✓		✓			✓	✓			✓		✓
Positive response		✓	✓	✓		✓		✓			✓	✓
Standard marking color code	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Tolerance zone within 24 inches	✓			✓	✓	✓	✓	✓	✓	✓		✓
Year of State legislation	1984	1978	1993	1978	1997	1977	1988	1994	1990	1996	1995	1996
Legislative activity in 1997		✓	✓	✓	✓							
Number of one-call service centers	1	1	1	1	3	1	1	3	8	1	1	10

[a] Subject to each State's definition of activity.

[b] Although notification calls may be recorded on a 24-hour basis, most States process notifications only during normal business hours.

Source: One-Call Systems International Directory, 1997–1998. The criteria identified for program characteristics were taken from the proceedings of the National Transportation Safety Board's workshop held in 1994 (NTSB/RP-95/01).

In April 1996, excavation damage of a water main in Buffalo, New York, flooded the downtown area. The municipal water department was not a member of the local one-call system. In fact, at that time four separate city utilities in Buffalo had to be notified to coordinate excavation work; none of those utilities participated in the local one-call system. This situation existed even though State law required participation and made it free for municipalities.

Panelists at the 1994 damage prevention workshop agreed that all owners/operators of buried facilities should participate in damage prevention programs; there should be no exceptions. Some States have realized the value of full participation and have taken legislative action to ensure participation. For example, according to Pennsylvania law, underground facility owners who are not one-call members cannot collect damage costs from excavators who hit their lines. A similar requirement became effective in Florida in October 1997. Oregon has mandatory one-call membership provisions for all facility owners with lines that cross public rights-of-way.[31]

The Safety Board agrees that the failure of all parties to participate in damage prevention programs can substantially undermine the effectiveness of the programs. When parties such as State transportation departments and railroads are given exemptions to participation in excavation damage prevention programs, these parties, in essence, are no longer obligated to use one-call notification centers to protect their facilities or to protect the facilities of others that use their rights-of-way. Nor are they obligated to inform other parties of their intent to dig or excavate. In addition to public safety interests, the Board is concerned that taxpayers ultimately bear the burden for these exemptions by paying for the cost of fixing excavation damage, particularly damage caused by State agencies that are not protecting their facilities. The Safety Board concludes that full participation in excavation damage prevention programs by all excavators and underground facility owners is essential to achieve optimum effectiveness of these programs.

Because of the number of State transportation department activities that are exempt from participating in excavation damage prevention programs, the Safety Board believes that the Federal Highway Administration should require State transportation departments to participate in excavation damage prevention programs and consider withholding funds to States if they do not fully participate in these programs.

Although railroad rights-of-way are not as prevalent as those of highways, they frequently serve as ideal routes for underground facilities, particularly for gas and oil transmission lines. Contractual provisions for underground facilities to use railroad rights-of-way are a revenue source for the railroads. However, railroads are also exempt from participating in some State excavation damage prevention programs. For the larger, Class 1 railroads, there are usually internal operating procedures for notification of

[31] Underspace Bulletin 3(9): 2. June 1997. Spooner, WI: Center for Subsurface Strategic Action (CSSA).

excavation work on railroad property. However, recent trends in contracting out construction and maintenance services suggest that not all work is controlled through internal operations. Additionally, the number of small, short line railroad companies is increasing. The Association of American Railroads estimates that there are 450–475 short line railroads; 424 are members of the American Short Line Railroad Association (ASLRA). ASLRA membership has doubled in the past 25 years. These smaller companies often do not have the resources to operate internal excavation notification systems. Consequently, the Safety Board believes that the Association of American Railroads and the American Short Line Railroad Association should urge their members to fully participate in statewide excavation damage prevention programs, including one-call notification centers.

One-Call Notification System

Function and Structure of the Centers.—A cornerstone of current damage prevention programs involves the use of one-call notification centers. One-call notification centers function as communication systems established by two or more utilities, government agencies, or other operators of underground facilities to provide one telephone number for notification of excavating, tunneling, demolition, or any other similar work.[32] The system is designed so that excavation contractors, other facility owners, or the general public can notify the one-call center of the location of intended digging or construction activity. The intended area of excavation may be pre-marked, generally with white spray paint, to specifically indicate the digging or construction area.[33] Based on that one call, the center, in turn, notifies its members that digging or construction will occur in a given location. The facility owners, or their contract locator service, go to the excavation site and mark the location of any of their underground facilities in that area. By avoiding the use of power-driven tools in the vicinity of marked facilities, there is a decreased risk of damage to underground facilities.

Notification services use a variety of names and logos to create meaningful associations in the public's mind: Miss Dig System in Michigan, Underground Service Alert in California, Utility Protection Center in Georgia, and Digger for the Chicago Utility Alert Network. There are 84 one-call centers in the U.S. covering almost all areas of the

[32] As defined by One-Call Systems International (OCSI), a subgroup of the American Public Works Association (APWA).

[33] Pre-marking is discussed later in this chapter.

country.[34] Of these, 55 are members of One-Call Systems International (OSCI). OSCI members recorded over 13 million excavation notifications in 1996.[35]

In 1996, a nationwide referral number, 1–888–258–0808, was established by the APWA and administered by Sprint. In the fall of 1997, this number was automated by the APWA and is handled through the Georgia One-Call Center. A placard containing this number is placed on all newly manufactured construction equipment; placarding resulted from coordination with the Equipment Manufacturers Institute. Ideally, a call to that nationwide referral number would result in an automatic transfer to the appropriate one-call center. This automatic transfer exists on a small scale for the State of California, which uses two one-call systems but uses only one statewide phone number. However, because automated switching of calls to the referral number would result in substantial expenses for long distance telephone charges and billing, the existing referral service informs the caller of the correct one-call number, based on the caller's identification of the geographic location of the excavation, and the caller must then place a second phone call to that center.

The organizational structure of one-call centers varies: some are functioning units of the local ULCC; others are joint efforts of a few facility owners. Statutory language in some States stipulates the composition of the Board of Directors (for example, Minnesota, North Dakota, South Dakota, Nebraska, and Oregon),[36] but government involvement varies by State and by one-call center. Many one-call centers have been organized as not-for-profit corporations that operate with a limited degree of State oversight. Their administrative framework, funding arrangements, and operating procedures also vary. For example, California allows local government agencies to recover all costs of one-call membership through the permit fees that it charges contractors. Several States make participation by municipalities free. According to the OCSI, its member organizations were "developed to best suit the needs of the underground facility owners in that state" and "state laws do not govern the operation of a one-call system. The laws generally set out who is required to belong to a one-call system and who must call a one-call system as well as enforcement provisions. No two State laws are alike."[37]

Methods of Operation.—The differences in State involvement translate into very practical distinctions between one-call centers. An assortment of communication methods are used to receive excavators' calls and to issue notification tickets to the centers' participants; centers may use telephone staff operators, voice recorded messages, e-mail,

[34] "Nationwide One-Call Directory." Pipeline & Utilities Construction. April 1996.

[35] Don Evans of USA South cited 13,362,684 in the "Options in Load Management" session at the 22^{d} annual One Call Systems and Damage Prevention Symposium, April 20–23, 1997, New York City.

[36] Kelly, Walter. 1996. Making One-Call Work for You. Constructor, November 1996: 19.

[37] Correspondence dated February 10, 1997, from L.D. Shamp, representing the OCSI, to the Association of Oil Pipe Lines. The letter offered comments and suggestions regarding the provisions of the proposed one-call legislation.

fax machines, Internet bulletin boards, or a combination of methods. Service hours may be seasonally limited to a few hours a day or extend to 24 hours a day. Some locations operate only seasonally because of construction demand; most operate year-round. Most centers have statewide coverage but may not strictly follow State boundaries. A center may cover portions of several States (Miss Utility in Virginia, Maryland, and the District of Columbia) or there may be several centers within a State (Idaho has six different one-call systems; Washington and Wyoming each have nine). Centers may provide training to the construction community, conduct publicity campaigns to educate the public to excavation notification requirements, and work with facility operators to protect their underground facilities. Other centers do little work in these areas.

Some centers use positive response procedures—members who do not mark facilities in the construction area confirm that they have no facilities in the area rather than just not mark a location; other centers do not have this requirement. A part of the Miss Utility program in the Richmond, Virginia, area uses positive response procedures to notify the excavator when the marking is complete. Facility owners directly inform a voice messaging system of the status of a notification ticket. (Notification tickets are identified and discussed in the following section.) As a time-saving alternative, the contractor can call the information system anytime to receive an up-to-date status of their marking request. Information indicating that marking has been completed, or that no facilities are located in the area of excavation, allows construction work to proceed as soon as marking is completed rather than waiting the full time period for which marking activity is allowed.

The important elements of an effective one-call notification center have been generally identified by industry organizations. For example, the position of the Associated General Contractors of America on one-call systems[38] is summarized in six elements: mandatory participation; statewide coverage; 48-hour marking response; standard marking requirements; continuing education; and a fair system of liability. Participants at the Safety Board's 1994 workshop, on the other hand, developed detailed lists of elements they believed are essential for an effective one-call notification center, other elements a center should have, and elements it could have (appendix D). All agreed, however, that first and foremost was the need for mandatory participation and use of notification centers by all parties. The Safety Board concludes that many essential elements and activities of a one-call notification center have been identified but have not been uniformly implemented.

Excavation Notification Tickets.—A record of a locate request is generally called an excavation notification ticket, but there is no standard format for one-call excavation notification tickets. One-call centers track excavation activity based on the number of notification tickets they handle for their members, but they do not necessarily track

[38] Transportation Research Board, National Research Council. 1988. Pipelines and Public Safety. Special Report 219 (p. 133). Washington, DC.

how many of those digging activities result in excavation hits. For the centers that do maintain a record of hits, one-call members must report their hits to the center; the center then compiles the information.

The OCSI Committee on Communication Standards is developing a universal ticket format to address the problem of underground facility owners who work in different States and who receive tickets from more than one notification center.[39] For large companies working in different one-call areas, information that is organized into different formats can be confusing and can lead to unsafe activities at the excavation site. According to discussions at the Safety Board's 1994 workshop, the format needs to be consistent between centers, both in terms of ticket information and the work unit represented by a ticket. For example, a ticket from one center might encompass work for all utilities at a given two-block construction site, whereas another might separate tickets for each utility, or by smaller geographic areas. Damage reports must also be consistent, and OCSI is considering the feasibility of including damage information in the universal ticket format. The committee expects to finalize a universal ticket format in January 1998. An example of a universal damage report form developed by Alberta One-Call is included in appendix E. The Safety Board encourages the OCSI members and all other notification centers to adopt a universal ticket format and to maintain ticket data. Standard ticket information would be an essential first step in developing performance measures for damage prevention programs. (Performance measures are discussed in more detail in chapter 5.)

Effective Sanctions

Penalties for failure to act in accordance with State damage prevention programs vary depending on location; provisions for oversight and timely enforcement can be quite different from State to State. Administrative enforcement of State excavation damage prevention laws does not require State court actions and has been shown to be effective in several States. For example, in Pennsylvania's new legislation (Act 187 enacted in 1996), the process of enforcement includes $100 and $200 citations for minor infractions to the State's excavation damage prevention law and $2,500 and $25,000 civil penalties for more serious infractions. The Department of Labor and Industry is responsible for administrative enforcement; the State's Attorney General handles civil penalties.

The use of administrative enforcement is a characteristic of several State programs for excavation damage prevention. The following examples from Massachusetts, Minnesota, and Connecticut illustrate three programs that operate differently but use administrative enforcement to effect safer excavation practices. The structure and cost of

[39] Underspace Bulletin 2(11): 2. August 1996. Spooner, WI: Center for Subsurface Strategic Action (CSSA).

penalties for non-participation in the excavation damage prevention programs varies, but the States' common goal is to foster safe practices.

Massachusetts originally passed damage prevention legislation in 1959; it required all excavators to notify utilities before they began to dig. Legislation in 1980 empowered the Department of Public Utilities (DPU) with enforcement authority under the State's Administrative Procedures Act. Beginning in 1986, the Dig Safe Law enforcement was delegated to the chief engineer in the pipeline engineering and safety division of the DPU. A staff of one person handles the administrative enforcement of damage prevention for the State of Massachusetts. That person has authority to issue notices of probable violation with fines that range from $200 to $1,000. In administering the program, the DPU keeps fines at a reasonable level compared to many other States. Since 1986, the State has issued over 3,000 notices; third-party damages dropped from 1,138 in 1986 to 412 in 1993. The Department requires utility companies to report any third party damages within 30 days, and excavators are encouraged to send the Department violation notices for State adjudication if they find fault with the utility companies. State utility owners and excavators are provided books of violation tickets to document infractions of damage prevention rules to the DPU. Using this mechanism, involved parties can notify the State of problems, such as when facilities are mismarked or not marked within the required time, when excavators do not use the notification system, or when line hits are not reported. The State has found that its readiness to dispense small penalties has resulted in awareness of damage prevention throughout the industry. The State's administrative enforcement process does not rely on the Attorney General's office for execution; thus it keeps State pipeline safety actions from being in direct competition with all other State actions.

Other States have also found benefits from administrative rather than court enforcement of their regulations. Minnesota's Department of Public Safety, Office of Pipeline Safety, takes complaints, investigates, and issues penalties of up to $500. The State Office of Pipeline Safety, MnOPS, is the enforcement entity. Minnesota focuses strongly on education as a key to the success of damage prevention. Violators of the regulation often are allowed to institute training actions instead of paying fines.

Connecticut also uses an administrative process to enforce its damage prevention program. Its Call-Before-You-Dig law, first passed in 1978, had only one penalty provision: if an excavator failed to call before digging and subsequently damaged facilities, the excavator could be fined up to $10,000. A representative from Connecticut Call Before You Dig has stated, however, because of the severity, the penalty was not used.[40] An accident on December 6, 1985, in Derby, Connecticut, occurred when an excavator struck a gas line; the excavator had used the notification system.[41] Natural gas from the broken

[40] National Transportation Safety Board. 1995. Proceedings of the Excavation Damage Prevention Workshop; September 8–9, 1994. Report of Proceedings NTSB/RP-95/01 (p. 16). Washington, DC.

[41] National Transportation Safety Board Accident Brief DCA86FP004.

main migrated into the basement of a restaurant, exploded, and killed seven people. The severity of this accident focused attention on the shortcomings of the existing law and resulted in a change in the penalties, fines, and overall structure for enforcement. Connecticut created a position of compliance supervisor, an employee of the one-call center, who serves as a field investigator and expert witness at that State's DPU hearings. The compliance supervisor receives incident reports and maintains case files on noncompliance. Connecticut law allows for fines on the first or second offense if the severity of the offense, injuries, or past performance warrants. Otherwise, the compliance supervisor sends a letter to the party explaining the damage prevention program and stating what compliance actions are needed. The DPU may send letters of inquiry or interrogatories, proceed with a docket for penalties, or schedule a "show cause" hearing. Offending parties have 30 days to appeal by requesting a hearing. In 1994, excavation damage to underground lines in Connecticut declined 28.5 percent compared to earlier years before administrative enforcement. Of the 436 incidents of damage in that year, 223 were gas lines, 91 were water lines, 78 were electric lines, 40 were communication lines, and 4 were sewer lines.[42]

Other States have implemented stringent programs for excavation damage prevention, with severe penalties for noncompliance. Because of its small area and concentrated population, New Jersey has a dense network of pipelines: 30,000 miles (48 270 kilometers) of intrastate lines and 1,000 miles (1609 kilometers) of interstate lines.[43] As a result of the 1994 accident in Edison, New Jersey, the State implemented heavy fines and strong enforcement, effective in 1995. Digging near a gas line without calling for the facility owner to mark the location can result in a $25,000 fine, and the company involved in underground facility damage is required to provide a written plan for remediation and training. The number of one-call notifications has increased 30 percent between 1995 and 1996. The New Jersey Board of Public Utilities recorded 2.2 million notifications for 1996. Even though there were 17 percent fewer hits in 1996, they still totaled 3,961. As previously mentioned, however, the New Jersey State Department of Transportation is exempt from participating in the one-call notification process.

Participants at the Safety Board's 1994 workshop generally agreed that penalties need to be enforced in order to recover the costs of the damage prevention programs; however, the participants also believed that self-policing partnerships between operators and excavators were essential and that the administration of the program should be as simple and streamlined as possible with a minimum of government oversight. The participants believed that by doing so, costs to stakeholders would be minimized and there would be a greater potential for success. The participants also indicated that State programs should have enough flexibility to be able to implement alternative procedures that still meet the intent of the program.

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[42] "Connecticut Data Reveals Damage Causes." Underground Focus 10(5): 17. July/August 1996.

[43] "New Jersey Takes a Hard Line on Underground Damage Prevention." Underground Focus 11(3): 26–27. April 1997.

The administrative approach to enforcement of damage prevention programs is designed to promote compliance rather than punishment, and to create awareness of good damage prevention practices rather than to collect fines or to put small companies out of business. Administrative enforcement has been accomplished without creating an additional bureaucracy, and the cost of the enforcement program has been covered even with the small fines and penalties that are imposed. The Safety Board concludes that administrative enforcement has proven effective in some State excavation damage prevention programs.

Excavation Marking

Excavation occurs frequently. The excavation notification system in Illinois recorded over 100,000 calls during the month of April 1997.[44] In New Jersey, its one-call system records 2.2 million excavation markings per year, an average of more than 6,000 per day.[45] With this rate of occurrence, the frequency of hits would be dramatically higher if some information about line locations were not available.

An entire industry of underground utility locating businesses have developed in the last two decades. Primarily, these businesses serve utility companies by performing the marking services associated with one-call notification. Referred to as locators, these technicians visit construction sites and mark the location of underground facilities using both mapping technology and electronic tools. Practices for marking the underground facilities can have an impact on the risk of excavation damage. Good practices include pre-marking the intended excavation site by the excavator to clearly identify to the facility locator the area of digging; positive response by the utility owner to confirm that underground facilities have been marked or to verify that no marking was necessary; the use of industry-accepted marking standards to unambiguously communicate the type of facility and its location; marking facility locations within the specified notification time; and responding to requests for emergency markings, when necessary.

The timeframe for excavation marking is usually specified by State damage prevention laws. Twenty States require underground facility marking to be accomplished within 48 hours of excavation notification. Construction work planning is not evenly distributed throughout the week; consequently, one-call centers may schedule three or four times the number of locates for some days compared to other days. This, in turn, creates variable workloads for utility locators.

[44] "News Briefs." Underground Focus 11(5): 14. July/August 1997.

[45] "New Jersey Takes a Hard Line on Underground Damage Prevention." Underground Focus 11(3): 26–27. April 1997.

Pre-Marking.—Participants at the 1994 workshop agreed that pre-marking the proposed excavation area has been demonstrated to enhance the safety of excavation activities. Pre-marking allows the excavators to specifically tell facility owners where they intend to dig. Some States require the use of white marking to indicate the boundaries of planned excavations. Maine was one of the first States to have mandatory pre-marking for non-emergency excavations. Connecticut has also adopted a pre-marking requirement; the law provides for face-to-face meetings between operators and excavators for projects that are too large for or not conducive to pre-marking.

According to workshop participants, pre-marking an excavation site helps to ensure that owners of underground facilities are aware of the specific area that is to be excavated. Facility owners avoid unnecessary work locating underground facilities that are not associated with the planned excavation. Excavators can be certain that underground facilities within their intended area of excavation are well marked.

Because pre-marking defines the physical boundary of the excavation site, it removes ambiguity about what underground facilities need to be located. Marking the intended excavation area creates a greater likelihood that affected underground facilities will be identified to the excavator. The Safety Board concludes that pre-marking an intended excavation site to specifically indicate the area where underground facilities need to be identified is a practice that helps prevent excavation damage.

Marking Standards.—Most State laws on damage prevention call for facility owners to follow the standards for temporary marking developed by the ULCC. Figure 3–1 identifies the color codes. Local one-call centers often distribute pocket-size flash cards with these color codes to excavators. The use of standard marking colors informs the excavator about the type of underground facility whose location has been marked.

Markings of the appropriate color for each facility are placed directly over the centerline of the pipe, conduit, cable, or other feature. There are procedures for offset markings when direct marking cannot be accomplished. For most surfaces, including paved surfaces, spray paint is used for markings; however, stakes or flags may be used if necessary. In addition to uniform color codes used to transmit standard information about the type of facility marked, the National Utility Locating Contractors Association (NULCA) has developed a proposal for standard marking symbols. The proposal is currently available only for internal use but is being designed for distribution to members in the future. NULCA's proposed standard addresses conventions for marking the width of the facility, change of direction, termination points, and multiple lines within the same trench. The standard symbology indicates how to mark construction sites to ensure that excavators know important facts about the underground facilities; for example, hand-dig areas, multiple lines in the same trench, and line termination points. The Safety Board recognizes the benefit of industry efforts to standardize marking practices. Such conventions help to avoid misinterpretation between locators who designate the position of underground facilities and excavators who work around those facilities. Participants at the workshop recommended that uniform marking include the facility owners' identification.

NULCA's work to define standard marking symbols incorporates the use of facility owner's identification marks along with conventions for identifying underground system configurations.

Color	Feature identified
red	electric power lines, cables, conduit and lighting cables
yellow	gas, oil, steam, petroleum, gaseous materials
orange	communications, alarm or signal lines, cable or conduit
blue	water, irrigation, and slurry lines
green	sewers, drain lines
pink	temporary survey markings
purple	cable television
white	proposed excavation

Figure 3–1. Uniform color code of the American Public Works Association, Utility Location and Coordinating Council.

Employee Qualifications and Training

Training to prevent excavation damage to the underground infrastructure is not limited to the pipeline industry and operating personnel: locators need training in locating techniques, equipment technology, and marking procedures; excavators need training to fully participate in the notification process and to understand locator marking symbols; one-call operators need training to efficiently and effectively transmit information between excavators and underground system operators; and the general public needs to be aware of the one-call notification process when they dig for private projects. In addition, anyone working to operate underground systems or whose work requires underground digging needs to be trained in emergency response procedures. This diversity of training needs presents a challenge to both system regulators and the industry.

Training and Educating Excavation Personnel.—Excavators need to be trained and educated about safe work conditions, good excavation practices, relevant State laws, and one-call procedures. In this context, the excavator is not only the backhoe operator at the construction site, but also the project manager, the scheduler, company

officials—anyone connected to excavation work. In an effort to ensure that excavators are aware of their responsibilities to protect underground facilities, some States have licensing requirements that assess professional knowledge. For example, Florida law (in Section 556.104 of the Florida Statutes) requires contractors who work near buried facilities to be licensed, a process that involves passing a written examination. Excavators should fully understand the one-call notification process: the meaning of facility markings, requirements for hand digging near underground facilities, notification responsibilities when the scope of work changes, and emergency response procedures. Many one-call centers offer outreach training programs designed for excavators. Some one-call center personnel have met with local union organizations and industry associations to explain the notification process and State damage prevention laws.

Because marking the position of an underground line is a safety-critical job, training is necessary to ensure that locators are well prepared to perform this function. NULCA has defined a set of minimum standards for its members to adopt as part of their training programs.[46] The program includes 118 hours of structured training in the topics of system design, construction standards, equipment techniques, recognition of line type, locating theory, and safety procedures. In addition to recommending the use of written tests, the program recommends field training and annual re-testing.

The NULCA has also developed guidelines for excavation practices and procedures for damage prevention. These guidelines, which were revised in September 1997, incorporate OSHA requirements and identify best practices applicable to excavation work. Use of the guidelines is voluntary, but NULCA's brochure explains that legislation in most States requires contractors who plan to excavate to notify the appropriate one-call center and non-member facility owners before the job begins. Appendix F contains NULCA's Excavation Practices and Procedures. The guidelines address pre-planning and job site activities for both large and small projects. Instructions for handling damage, along with a construction facility damage report form, are also included. The Safety Board commends NULCA's efforts in promulgating good practices among its members and the excavation community.

Title 29 CFR 1926, Subpart P, contains several worker safety requirements on excavation activities. In 1990, OSHA developed and issued a booklet, *Excavation*, to assist excavation firms and contractors in protecting workers from excavation hazards. The booklet is based on the requirements of Part 1926 and gives specific advice on preventing cave-ins and providing protective support systems. OSHA employs several methods of providing information to persons subject to its regulations; its latest information system uses the Internet via the World Wide Web to provide assistance to excavators and contractors on complying with OSHA requirements. Responses to frequently asked questions, statistical data, news releases, OSHA pamphlets and

[46] National Utility Locating Contractors Association. 1996. Locator Training Standards & Practices. Spooner, WI.

publications, and a listing of available training materials can be obtained via the computer.

Federal training requirements for the transport of hazardous liquids are stated in 49 CFR 195.403. These are general requirements that do not specifically discuss excavation activities, and there are no comparable general training requirements for gas operator employees. RSPA has a joint industry and government working group that periodically meets to develop proposed requirements for employee qualification and training. That committee, the Negotiated Rulemaking Advisory Committee on Pipeline Personnel Qualifications, completed its fourth meeting in August 1997. It has prepared three drafts of a proposed operator qualification regulation for committee consideration. The committee has not reached consensus and is still considering draft regulatory language.

Participants at the Safety Board's workshop recommended that excavator associations work in conjunction with operators of buried facilities and one-call notification centers to provide buried-facility damage-prevention training as part of their safety training programs. The participants acknowledged that the Associated General Contractors of America and many contractor organizations are very safety conscious and have produced several videotapes about safety issues. Few of these education efforts, however, include testing. The current negotiated regulation process at RSPA has addressed the issue of training verification and testing, but the scope of that work is limited to only oil and gas operators subject to Federal regulations.

The Safety Board has long been concerned that all personnel involved in excavation activity be properly trained and qualified and has issued several recommendations in this area as a result of its accident investigations. Following the investigation of an accident in Derby, Connecticut, in December 1985, the Safety Board recommended that Northeast Utility Service Company

> Emphasize in its training of operating personnel the importance of following the company procedures for patrolling and protecting its gas mains in proximity to excavation projects. (P-86-19)[47]

The Safety Board's investigation of an accident that occurred 3 months later in Chicago Heights, Illinois, also generated a recommendation concerning training. The Board recommended that Northern Illinois Gas Company

> Emphasize in company training the importance of following company procedures for making areas near gas pipeline leaks safe for the public by evacuation or other means. (P-87-38)[48]

[47] National Transportation Safety Board. 1986. Northeast Utilities Service Co. Explosion and Fire; Derby, Connecticut; December 6, 1995. Pipeline Accident Report NTSB/PAR-86/02. Washington, DC. As a result of the Northeast Utility Service Company's positive response to Safety Recommendation P-86-19, the recommendation was classified "Closed—Acceptable Action" on May 14, 1987.

As a result of an explosion and gas-fueled fire that occurred on July 22, 1993, when a backhoe of the city of St. Paul Department of Public Works hooked and pulled apart a high-pressure gas service line, the Safety Board asked the American Public Works Association to

> Advise its members of the circumstances of the July 22, 1993, explosion in St. Paul, Minnesota, and urge them to develop and implement written procedures and training to prevent excavation-caused pipeline damages. (P-95-24)[49]

In 1987, RSPA first issued a notice of proposed rulemaking (NPRM) to improve the competency of operator personnel and to set minimum training and testing standards for employees of pipeline operators. A notice issued in October 1991 stated that a second proposal, based on comments received earlier, would be forthcoming. By 1993, RSPA still had not acted to implement any employee qualification and testing standards, and the Safety Board urged that this issue become a priority in the regulatory agenda. Ten years after its original NPRM in 1987, RSPA has entered into negotiated rulemaking. Action on this issue is long overdue. The Safety Board concludes that employee qualification and training is an integral component of an effective excavation damage prevention program, and industry has recognized the need for employee training but has not implemented training uniformly. Inadequate employee training was highlighted in the Safety Board's report of the San Juan accident.[50] In that report, the Board recommended (P-97-7) that RSPA complete a final rule on operator employee qualification, training, and testing standards within 1 year. The Board further stated in that recommendation that the final rule should require operators to test employees on the safety procedures they are expected to follow and to demonstrate that they can correctly perform the work.

Because RSPA's rulemaking would cover only those employees of oil and gas operators subject to Federal regulations, additional efforts are needed by industry to provide training materials to those employees not covered by the regulations. The OCSI's Training Committee—which develops educational materials for use by notification center employees, facility owners, and excavators—would appear to be the appropriate organization to accomplish this goal. Therefore, the Safety Board believes that the APWA should review existing training programs and materials related to

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[48] National Transportation Safety Board. 1987. Chicago Heights, Illinois; March 13, 1986. Pipeline Accident Summary Report NTSB/PAR-87/01-SUM. Washington, DC. Safety Recommendation P-87-38 was classified "Closed—Acceptable Action" on September 29, 1988.

[49] NTSB accident DCA93FP004. Safety Recommendation P-95-24 is currently classified "Open—Acceptable Response" pending receipt of further information from the APWA.

[50] National Transportation Safety Board. 1997. San Juan Gas Company, Inc./Enron Corp. Propane Gas Explosion in San Juan, Puerto Rico, on November 21, 1996. Pipeline Accident Report NTSB/PAR-97/01. Washington, DC.

excavation damage prevention and develop guidelines and materials for distribution to one-call notification centers.

Emergency Response Planning.—Pipeline operators are required by law to establish written emergency procedures for classifying events that require immediate response, communicating with emergency response officials, and responding to each type of emergency.[51] Although the extent of emergency response planning may vary depending on the type of excavation activity, emergency response planning should involve a definition of responsibilities, a flow chart of actions, execution criteria, systems inventory and resource information, coordination procedures (internal and external), and simulation exercises of response actions.

Federal regulations require no emergency response plan for excavators; however, these are the very people that often have responsibility for first response at an excavation disaster. The Safety Board has addressed the need for emergency response plans and procedures in many of its reports of accidents involving excavation damage. One such accident was an explosion in Cliffwood Beach, New Jersey, on June 9, 1993, that occurred as a result of a utility contractor's trenching operation. The Safety Board's investigation determined that a failure in training was causal to the accident.[52] The utility operator did not brief or determine whether the contractor knew what procedures to follow should the crew damage a main or service line. In addition, the Safety Board found no record or evidence of the contractor being properly trained in emergency procedures, and the facility operator's procedures did not include emergency response training for contractors. As a result of its investigation, the Safety Board recommended that the gas company take the following actions:

> Train all gas operations construction contractors for emergencies involving struck pipelines; training should stress immediately reporting natural gas pipeline strikes to New Jersey Natural Gas's emergency phone number. (P-94-01)[53]

As a result of the previously mentioned accident in St. Paul, Minnesota, on July 22, 1993, the Safety Board recommended that the American Public Works Association

> Urge your members to call 911 immediately, in addition to calling the gas company, if a natural gas line has been severed. (P-95-25)[54]

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[51] 49 CFR Part 192.615, "Emergency plans" [for gas pipelines]; and Part 195.402, "Procedural manual for operations, maintenance, and emergencies" [for hazardous liquids].

[52] NTSB accident DCA93FP008.

[53] On August 1, 1995, the Safety Board classified this recommendation "Closed—Acceptable Action."

[54] This recommendation is currently in an "Open—Acceptable Response" status pending further action by the APWA.

The Safety Board concludes that, at a minimum, excavators should formulate an emergency response plan appropriate for the specific construction site and ensure that employees working at that site know the correct action to take if a buried facility is damaged. The local one-call center can also play an important role in planning with local officials to define the best emergency response appropriate for its communities. The local one-call centers also are in a good position to disseminate this information on a regular basis. Therefore, the Safety Board believes that the APWA should develop guidelines and materials that address initial emergency actions by excavators when buried facilities are damaged and then distribute this information to all one-call notification centers.

Discussion

The Safety Board acknowledges that considerable progress has been made by RSPA and the industry in the area of improving excavation damage prevention programs since the Board's 1994 workshop and most likely because of it. The workshop provided a valuable forum to discuss how government and industry can work together to improve excavation damage prevention programs. The Safety Board believes that by continuing to focus attention on this important safety issue, the number of excavation-caused accidents to the Nation's underground facilities will ultimately decrease. Therefore, the Safety Board believes that RSPA should conduct at regular intervals, joint government and industry workshops on excavation damage prevention that highlight specific safety issues, such as full participation, enforcement, good marking practices, the importance of mapping, and emergency response planning.

Specific progress has been made to standardize marking symbols, to develop a uniform notification ticket, to develop guidelines for excavation practices and procedures, and to develop minimum standards for training programs. The importance of mandatory participation has been advocated by industry as well as government, yet many entities are granted exemptions to participation in State excavation damage prevention programs. Although many elements of an effective State excavation damage prevention program have been identified, the Safety Board is concerned that these elements have not been uniformly implemented. Some States have realized the benefit of swift, effective sanctions through the administrative process, yet many States are lacking effective enforcement programs. The practices and activities of one-call notification centers have also been identified, but these practices have not been uniformly implemented. The Safety Board concludes that although considerable progress has been made to improve State excavation damage prevention programs, additional efforts are needed to uniformly develop and implement programs that are most effective.

In 1996, RSPA established a joint government/industry Damage Prevention Quality Action Team. Participants include the American Petroleum Institute (API), the American Gas Association (AGA), the American Public Gas Association (APGA), the

Interstate Natural Gas Association of America (INGAA), One-Call Systems International (OCSI) of the APWA, the National Telecommunications Damage Prevention Council, the National Association of Regulatory Utility Commissioners (NARUC), the Associated Electrical and Gas Insurance Services, the National Association of Pipeline Safety Representatives, and industry participants. As stated in its charter, "the purpose of that team is to assess the status of current excavation damage prevention efforts and their effectiveness, and to identify additional efforts that would lead to reduction of excavation damage." However, rather than assessing the status of damage prevention efforts, the group set as its goal to "conduct a national pipeline awareness campaign." As of June 1997, the team had developed and distributed surveys to assess the awareness of one-call systems. Because the critical elements of an effective excavation damage prevention program have not been uniformly implemented at the State level, the Safety Board believes there is a need to review and evaluate existing damage prevention programs and to highlight deficiencies in existing programs so that corrective action can be taken. The Safety Board supports current legislative interest in provisions for a review of existing excavation damage prevention programs but does not believe there is a need to await Congressional action before such an evaluation is undertaken. The Damage Prevention Quality Team appears to be an appropriate mechanism for accomplishing a detailed evaluation of existing programs. Therefore, the Safety Board believes that RSPA, in conjunction with the APWA, should initiate and periodically conduct detailed and comprehensive reviews and evaluations of existing State excavation damage prevention programs and recommend changes and improvements, where warranted, such as full participation, administrative enforcement of the program, pre-marking requirements, and training requirements for all personnel involved in excavation activity.

Chapter 4

Accuracy of Information Regarding Buried Facilities

Underground Detection Technologies

Both facility owners and excavators have genuine interest in identifying the location of underground facilities. But with current locating equipment technologies and mapping records, there remains a variety of errors that can potentially affect the ability to positively identify the position of underground facilities. There is no one procedure or tool that can provide accurate location information for all types of facilities in all types of situations. Location work is a combination of operator experience and the correct use of technology.

A variety of remote sensing technologies can be used for detecting underground facilities. Different types of locating equipment and techniques are needed depending on structural composition of the buried materials, soil composition, and surface access.[55] A brief description of the types and attributes of locator tools is shown in table 4–1.

In addition to equipment choice, there are situational variables that affect detection accuracy. The more conductive the soil, the more shallow the conductor will appear. Sandy, loose soil with a high mineral content will give sensitive readings; pipe locations under these conditions may be deeper than the locator equipment readings indicate. Moisture content or water table levels can also affect depth readings.

For equipment types that determine location by sensing an electronic signal that has been introduced into the underground system, strength of the locating signal depends on where the signal was introduced into the system, the proximity of structural uprights connected to the underground system, and nearby surface obstructions that dissipate the signal. Selection of radio signal frequency can also affect signal clarity. Equipment readings cannot be taken as absolute values; they depend on situational effects associated with locator equipment calibration, field conditions, and the operators familiarity with the particular operating characteristics.

[55] Anspach, J.H. 1994. Locating and Evaluating the Conditions of Underground Utilities. In: RETROFIT ’94. Washington, DC: National Science Foundation. Sponsored by: Stanford University and the National Science Foundation.

Table 4–1. Types of locator equipment.

Equipment type	Functional description	Attributes
Radio frequency (RF) detection techniques	Conventional underground line detection method. Requires a transmitter and a receiver. Conductive tracing attaches the transmitter directly to the line or tracer wire. Inductive tracing does not require direct line connection.	Oldest, most widely used technology. Inductive signal detection is quicker, but conductive signal reading is more accurate.
Electromagnetic techniques	Records signal differentials of magnetic fields. Similar to radio frequency technology.	Useful for detecting metal objects or structures that exhibit strong magnetic fields at the ground surface. This type of detector is affected by obstructions between the transmit signal and the locating equipment.
Magnetic methods	Useful for detecting iron and steel facilities.	Magnetic flux methods are easy to use and inexpensive, but they are subject to interference from metal surface structures.
Vacuum extraction	Small test holes are dug from the surface by vacuuming out the soil. The activity, usually referred to as “potholing,” follows more preliminary locating work to identify the general facility location. The pothole then confirms the location and verifies a depth for that specific site.	Requires preliminary records search to approximate location for potholing and special vacuum equipment. Process can be expensive and labor intensive.
Ground penetrating radar	Radar wave reflections from underground surfaces of different dielectric constants are used to identify subsurface structures.	This method is relatively expensive compared to other locator methods and does not work well in clay or saltwater.
Terrain conductivity	Detects current measures that differ from average ground surface conductivity.	This method can be useful in areas of high conductivity, such as marine clay soils, particularly for locating underground storage tanks.
Global positioning system (GPS)	Uses triangulated satellite telemetry to identify latitude/longitude location of ground unit.	While not a detection technology, GPS coordinates are frequently used to define geographic location.

Adapted from: Anspach, J.H. 1994. Locating and Evaluating the Conditions of Underground Utilities. In: RETROFIT ’94. Washington, DC: National Science Foundation. Sponsored by: Stanford University and the National Science Foundation.

Many water and sewer lines are made of plastic or concrete pipe, gas systems commonly use plastic pipe, and fiber optic cable is often used in telecommunication lines. These systems are difficult to detect with common locator tools because they do not contain metal. A metal tracer wire can be buried with the pipe to facilitate future locating work. Typically, pipe is laid in the trench and covered by a shallow layer of fill dirt. The tracer wire is then placed over the pipe and trench filling is completed. Detectable warning tape—aluminum foil covered with color-coded polyester—can be buried with nonmetallic underground facilities to permanently mark the lines. Varieties of tracer wire and detectable warning tape are designed to be sturdy enough to be plowed into the trench during backfill operations.

The Safety Board recognizes industry efforts to inform locators about issues relevant to locator technology. *Underground Focus* magazine sponsors an annual utility locating technology seminar. This training event, currently in its 6th year, provides information on utility locating techniques, equipment, and new technology. Participants include locators, equipment manufacturers, engineers, trade association representatives, and academic interests. Topics related to locator equipment are also regularly addressed at conferences such as the annual OCSI symposium and the Underground Safety Association forum.[56]

Vertical/Depth Location

The only certain method of determining facility depth is to expose the pipe, conduit, or cable through hand digging or through vacuum excavation. Southwestern Bell's use of vacuum excavation to expose and document exact facility locations is credited with decreasing cable damages by 50 percent in Texas during 1996.[57] This method positively identifies both the horizontal and vertical location of the pipe at a specific site. But certainty about the line's position is inversely related to its distance from the test hole. Depth depends on how the line was installed and on the changes in surface grade caused by erosion or construction since installation.

For selected models of locating equipment, manufacturers claim that the units can accurately determine depth.[58] Accurate depth measurements are a highly desirable attribute of locating equipment. Based on equipment manufacturers' claims, States have begun

[56] OCSI will hold its 23d annual symposium in March 1998, and the Underground Safety Association will hold its forum in February 1998.

[57] Underspace Bulletin 3(7): 2. April 1997. Spooner, WI: Center for Subsurface Strategic Action (CSSA).

[58] According to advertisements for the Sure-Lock locator by Heath Consultants, that equipment provides a continuous depth reading. Other equipment manufacturers, Fisher TW-770 and Metrotech 9800, advertise a pushbutton feature for digital display of depth.

to consider adding requirements for depth location information to their damage prevention legislation. Wyoming's Underground Facilities Notification Act of 1996 requires construction project owners to furnish information on the nature, location, and elevation of underground facilities.[59] Minnesota is considering a similar requirement.

Remote locating devices that measure depth are susceptible to calibration problems, antenna misalignment, and electronic fields that are combined from more than one surface conductor.[60] The capability for accurate depth measurement may exist under ideal situations, but given field conditions, depth measures may lack a high rate of reliability. Participants in the 1994 damage prevention workshop concluded that remote sensing methods should not be used for determining facility depth location. More recently, at the 1997 One-Call Systems and damage prevention symposium, a session on depth perception concluded that remote locator equipment was available that could provide elevation readings but not with a degree of accuracy that warrants placing the liability with the locating service.[61]

The capability of locator equipment needs to be incorporated into damage prevention practices. The Safety Board concludes that more research and testing is needed to determine the accuracy of depth detection by remote locating equipment. Therefore, the Safety Board believes that RSPA should sponsor independent testing of locator equipment performance under a variety of field conditions. Further, the Board believes that as a result of the testing, RSPA should develop uniform certification criteria of locator equipment. Finally, once locator equipment performance has been evaluated and defined by certification criteria, RSPA should review State requirements for location accuracy and hand-dig tolerance zones to determine that they can be accomplished with commercially available technology.

Directional Boring/Trenchless Technology

Excavation work is frequently for the purpose of installing additional facilities. General practices require digging an open trench from the surface down to the installation depth. However, trenchless technology offers a different method for installing underground facilities. Directional boring "snakes" a new line that follows a drill bit horizontally through the subsurface. This method is particularly advantageous for traversing

[59] "Wyoming's Unique One-Call Legislation." Constructor, November 1996:17.

[60] Anspach, J.H. 1994. Locating and Evaluating the Conditions of Underground Utilities. In: RETROFIT '94. Washington, DC: National Science Foundation. Sponsored by: Stanford University and the National Science Foundation.

[61] "Depth Perception" session at the 22[d] annual One-Call Systems and damage prevention symposium, April 20-23, 1997, New York City. Panel participants at the moderated session represented equipment manufacturers and underground locator services.

below waterways, ecologically sensitive wet lands, or major traffic arteries. But there are practical limits to the depth that lines are installed. Eventually, additional depth becomes infeasible because of the cost of the extended line runs, geologic changes at lower stratum, or practical concerns for future maintenance. New lines must then go through the areas that have had line laid by directional boring.

Differences in soil density, rock formations, and variable torque on the drilling head often result in a directional line that does not run along a straight route. Drilling heads can be deflected by hard rock or unknown underground objects. The operational accuracy of directional boring depends on the accuracy of sensors located on the drill bit and the drilling unit's resolution and correlation to a common base map. Though they do not involve sensors, similar problems can be found with the use of pneumatic drills and mechanical augers.

Directional boring is not always sensitive to line hits; it is possible for a boring equipment operator to hit a facility without being aware of the hit. The drill bits, designed to go through rock, experience little change in resistance when going through plastic pipe or cable. This sets up a situation for hitting a gas line without knowing it; migrating gas can then collect, creating conditions for an explosion. The Safety Board recently investigated an accident involving directional boring in Indianapolis, Indiana.[62] The explosion resulted in one fatality, one injury, and extensive damage to a residential subdivision.

Over the past year, the trade literature has documented several accidents, not investigated by the Safety Board, that resulted from horizontal directional boring. For example:

- In Seattle, directional boring caused a gas explosion that destroyed a home;
- A major traffic artery in northern New York State was closed for several days to determine if a water main break resulting from directional boring had seriously weakened the roadbed; and
- Two people were hospitalized in Overland Park, Kansas, when a gas explosion, caused by directional boring, destroyed four homes.[63]

Equipment manufacturers have tried to address the problem of recording the position of lines installed by directional boring. Sensors, generally magnetic guidance-type sensors attached to the drill bit, record location information for mapping the line. The relative position of the drill bit is plotted on a real-time display at the drilling operator's control position.[64] Stored as an electronic data file, this information can be archived in

[62] NTSB accident DCA97FP005; the accident occurred on July 21, 1997.

[63] (a) Underground Focus 10(6): 16–19; 22–23. September/October 1996. (b) Underground Focus 10(7): 18–19. November/December 1996.

[64] Configuration of the Mole Map System developed by McLaughlin Boring Systems.

facility data records. Conceptually, this accounts for "recording the course of a new line." Associated issues, however, can affect the accuracy of information gathered in this manner. First, accuracy depends on sensor calibration. Operators must know how to check for and correct calibration error. Second, the drill's sensor may know where it is in relation to some global positioning system (GPS) coordinates, but it may not know its location in relation to ground surface. Depth of line, an important fact, is dependent on accurately orienting the drilling activity on a topographic survey map. The accuracy of the topographic map is, in turn, affected by erosion and grade changes over time.

The Safety Board concludes that facility maps should have a standard depiction for underground facilities that were installed using directional boring techniques. The Safety Board believes that the APWA should work in conjunction with the American Society of Civil Engineers (ASCE) to develop standards for map depiction of underground facilities that were installed using directional boring techniques.

Mapping

Maps are important to many aspects of excavation damage prevention. Rather than using a standard, common mapping system, current damage prevention programs use many different maps. An excavator usually uses a city road map to identify to the one-call center the intended area of construction activity. The one-call center refers to its coverage map (grid system coded with database information) to identify which facility owners should be notified to mark their underground facilities. Locators use a combination of utility maps to direct their field work.

Engineers and project designers are forced to use a variety of data sources from both public and private organizations to determine the structure and location of the underground facility network. Land use and zoning maps, tax assessor maps, easement descriptions, highway and transportation network maps, quadrangle and topographic maps of the U.S. Geologic Survey, construction permit drawings, construction plans, and aerial photographs are also used to help define the location. As the following example illustrates, map quality can vary. Excavation to install telephone cable on the University of New Haven campus in Connecticut in August 1996 hit a gas main, but the gas did not ignite. The gas crew searched for 33 minutes to find the correct shutoff valve. The director of facilities for the university said the gas line was not marked on maps of the campus.[65]

[65] Underground Focus 10(6): 17. September/October 1996.

Facility records maintained by the utility owners or pipeline operators are the most widely used sources of information about the underground infrastructure. As a result of the Pipeline Safety Act of 1992, OPS requires operators to identify facilities in environmentally sensitive areas and in densely populated areas, but there is no requirement for system operators to maintain a comprehensive system map of their underground facilities, though most do maintain this information to facilitate their business operations. Different utility services use different types of maps; they vary in scale, accuracy, resolution, standard notation, and data format. System records developed prior to the widespread use of computer technology most likely exist as architectural and engineering diagrams. For some systems, these diagrams have been electronically imaged so that they are easier to reference, update, and store. Digitized versions of early maps do not always reflect the uncertainty of information that may have been inherent on the hand-drafted version. Structural references and landmarks that define the relative locations of underground facilities also change over time and may not be reflected on maps.

Many system maps lack documentation of abandoned facilities. Abandoned facilities result when the use of segments of the underground system are discontinued, or when replaced lines run in new locations, or when entire systems are upgraded. Without accurate records of abandoned facilities, excavators run the risk of mistaking the abandoned line for an active one, thereby increasing the likelihood of hitting the active line. Several States have recognized the need to require facility operators to map abandoned lines; for example, Arizona requires that any line abandoned after December 1988 be mapped.

In addition to documenting the location of a facility, utility map records may also contain information on the age of the facility, type and dimensions of the material, history of leakage and maintenance, status of cathodic protection, soil content, and activity related to pending construction. However, the quality of this information varies widely. Participants at the 1994 damage prevention workshop recommended that when excavation revealed errors in mapping, operators should be required to update system maps.

Recent utility records often exist as geographical information systems in a variety of computerized software packages and electronic data storage formats. The Mapping Requirements and Standards task group of the AGA's Distribution Engineering Committee surveyed member companies in 1995 about mapping requirements and practices. Of the 27 companies that responded, 12 used computer-based mapping systems, 12 others were planning to automate their mapping systems, and 3 reported that they had no plan to automate mapping records.[66]

Many automated mapping programs are not compatible, and it is difficult to merge system records developed over the years by different departments and companies.

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[66] Place, J.C. 1996. "Gas Utility Mapping: What's Needed, What's Used." Gas Industries, January: 21–22.

Additionally, computerized diagrams may be associated with large databases that contain entry errors that are difficult to identify. Inconsistencies between data dictionaries—similar information labeled differently in different databases—require considerable effort to correct once identified. More importantly, these differences may lead to an unknown error if they are not resolved. A good quality printed image of an electronic map can disguise the poor level of information used to generate the image.

One-call systems are beginning to use GPS receivers and mapping programs.[67] Arizona Blue Stake One-Call and Ohio Utility Protection Service are working to develop positionally accurate, map-driven software to support their notification systems. California's USA North One Call ticket locations can be displayed as GPS coordinates.[68] Excavators, locators, and utility operators can use GPS information to identify field locations (longitude and latitude coordinates), and they can use this information to navigate to the sites. With the added capability of differential GPS, objects can be located to an accuracy of better than 1 meter (1.1 yards). This degree of accuracy makes differential GPS appropriate for many aspects of mapping underground facilities. The Tennessee One-Call System is considering the feasibility of installing differential GPS antennas across the State to provide location accuracy.

Most commercial maps are based on topographically integrated geographic encoding and referencing (TIGER) files from the U.S. Census Bureau. These files often contain positional inaccuracies that can be problematic when integrated with GPS latitude and longitude coordinates. For example, many, if not most, existing underground systems are not documented by GPS coordinates. Consequently, a facility owner working on a line may want to update the positional record of that line to include the coordinates. Using a GPS receiver, the facility owner acquires the line's position and then references a TIGER-based map for that area to verify aboveground landmarks. The map can indicate that those coordinates are on the south side of the highway, yet the locator might actually be standing above the underground facility on the north side of the highway.

In 1994, the Federal Geographic Data Committee recommended a plan for the Nation's spatial data infrastructure, and Congress mandated governmental response to the plan.[69] The OPS subsequently formed a joint government/industry team to start a national pipeline mapping system. The team's 1996 report, "Strategies for Creating a National Pipeline Mapping System," made several recommendations: (1) develop, promote, and aggressively communicate pipeline data standards that are consistent with the standards of the Federal Geographic Data Committee; (2) formalize a partnership with industry, and

[67] Vista One Call Mapping Program by Kuhagen, Inc., is compatible with California's USA North One Call System and has been accepted for use by the State fire marshal as a method for digitizing pipeline mapping.

[68] "One-Calls Eye New Mapping." Underground Focus 10(2): 6. Symposium Edition 1996.

[69] The Federal Office of Management and Budget (OMB), under the directive of OMB Circular A16, created the Federal Geographic Data Committee, which is chaired by the Secretary of the Interior. The 1994 Plan for the National Spatial Data Infrastructure was issued in March 1994.

Federal and State agencies; (3) develop a partnership with One-Call Systems International to reach a better understanding of one-call system data needs and gather support for using geographically referenced data; and (4) create a distributed mapping system with centralized quality control and decentralized access capabilities.

There are many different facility mapping systems in use by one-call systems and facility owners. Those with GPS positional accuracy lack information on landmarks and developed structures, and maps that accurately reflect current structural improvements often lack positional accuracy. The Safety Board concludes that underground facility mapping must consider the amount of detail and the accuracy of information necessary for effective use. The Safety Board recognizes RSPA's effort in creating strategies for a national pipeline mapping system and for its current Mapping Implementation Quality Action Team. The Board believes RSPA should develop mapping standards for a common mapping system, with a goal to actively promote its widespread use.

Subsurface Utility Engineering

Subsurface utility engineering (SUE) is a process for identifying, verifying, and documenting underground facilities. Depending on the information available and the technologies employed to verify facility locations, a level of the quality of information can be associated with underground facilities. These levels, shown in table 4–2, indicate the degree of uncertainty associated with the information; level A is the most reliable and level D the least reliable. This categorization is a direct result of the source of information and the technologies used to verify the information.

A comprehensive map and automated computer diagram of a construction site is developed as a SUE product; it depicts co-registered information for all utilities in that area. The SUE process identifies all utilities during a single coordinated effort. In this way, information known about one facility can beneficially affect the mapping of other utilities, and unknown facilities are more likely to be documented. By signing the SUE product, a professional engineer warrants the maps against errors and omissions and assumes liability for the accuracy of the information.

The Federal Highway Administration (FHWA) considers SUE an integral part of preliminary engineering work on highway projects receiving Federal aid. It has the potential to reduce facility conflicts, relocation costs, construction delays, and redesign work. In 1984, the State of Virginia began a SUE program, called the Utility Designation and Locating Program, and determined that there were substantial cost savings. A highway project in the city of Richmond used SUE work costing $93,553 to avoid an estimated $731,425 worth of expenses to move utilities had the highway projects not been designed to avoid conflict with underground facilities. Virginia's estimate of cost savings, just in terms of avoiding utility relocations, was $4 saved for each dollar spent.

Table 4–2. Subsurface utility engineering (SUE) levels of information.

Quality level of the information	Description
Level D	Information is collected from **existing utility records** without field activities to verify the information. The accuracy or comprehensiveness of the information cannot be guaranteed; consequently, this least certain set of data is the lowest quality level.
Level C	**Adds aboveground survey data** (such as manholes, valve boxes, posts, and meters) to existing utility records. The Federal Highway Administration Office of Engineering estimates that 15–30 percent of level C facility information pertinent to highway construction is omitted or plotted with an error rate of more than 2 feet.[(a)]
Level B	**Confirmed existence and horizontal position of facilities are mapped** using surface geophysical techniques. The two-dimensional, plan-view map is useful in the construction planning phase when slight changes to avoid conflicts can produce substantial cost savings by eliminating the relocation of utilities.
Level A	Vacuum excavation is used to **positively verify both the horizontal and vertical depth location** of facilities.

[(a)] Scott, Paul. 1995. "Subsurface Utility Engineering: An Alternative to Excavation Damage." In: Proceedings, Excavation Damage Prevention Workshop; 1994 September 8-9; Washington, DC. Report of Proceedings NTSB/RP-95/01. Washington, DC: National Transportation Safety Board: 186-189.

Source: Stutzman, H.G.; Anspach, J.H. 1993. "Site Investigation and Detection." In: Research Needs in Automated Excavation and Material Handling: Proceedings, National Science Foundation Symposium; 1993 April. Washington, DC: National Science Foundation.

Additionally, Virginia credits the process with reducing design time by 20 percent.[70] The utility coordinator for Maryland's State Highway Administration estimates a savings of $18 for each dollar spent. Florida DOT found that it saved $3 in contract construction delay claims for each dollar spent on SUE. Variations in these estimates reflect different cost assumptions, geographic conditions, and system configurations. Twenty-six highway agencies have used SUE at some level on some projects;[71] FHWA estimates a nationwide savings of $100 million a year as a result of SUE.[72]

Compiling comprehensive information on underground facilities can be expensive and labor intensive. Small contractors generally do not have the resources or expertise available to accomplish SUE on a regular basis; consequently, SUE is generally used on large construction projects such as those typical of highway development.

[70] U.S. Department of Transportation, Federal Highway Administration. 1995. Subsurface Utility Engineering Handbook. FHWA-PD-96-004 (p. I–14). Washington, DC. November.

[71] According to the FHWA, Maryland, Pennsylvania, Delaware, North Carolina, and Arizona use SUE on an extensive basis.

[72] U.S. Department of Transportation, Federal Highway Administration. 1995. Subsurface Utility Engineering Handbook. FHWA-PD-96-004 (p. I–29). Washington, DC. November.

Architects, engineers, and contractors should have ready access to information on the location of underground facilities to plan construction activities. The advantage of this information was recognized at the 1994 damage prevention workshop. The Safety Board concludes that providing construction planners with information on the location of underground facilities, referred to as "planning locates," can reduce conflicts between construction activities and existing underground facilities. The Safety Board believes that the APWA should encourage one-call notification centers to work with their members to provide facility location information for the purpose of construction planning.

The Standards Committee of the ASCE is developing standards for depicting underground facilities on construction drawings. The Board thus believes that the APWA and the ASCE should address the accuracy of information that depicts subsurface facility location on construction drawings. Further, the Safety Board believes that the Associated General Contractors of America should promote the use of subsurface utility engineering practices among its members to minimize conflicts between construction activities and underground systems.

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Chapter 5

System Performance Measures

Few performance-based measures are available and useful for assessing excavation damage prevention programs. Those measures that are maintained are specific to selected States or are maintained by individual companies for a specific underground system. Data concerning underground damage for all types of systems are needed: (1) to determine if changes to State damage prevention programs are effective in decreasing underground facility damage; (2) to assess the benefit of different practices followed by one-call notification centers; (3) to identify the risks of different field practices used by facility operators, locators, and excavators; (4) to allow facility operators to evaluate their company's excavation damage prevention programs; (5) to assess the needs and benefits of training; and (6) to perform risk assessment for the purposes of business, insurance, and public policy decisions.

Risk Exposure

A critical component of excavation damage data is the total number of excavations that present a chance for damage. These data, however, are not available. The number of excavations presented in this report are industry estimates; they did not result from a national data collection system. To quantify the number of accidents in relation to how many could have occurred, it is necessary to determine some frequency of exposure. In the context of excavation damage, exposure can be measured by the number of excavations. This measure can be approximated by the number of locate tickets issued by one-call centers, although that number will capture only those excavations that were reported to one-call centers.

One-call centers offer the best opportunity for the industry as a whole to determine the rate of excavation damage. The OCSI Delegate Committee is developing a process to standardize and collect one-call center information from its members. To be useful, the information will need to be qualified by reporting criteria. Categories will need to be clearly defined: what is an excavation activity, what constitutes a facility hit, how is the level of damage categorized, what caused the damage?

Many facility operators, particularly companies that transport gas and hazardous liquids, investigate and record "line hits" in terms of damages per thousand locate

requests. But because of proprietary interests, these numbers are rarely compiled across companies. The Gas Research Institute's (GRI) 1995 study made an effort to determine risk exposure for the gas industry.[73] The study surveyed 65 local distribution companies and 35 transmission companies regarding line hits. Less than half (41percent) of the companies responded, and several major gas-producing States were poorly represented (only one respondent from Texas and one from Oklahoma). The GRI estimate was determined by extrapolation and may be subject to a large degree of error because the data sample was not representative. Based on survey responses, however, GRI calculated an approximate magnitude of risk. For those companies that responded, a total of 25,123 hits to gas lines were recorded in 1993; from that, the GRI estimated total U.S. pipeline hits in 1993 to be 104,128. For a rate of exposure, this number can be compared to pipeline miles: for 1993, *Gas Facts* reported 1,778,600 miles (2 861 767.4 kilometers) of gas transmission, main, and service line, which calculates to a risk exposure rate of 58 hits per 1,000 line miles (1609 kilometers).[74]

Because the risk of excavation damage is associated with digging activity rather than system size, "hits per digs" is a useful measure of risk exposure. For the same year that GRI conducted its survey, one-call systems collectively received more than an estimated 20 million calls from excavators. (These calls generated 300 million work-site notifications for participating members to mark many different types of underground systems.) Using GRI's estimate of hits, the risk exposure rate for 1993 was 5 hits per 1,000 notifications to dig.[75] A comprehensive measure of hits per digs tracked over time can be a useful indicator of how well excavation damage prevention programs are performing. Because the measure is expressed as a rate rather than simply a number of hits, it can be used to compare years in which there were different levels of construction activity. The measure can also be used to compare geographic locations or utility systems of different size. Industry is beginning to use such measures of performance; for example, measures of hits per locates have been incorporated into contractual agreements between utilities and their locator services.[76]

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[73] Doctor, R.H.; Dunker, N.A.; Santee, N.M. 1995. Third-Party Damage Prevention Systems. GRI-95/0316. Final report, contract 5094–810–2870. Chicago, IL: Gas Research Institute. 67 p., plus appendixes.

[74] Calculated as total hits (104,128) ÷ miles of gas line (1,778,600) = 0.0585 hits per mile or 58.5 hits per 1,000 miles. (104,128 hits ÷ 2 861 767.4 kilometers = 0.0364 hits per kilometer or 36.4 hits per 1000 kilometers.) Note: Different categories of gas lines were added together. Transmission lines have a substantially lower rate than other gas systems: survey respondents reported 201 hits per 36,042 line miles (57 992 kilometers), for a rate of 5.5 hits per 1,000 miles (1609 kilometers). However, GRI survey numbers account for only 10 percent of the U.S. gas transmission system. If the number of transmission system hits per 1,000 miles is separated from the U.S. total, the rate for local distribution companies increases to 71 hits per 1,000 miles.

[75] Calculated as total hits (104,128) ÷ excavation notifications (20,000,000) = 0.0052 per notification or 5.2 per 1,000 notifications.

[76] Northern Illinois Gas incorporated a performance incentive based on hits per locates into its most recent locator service contract with Kelly Cable Corporation.

The Safety Board is encouraged that attempts are being made to calculate risk exposure data. Without this information, evaluations on the effectiveness of State damage prevention programs cannot be adequately performed. The Safety Board is concerned, however, that these isolated attempts to calculate exposure data are neither standardized nor centrally reported. A "utility" in one State may be defined differently for another State, resulting in inconsistent measures of damage.

If all digging activity were recorded through one-call systems, notification ticket volume would be a useful measure of risk exposure. The Safety Board recognizes that not all excavators currently use one-call notifications systems and that there are 84 separate one-call systems operating in the United States collecting different information in different formats. The Safety Board concludes that the one-call notification centers may be the most appropriate organizations to collect risk exposure data on frequency of digging and data on accidents. To standardize how and what information should be collected, the Safety Board believes that the APWA, in conjunction with RSPA, should develop a plan for collecting excavation damage exposure data and then work with the one-call systems to implement the plan to ensure that excavation damage exposure data are being consistently collected. The universal damage report form developed by Alberta One-Call (appendix E) could be considered by the OCSI. Finally, the Safety Board believes that the APWA and RSPA should use excavation damage exposure data in the periodic assessments of the effectiveness of State excavation damage prevention programs described in other safety recommendations in this report.

Accident Reporting Requirements of RSPA

The requirements and criteria for reporting natural gas and hazardous liquid pipeline accidents are found in 49 CFR Part 191.3 and Part 195.50, respectively. A natural gas incident report is required for (1) an event that involves release of gas causing a death, or personal injury necessitating in-patient hospitalization, or property damage or loss of $50,000;[77] (2) an event that results in an emergency shutdown; or (3) an event that is significant in the judgment of the operator. For hazardous liquids, an accident report is required for any of the following conditions: (1) explosion or fire not intentionally set by the operator; (2) loss of 50 or more barrels of liquid product; (3) escape to the atmosphere of more than 5 barrels a day of volatile liquids; (4) death of any person; (5) bodily harm; (6) or estimated property damage exceeding $50,000.

[77] Before 1984, $5,000 was the OPS property loss threshold for reporting natural gas and liquid pipeline failures. In July 1984, this threshold was increased, resulting in a sharp decline in reportable line failures after 1983.

RSPA receives accident reports on only a small portion of the underground infrastructure, not as a result of failure to report on the part of industry, but because RSPA's oversight responsibilities are limited to only a portion of the gas and hazardous liquids systems, and of that subset, accident reports are required only when reporting thresholds are exceeded. Nonetheless, RSPA's database is important because there are few sources for national accident measures and because RSPA's experience in collecting pipeline accident data can be useful for designing future databases on excavation damage.

According to the GRI study of damage prevention, gas transmission and distribution systems accident reports by RSPA account for less than 1 percent of the occurrences of underground pipeline damage.[78] Although numerous accidents and incidents do not meet the above reporting criteria and, consequently, are not recorded by RSPA, the Safety Board is concerned that many accidents that should be reported are not being reported because the cost of damage is underestimated. For example, a recent university study determined that a gas line rupture, originally reported to cost $15,000, cost substantially more.[79] Survey responses from businesses, homeowners, and emergency response units determined that the cost of the accident, not including the cost of lost gas or legal fees associated with ongoing litigation, was over $300,000. Because of the $50,000 reporting threshold, this accident, based on the original damage estimate, was not required to be reported to RSPA.

Although a determination by the operator that an incident costs less than $50,000 alleviates the operator of the requirement to report the incident to RSPA and may be a factor in the under-reporting of accidents, estimating property damage can be difficult and very subjective. The incident reports filed by operators ask for estimated property damage; however, little guidance is provided to operators on all costs that should be included to ensure accurate reporting. Dollar amounts are generally assumed to represent product loss, facility damage incurred by the operator and others, and the environmental cleanup cost; however, the exclusion of any one of these costs could reduce the estimated damage to below the reporting threshold. As a result, the accident would not be reported to RSPA. The Safety Board concludes that facility operators are provided little guidance for estimating property damage resulting from an accident, and subjective estimates of damage below the reporting threshold may account for some accidents not being reported to RSPA when they should have been. Therefore, the Safety Board believes that RSPA should develop and distribute to pipeline operators written guidance to improve the accuracy of information for reportable accidents, including parameters for estimating property damage resulting from an accident.

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[78] Doctor, R.H.; Dunker, N.A.; Santee, N.M. 1995. Third-Party Damage Prevention Systems. GRI-95/0316. Final report, contract 5094–810–2870. Chicago, IL: Gas Research Institute. 67 p., plus appendixes.

[79] North Carolina State University, Construction Automation & Robotics Laboratory. 1996. Assessment of the Cost of Underground Utility Damages. Raleigh, NC. 17 p., plus appendixes. The study was also the subject of the following article: Carver, C. 1996. "Real Costs of Utility Damages Researched by NCSU." Underground Focus 10(6): 28. September/October.

Accident Causes

The accident report form for hazardous liquid pipelines offers seven categories of cause.[80] For accidents reported between 1986 and 1995, three categories (corrosion, outside force damage, and other) accounted for 78 percent of the reported accidents. For 1996, RSPA data indicated that "outside force damage" was the leading cause of accidents (damage by outside force is primarily, though not exclusively, the category in which excavation damage is placed). The second leading cause for that year was "other." The Safety Board has previously expressed concern that the definition of accident cause is imprecise and that distinctions between categories of cause are vague (see appendix G). For example, in the data for hazardous liquid pipeline accidents, pipeline accidents resulting from similar events (as described by text explanations) are categorized differently. Accidents described as "lightning strike," "vandalism," "drilled into pipe," and "bullet hole" appear in both the "outside force damage" and "other" categories. Because excavation damage is not separately categorized, Safety Board staff conducted a systematic review of the accidents reported to RSPA for the years 1991 through 1996 to determine the number of excavation-related accidents (table 5–1). The review indicated no trend toward a long-term decrease in excavation-related accidents (figure 5–1).

Numerous accident records in the databases for distribution, transmission, and hazardous liquids systems show $0.00 for accident costs.[81] This is particularly disturbing because in one case, a damage cost of $0.00 was reported for an accident that injured 12 persons (a distribution system accident, July 1996 in Brooklyn, New York). A review of text comments associated with the accident records indicated that most excavation damage accidents were classified in the database as "outside force damage." However, there were many additional accidents classified as "outside force damage" that were not excavation-caused and several incidents of excavation damage were mis-categorized as "other," "corrosion," "accidentally caused by operator," or "construction/operating error."

Based on this review and previous analysis of RSPA data, the Safety Board concludes that deficiencies in RSPA accident data, particularly with respect to the cause of accidents and a record of whether those involved in pipeline accidents participated in excavation damage prevention programs, precludes effective analyses of accident trends and evaluations of operator performance. Although RSPA and the industry consider excavation damage to be one of the leading causes of pipeline accidents, excavation damage is not specifically indicated on RSPA's accident form as a separate data element. A more useful analysis of accident data could also be performed if information were available on

[80] DOT Form 7000-1, Part D: (1) corrosion, (2) failed weld, (3) incorrect operation by operator personnel, (4) failed pipe, (5) outside force damage, (6) malfunction of control or relief equipment, (7) other—specify. Category 7 includes cases involving excavation damage, such as backhoe dug into line, and category 5 (outside force damage) includes vandalism and lightning strikes. Excavation damage is not separately categorized.

[81] Accidents with $0.00 damage are included in the database because they meet one of the other criteria for reporting. For 1996, the three databases show 76 accidents with $0.00 damage costs.

Table 5–1. Proportion of accidents that were excavation-related, 1991 through 1996.

System type and item	1991			1992			1993		
	All accidents	Excavation accidents[a]	Percentage	All accidents	Excavation accidents[a]	Percentage	All accidents	Excavation accidents[a]	Percentage
Distribution:									
Accidents	165	59	35.8	103	35	34.0	119	33	27.7
Injuries	78	29	37.2	65	20	30.8	82	27	32.9
Fatalities	14	6	42.9	7	2	28.6	16	7	50.0
Property damage (million)	$7.9	$3.1	39.0	$6.8	$1.5	21.5	$14.7	$3.7	25.1
Transmission:									
Accidents	72	28	38.9	75	11	14.7	97	16	16.5
Injuries	12	2	16.7	15	3	20.0	18	2	11.1
Fatalities	0	0	0	3	2	66.7	1	0	0
Property damage (million)	$12.0	$1.9	15.8	$24.7	$1.0	4.0	$23.0	$0.7	3.2
Hazardous liquids:									
Accidents	220	43	19.5	223	42	18.8	229	51	22.3
Injuries	9	1	11.1	38	8	21.1	10	5	50.0
Fatalities	0	0	0	5	0	0	0	0	0
Property damage (million)	$25.5	$6.5	25.4	$64.4	$29.1	45.3	$29.2	$13.4	45.8
Total:									
Accidents	457	130	28.4	401	88	21.9	445	100	22.5
Injuries	99	32	32.3	118	31	26.3	110	34	30.9
Fatalities	14	6	42.9	15	4	26.7	17	7	41.2
Property damage (million)	$45.3	$11.4	25.2	$95.9	$31.6	32.9	$67.0	$17.8	26.6

(continued)

Table 5–1. Proportion of accidents that were excavation-related, 1991 through 1996.

	1994			1995			1996		
	All accidents	Excavation accidents[a]	Percentage	All accidents	Excavation accidents[a]	Percentage	All accidents	Excavation accidents[a]	Percentage
(continued)									
Distribution:									
Accidents	125	37	29.6	103	38	36.9	120	36	30.0
Injuries	86	25	29.1	47	17	36.2	69	31	44.9
Fatalities	18	4	22.2	12	1	8.3	22	4	18.2
Property damage (million)	$50.2	$4.4	8.7	$12.6	$1.7	13.5	$12.2	$4.6	$37.8
Transmission:									
Accidents	69	7	10.1	68	10	14.7	73	19	26.0
Injuries	12	8	66.7	12	0	0	4	0	0
Fatalities	0	0	0	2	0	0	1	0	0
Property damage (million)	$43.3	$25.3	58.4	$11.1	$1.2	11.2	$12.5	$2.2	17.8
Hazardous liquids:									
Accidents	206	24	11.7	214	34	15.9	211	42	19.9
Injuries	930	0	0	13	0	0	13	7	53.8
Fatalities	1	1	100.0	3	0	0	5	3	60.0
Property damage (million)	$49.8	$2.7	5.5	$38.3	$8.7	22.8	$41.6	$6.2	14.9
Total:									
Accidents	400	68	17.0	385	82	21.3	404	97	24.0
Injuries	1,028	33	3.2	72	17	23.6	86	38	44.2
Fatalities	19	5	26.3	17	1	5.9	28	7	25.0
Property damage (million)	$143.3	$32.4	22.6	$62.2	$11.7	18.8	$66.3	$13.0	19.6

[a] Using data maintained by the Office of Pipeline Safety, Research and Special Programs Administration, the Safety Board charactertized the accidents/incidents that were determined to be excavation-related based on incident text descriptions, then calculated the proportion of injuries, fatalities, and property damage.

Source: Office of Pipeline Safety, Research and Special Programs Administration.

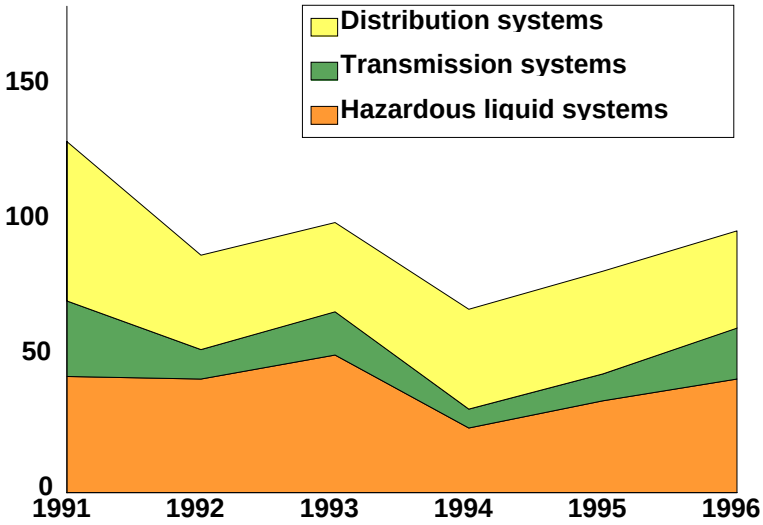

Figure 5–1. Number of excavation-related accidents for distribution, transmission, and hazardous liquid systems, 1991–1996.

the primary, secondary, and contributing causes. The Safety Board has found through years of accident investigations that accidents are rarely the result of one event, but rather the consequence of a sequence or combination of events. Categories based on purpose of the excavation (building construction, road grading, utility maintenance); type of equipment involved (backhoe, grader, road vehicle); excavator (facility owner employee, contract employee, landowner, general public); and locator (facility owner or contract support) could provide meaningful information with which analyses of accident trends and evaluations of operator performance could be conducted.

The Safety Board has addressed deficiencies in RSPA's accident data on several previous occasions.[82] Most recently, in a 1996 special investigation report, the Safety Board evaluated RSPA's collection and analysis of accident data for petroleum product pipelines.[83] In that report, the Board concluded that RSPA's failure to fully implement the Safety Board's original 1978 safety recommendations to evaluate and analyze its accident data reporting needs has hampered RSPA's oversight of pipeline safety. Consequently, the Safety Board recommended that RSPA

[82] See appendix G for a list of Safety Board recommendations related to RSPA's accident data.

[83] National Transportation Safety Board. 1996. Evaluation of Accident Data and Federal Oversight of Petroleum Product Pipelines. Pipeline Special Investigation Report NTSB/SIR-96/02. Washington, DC. 67 p. The special investigation was prompted by the ruptures of two petroleum product pipelines operated by the same company. Both ruptures occurred within a 15-month period.

> Develop within 1 year and implement within 2 years a comprehensive plan for the collection and use of gas and hazardous liquid pipeline accident data that details the type and extent of data to be collected, to provide the Research and Special Programs Administration with the capability to perform methodologically sound accident trend analyses and evaluations of pipeline operator performance using normalized accident data. (P-96-1)

RSPA indicated that it agreed with the Board's recommendation and was working with the pipeline industry to determine the value of industry's data to RSPA.[84] Industry and RSPA have conducted workshops to review data issues and, as recommended by the Safety Board, RSPA has obtained database information from the Federal Energy Regulatory Commission for analysis. The Safety Board believes that given the large percentage of accidents that are caused by excavation damage and the emphasis in recent years by industry to address and respond to these types of accidents, RSPA should, as part of its comprehensive plan for the collection and use of gas and hazardous liquid data, revise the cause categories on its accident report forms to eliminate overlapping and confusing categories and to clearly list excavation damage as one of the data elements, and consider developing categories that address the purpose of the excavation.

[84] Correspondence dated August 7, 1996, from the RSPA Administrator. On January 2, 1997, the Safety Board classified Safety Recommendation P-96-1 "Open—Acceptable Response" based on RSPA's response and pending a further progress report.

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Conclusions

1. Full participation in excavation damage prevention programs by all excavators and underground facility owners is essential to achieve optimum effectiveness of these programs.

2. Many essential elements and activities of a one-call notification center have been identified but have not been uniformly implemented.

3. Administrative enforcement has proven effective in some State excavation damage prevention programs.

4. Pre-marking an intended excavation site to specifically indicate the area where underground facilities need to be identified is a practice that helps prevent excavation damage.

5. Employee qualification and training is an integral component of an effective excavation damage prevention program, and industry has recognized the need for employee training but has not implemented training uniformly.

6. At a minimum, excavators should formulate an emergency response plan appropriate for the specific construction site and ensure that employees working at that site know the correct action to take if a buried facility is damaged.

7. Although considerable progress has been made to improve State excavation damage prevention programs, additional efforts are needed to uniformly develop and implement programs that are most effective.

8. More research and testing is needed to determine the accuracy of depth detection by remote locating equipment.

9. Facility maps should have a standard depiction for underground facilities that were installed using directional boring techniques.

10. Underground facility mapping must consider the amount of detail and the accuracy of information necessary for effective use.

11. Providing construction planners with information on the location of underground facilities, referred to as “planning locates,” can reduce conflicts between construction activities and existing underground facilities.

12. One-call notification centers may be the most appropriate organizations to collect risk exposure data on frequency of digging and data on accidents.

13. Facility operators are provided little guidance for estimating property damage resulting from an accident, and subjective estimates of damage below the reporting threshold may account for some accidents not being reported to the Research and Special Programs Administration when they should have been.

14. Deficiencies in the Research and Special Programs Administration's accident data, particularly with respect to the cause of accidents and a record of whether those involved in pipeline accidents participated in excavation damage prevention programs, precludes effective analyses of accident trends and evaluations of operator performance.

Recommendations

As a result of this safety study, the National Transportation Safety Board made the following recommendations:

To the Research and Special Programs Administration—

Conduct at regular intervals joint government and industry workshops on excavation damage prevention that highlight specific safety issues, such as full participation, enforcement, good marking practices, the importance of mapping, and emergency response planning. (P-97-14)

Initiate and periodically conduct, in conjunction with the American Public Works Association, detailed and comprehensive reviews and evaluations of existing State excavation damage prevention programs and recommend changes and improvements, where warranted, such as full participation, administrative enforcement of the program, pre-marking requirements, and training requirements for all personnel involved in excavation activity. (P-97-15)

Sponsor independent testing of locator equipment performance under a variety of field conditions. (P-97-16)

As a result of the testing outlined in Safety Recommendation P-97-16, develop uniform certification criteria of locator equipment. (P-97-17)

Once locator equipment performance has been evaluated and defined by certification criteria as outlined in Safety Recommendation P-97-17, review State requirements for location accuracy and hand-dig tolerance zones to determine that they can be accomplished with commercially available technology. (P-97-18)

Develop mapping standards for a common mapping system, with a goal to actively promote its widespread use. (P-97-19)

Develop and distribute to pipeline operators written guidance to improve the accuracy of information for reportable accidents, including parameters for estimating property damage resulting from an accident. (P-97-20)

As part of the comprehensive plan for the collection and use of gas and hazardous liquid data, revise the cause categories on the accident report forms to eliminate overlapping and confusing categories and to clearly list excavation damage as one of the data elements, and consider developing categories that address the purpose of the excavation. (P-97-21)

In conjunction with the American Public Works Association, develop a plan for collecting excavation damage exposure data. (P-97-22)

Work with the one-call systems to implement the plan outlined in Safety Recommendation P-97-22 to ensure that excavation damage exposure data are being consistently collected. (P-97-23)

Use excavation damage exposure data outlined in Safety Recommendation P-97-22 in the periodic assessments of the effectiveness of State excavation damage prevention programs described in Safety Recommendation P-97-15. (P-97-24)

To the American Public Works Association—

Initiate and periodically conduct, in conjunction with the Research and Special Programs Administration, detailed and comprehensive reviews and evaluations of existing State excavation damage prevention programs and recommend changes and improvements, where warranted, such as full participation, administrative enforcement of the program, pre-marking requirements, and training requirements for all personnel involved in excavation activity. (P-97-25)

In conjunction with the Research and Special Programs Administration, develop a plan for collecting excavation damage exposure data. (P-97-26)

Work with the one-call systems to implement the plan outlined in Safety Recommendation P-97-26 to ensure that excavation damage exposure data are being consistently collected. (P-97-27)

Use excavation damage exposure data outlined in Safety Recommendation P-97-26 in the periodic assessments of the effectiveness of State excavation damage prevention programs described in Safety Recommendation P-97-25. (P-97-28)

Review existing training programs and materials related to excavation damage prevention and develop guidelines and materials for distribution to one-call notification centers. (P-97-29)

Develop guidelines and materials that address initial emergency actions by excavators when buried facilities are damaged and then distribute this information to all one-call notification centers. (P-97-30)

Encourage one-call notification centers to work with their members to provide facility location information for the purpose of construction planning. (P-97-31)

Develop standards, in conjunction with the American Society of Civil Engineers, for map depiction of underground facilities that were installed using directional boring techniques. (P-97-32)

Address, in conjunction with the American Society of Civil Engineers, the accuracy of information that depicts subsurface facility locations on construction drawings. (P-97-33)

To the Federal Highway Administration—

Require State transportation departments to participate in excavation damage prevention programs and consider withholding funds to States if they do not fully participate in these programs. (P-97-34)

To the Association of American Railroads—

Urge your members to fully participate in statewide excavation damage prevention programs, including one-call notification centers. (P-97-35)

To the American Short Line Railroad Association—

Urge your members to fully participate in statewide excavation damage prevention programs, including one-call notification centers. (P-97-36)

To the American Society of Civil Engineers—

Develop standards, in conjunction with the American Public Works Association, for map depiction of underground facilities that were installed using directional boring techniques. (P-97-37)

Address, in conjunction with the American Public Works Association, the accuracy of information that depicts subsurface facility locations on construction drawings. (P-97-38)

To the Associated General Contractors of America—

Promote the use of subsurface utility engineering practices among your members to minimize conflicts between construction activities and underground systems. (P-97-39)

By the National Transportation Safety Board

James E. Hall
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Vice Chairman

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Member

John Goglia
Member

George W. Black, Jr.
Member

Adopted: December 16, 1997

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Appendix A

NTSB Investigations of Accidents Caused by Excavation Damage, Since 1985

Date of accident	Location	NTSB accident number
06/09/94	Allentown, Pennsylvania	DCA94MP003
05/03/94	Green River, Wyoming	DCA94MP002
03/23/94	Edison, New Jersey	DCA94MP001
01/31/93	Allentown, Pennsylvania	DCA94FP002
07/22/93	St. Paul, Minnesota	DCA93MP011
06/09/93	Cliffwood Beach, New Jersey	DCA93FP008
03/28/93	Reston, Virginia	DCA93MP007
12/03/92	Denver, Colorado	DCA93FP003
08/19/92	Lancaster,Ohio	DCA92FP010
05/20/92	Rochester, Michigan	DCA92FP008
01/02/92	Ontario, New York	DCA92FP003
12/28/91	Santa Rosa CA	DCA92FP002
12/19/91	Fountain Inn, South Carolina (Durbin Creek)	DCA92FP001
02/05/91	Greendale, Wisconsin	DCA91FP004
02/19/91	Lititz, Pennsylvania	DCA91FP005
03/13/90	Blenheim, New York	DCA90MP006
11/19/88	Smithtown, New York	DCA91FP004
08/31/88	Green Oaks, Illinois (Waukegan)	DCA88FP015
12/18/87	Austin, Texas	DCA88FP002
11/12/87	Kalkaska, Michigan	DCA88FP001
08/05/87	Wilmington, North Carolina	DCA87FP014
06/11/87	Centerville, Virginia	DCA87FP011
12/06/86	Elk City. Oklahoma	DCA87FP005
10/16/86	Wausau, Wisconsin	DCA87FP003
10/13/86	Boise City, Oklahoma	DCA87FP002
09/15/86	Bellvue, Nebraska	DCA86FP017
07/06/86	New Castle, Oklahoma	DCA86FP013
04/24/86	Elgin, Illinois	DCA86FP012
03/13/86	Chicago Heights, Illinois	DCA86FP011
02/12/86	Fort Worth, Texas	DCA86FP010
02/04/86	Crystal City, Mississippi	DCA86FP007
12/24/85	Medley, Florida	DCA86FP006
12/06/85	Derby, Connecticut	DCA86FP004
04/27/85	Beaumont, Kentucky	DCA85MP011

Appendix B

Excerpts From Federal Regulations Pertaining to Excavation

Minimum standards for excavation damage prevention programs for operators of gas pipelines (from Title 49 Code of Federal Regulations):

§ 192.614 Damage prevention program.

(a) Except for pipelines listed in paragraph (c) of this section, each operator of a buried pipeline shall carry out in accordance with this section a written program to prevent damage to that pipeline by excavation activities. For the purpose of this section, "excavation activities" include excavation, blasting, boring, tunneling, backfilling, the removal of aboveground structures by either explosive or mechanical means, and other earth moving operations. An operator may perform any of the duties required by paragraph (b) of this section through participation in a public service program, such as a "one-call" system, but such participation does not relieve the operator of responsibility for compliance with this section.

(b) The damage prevention program required by paragraph (a) of this section must, at a minimum:

(1) Include the identity, on a current basis, of persons who normally engage in excavation activities in the area in which the pipeline is located.

(2) Provide for general notification of the public in the vicinity of the pipeline and actual notification of the persons identified in paragraph (b)(1) of the following as often as needed to make them aware of the damage prevention program:

(i) The program's existence and purpose; and

(ii) How to learn the location of underground pipelines before excavation activities are begun.

(3) Provide a means of receiving and recording notification of planned excavation activities.

(4) If the operator has buried pipelines in the area of excavation activity, provide for actual notification of persons who give notice of their intent to excavate of the type of temporary marking to be provided and how to identify the markings.

(5) Provide for temporary marking of buried pipelines in the area of excavation activity before, as far as practical, the activity begins.

(6) Provide as follows for inspection of pipelines that an operator has reason to believe could be damaged by excavation activities:

(i) The inspection must be done as frequently as necessary during and after the activities to verify the integrity of the pipeline; and

(ii) In the case of blasting, any inspection must include leakage surveys.

(c) A damage prevention program under this section is not required for the following pipelines:

(1) Pipelines located offshore.

(2) Pipelines, other than those located offshore, in Class 1 or 2 locations until September 20, 1995.

(3) Pipelines to which access is physically controlled by the operator.

(4) Pipelines that are part of a petroleum gas system subject to §192.11 or part of a distribution system operated by a person in connection with that person's leasing of real property or by a condominium or cooperative association.

[Amdt. 192-40, 47 FR 13824, Apr. 1, 1982, as amended by Amdt. 192-57, 52 FR 32800, Aug. 31, 1987; Amdt. 192-73, 60 FR 14650, Mar. 20, 1995; Amdt. 192-78, 61 FR 28785, June 6, 1996]

Minimum standards for excavation damage prevention programs for operators of hazardous liquid pipelines (from Title 49 Code of Federal Regulations):

§ 195.442 Damage prevention program.

(a) After September 20, 1995, and except for pipelines listed in paragraph (c) of this section, each operator of a buried pipeline shall carry out in accordance with this section a written program to prevent damage to that pipeline by excavation activities. For the purpose of this section, "excavation activities" include excavation, blasting, boring, tunneling, backfilling, the removal of above ground structures by either explosive or mechanical means, and other earth moving operations. An operator may comply with any of the requirements of paragraph (b) of this section through participation in a public service program, such as a one-call system, but such participation does not relieve the operator of responsibility for compliance with this section.

(b) The damage prevention program required by paragraph (a) of this section must, at a minimum:

(1) Include the identity, on a current basis, of persons who normally engage in excavation activities in the area in which the pipeline is located.

(2) Provide for notification of the public in the vicinity of the pipeline and actual notification of the persons identified in paragraph (b)(1) of this section of the following, as often as needed to make them aware of the damage prevention program:

(i) The program's existence and purpose; and

(ii) How to learn the location of underground pipelines before excavation activities are begun.

(3) Provide a means of receiving and recording notification of planned excavation activities.

(4) If the operator has buried pipelines in the area of excavation activity, provide for actual notification of persons who give notice of their intent to excavate of the type of temporary marking to be provided and how to identify the markings.

(5) Provide for temporary marking of buried pipelines in the area of excavation activity before, as far as practical, the activity begins.

(6) Provide as follows for inspection of pipelines that an operator has reason to believe could be damaged by excavation activities:

(i) The inspection must be done as frequently as necessary during and after the activities to verify the integrity of the pipeline; and

(ii) In the case of blasting, any inspection must include leakage surveys.

(c) A damage prevention program under this section is not required for the following pipelines:

(1) Pipelines located offshore.

(2) Pipelines to which access is physically controlled by the operator.

[Amdt. 195-54, 60 FR 14651, Mar. 20, 1995]

Summary of selected OSHA requirements relating to excavation (from Title 29 Code of Federal Regulations):

Paragraph 1926.650(b) defines *competent person* as one "who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them." (The preamble to the final rule for 26 CFR 1926 advises that a "competent person" must have had training in, and be knowledgeable about, soils analysis, the use of protective systems, and the requirements of standard 1926.)

Paragraph 1926.651(b) requires that the estimated location of utility installations, including gas lines, must be determined before opening an excavation. Consistent with local time constraints, such as those in Pennsylvania Act 38 and before beginning an excavation, excavators are required to contact utility companies/owners, advise them of the proposed work, and ask them to establish the locations of underground installations. When the excavator is approaching the estimated location of a marked buried facility, he is required to determine the exact location by safe and acceptable means. While the excavation is open, underground installations must be protected, supported, or removed as necessary to safeguard employees and people that live or work in the vicinity.

Paragraph 1926.651(i) requires protection of adjacent structures by support systems, such as shoring, if the excavation operations endanger them.

Paragraph 1926.651(k) requires daily inspections of excavations when employee exposure can be reasonably anticipated of the adjacent areas and of protective systems by a competent person for evidence of a situation that could result in cave-ins, failure of protective systems, hazardous atmospheres, or other hazardous conditions. The paragraph also requires that employees be removed from any hazardous condition until proper corrective action has been taken.

Paragraph 1926.652(a) requires protection of employees from cave-ins when in excavations 5 feet deep or more. The protective system may be one of several described in the regulation, such as sloping, benching, or shoring.

Appendix C

Characteristics of Current State Laws on Excavation Damage Prevention

The characteristics in this appendix were reproduced from the following publication:

> American Public Works Association. 1997. One-Call Systems International Directory 1997–1998 and Excavator's Damage Prevention Guide. Kansas City, MO. 45 p. (p. 31–43).

CURRENT DAMAGE PREVENTION LAWS

ALABAMA

LEGISLATION: Yes, 94-487 **DATE:** 1994
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: No, except in the case of where are found and excavator initiates a callback. Utilities have up to 4 hours to positively respond
EXEMPTS: D.O.T., County Officials, Railroads, Government Entity with Right of Way, Agricultural, Operating Water and Sewer Boards, Rural Water Systems and Property Owners or Easements
ACCURACY OF LOCATION: 18' on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 working days, no more than 30 days prior to excavation
COLOR CODE: Yes
PROTECTION/EXCAVATION: No **PENALTY CLAUSE:** Yes
ISSUE PERMITS: No

ALASKA

LEGISLATION: No, (Local Ordinance Anchorage only) **DATE:** 1987
PARTICIPATION: Volunteer **PROTECTS:**
POSITIVE RESPONSE: No
EXEMPTS:
ACCURACY OF LOCATION: 2' on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: 48 hours **PENALTY CLAUSE:** $2000 and
ISSUE PERMITS: Yes injunctive relief

ARIZONA

LEGISLATION: Article 6.3 Chapter 2 Section 40-360.21-.32 **DATE:** 1974, 1995
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: Agricultural/Extraction of Natural Resources; Property Owners w/ hand tools while gardening or tilling; Emergency
ACCURACY OF LOCATION: 24" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Uncover using methods recommended by operator
PENALTY CLAUSE: $1000 each violation **ISSUE PERMITS:** No

ARKANSAS

LEGISLATION: Yes, Act 600 as amended in 1989, 1991, and 1995 **DATE:** 1987
PARTICIPATION: Mandatory with **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes, exceptions for some water, wastewater and CATV
EXEMPTS: Agricultural - Right-of-Way; does not include Property Owners and Solid Waste Disposal Site
ACCURACY OF LOCATION: 18" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Uncover using methods approved by operator
PENALTY CLAUSE: $2,500 each violation **ISSUE PERMITS:** No

CURRENT DAMAGE PREVENTION LAWS

CALIFORNIA

LEGISLATION: Yes, GC 4216 **DATE:** 1984
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: D. O. T.; Non-pressurized sewer, storm or drain lines
ACCURACY OF LOCATION: 24" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days but not more than 14 calendar days
COLOR CODE: Yes **PROTECTION/EXCAVATION:** Expose with hand tools
PENALTY CLAUSE: $10,000 - $50,000; Loss of License by Contractor's Board
ISSUE PERMITS: Yes, must notify center to validate permits

COLORADO

LEGISLATION: Yes, S.B. 93-155 **DATE:** 1993
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: No
EXEMPTS: Railroad
ACCURACY OF LOCATION: Within 18" on both sides of marking
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 days not to include the day of actual notice
COLOR CODE: Yes **PROTECTION/EXCAVATION:** Careful and prudent manner
PENALTY CLAUSE: $200 - for not calling; $1000 for damages-First offense, $3000 each additional **ISSUE PERMITS:** No

CONNECTICUT

LEGISLATION: Yes, Public Act 77-16-345-9 G.C.R. **DATE:** 1977, 1987
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: None
ACCURACY OF LOCATION: 18" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 days not more than 30 **COLOR CODE:** Yes
PROTECTION/EXCAVATION: If gas, hand dig within 18"
PENALTY CLAUSE: Up to $10,000 **ISSUE PERMITS:** No

DELAWARE

LEGISLATION: Yes, Title 26, Chapter 8 **DATE:** 1979
PARTICIPATION: Mandatory
PROTECTS: All Utilities and the Public Health and Safety
POSITIVE RESPONSE: Yes **EXEMPTS:** Homeowners; Agricultural
ACCURACY OF LOCATION: Within 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Careful and prudent
PENALTY CLAUSE: $100 to $1000 **ISSUE PERMITS:** No

DIST. OF COLUMBIA

LEGISLATION: Yes, 3-240 **DATE:** 1979
PARTICIPATION: Mandatory **PROTECTS:** All Utilities

CURRENT DAMAGE PREVENTION LAWS

DIST. OF COLUMBIA (continued)

POSITIVE RESPONSE: Yes
EXEMPTS: U.S. Government and D.C. Government
ACCURACY OF LOCATION: 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: If gas hand dig in prox. unless D.C. has previously dug test hole
PENALTY CLAUSE: Damage without notification, double damages can be recovered $1000
ISSUE PERMITS: Yes

FLORIDA

LEGISLATION: Yes, Chapter 556.10 **DATE:** 1993
PARTICIPATION: Voluntary **PROTECTS:** All Underground Facilities
POSITIVE RESPONSE: Yes
EXEMPTS: Various, Refer to Chapter 556 Section 108 and 109
ACCURACY OF LOCATION: 24" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: not less than 2 nor more than 5 business days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Excavate in careful and prudent manner
PENALTY CLAUSE: Yes, a non-criminal infraction can be of a $250 fine up to $5,000.
ISSUE PERMITS: No

GEORGIA

LEGISLATION: Yes, HB 128, HB 166-1978, HB 1489-1986, HB 1651 **DATE:** 1969
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Only if caller requests for gas, power, telephone and CATV one if no facilities are involved **EXEMPTS:** D.O.T. and Railroads
ACCURACY OF LOCATION: 24 " from the outside edge
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 72 hours excluding weekends and holidays
COLOR CODE: Yes **PROTECTION/EXCAVATION:**
PENALTY CLAUSE: $1000-First Offense and $3000 subsequent occurring within 12 months
ISSUE PERMITS: No

HAWAII

LEGISLATION: No **DATE:**
PARTICIPATION: **PROTECTS:**
POSITIVE RESPONSE: No **EXEMPTS:**
ACCURACY OF LOCATION: **EMERGENCY CLAUSE:** No
NOTIFICATION TIME: **COLOR CODE:**
PROTECTION/EXCAVATION:
PENALTY CLAUSE: **ISSUE PERMITS:** No

IDAHO

LEGISLATION: Yes, Chapter 22, Section 55-2201 through 55-2210 **DATE:** 1991
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes

CURRENT DAMAGE PREVENTION LAWS

IDAHO (continued)

EXEMPTS: Excavation of less than 15"; Agricultural; Extraction of Minerals; Normal road maintenance; Public Highway r/w; Railroads
ACCURACY OF LOCATION: within 24" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 business days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Hand dig 2' either side of width of UG facility
PENALTY CLAUSE: Not more than $1000 **ISSUE PERMITS:** Yes

ILLINOIS

LEGISLATION: Yes, State Law **DATE:** 1991
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: Agricultural; Railroads
ACCURACY OF LOCATION: 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION: **PENALTY CLAUSE:** $200/No call, $100/Call
but doesnÔt wait 48 hours **ISSUE PERMITS:** No

INDIANA

LEGISLATION: Yes, Revision Pending HB1121 **DATE:** 1990
PARTICIPATION: Volunteer **PROTECTS:**
POSITIVE RESPONSE: Yes
EXEMPTS: Normal farming practices, hand digging, RR except at public grade crossings
ACCURACY OF LOCATION: 24Ó on either side of the facility
EMERGENCY CLAUSE: Yes **NOTIFICATION TIME:** 2 full working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Hand dig 24" on either side of the buried facility
PENALTY CLAUSE: Damages, plus up to three times punitive damages
ISSUE PERMITS: No

IOWA

LEGISLATION: Yes **DATE:** 1/1/93
PARTICIPATION: Mandatory **PROTECTS:** All Underground Facilities
POSITIVE RESPONSE: Yes **EXEMPTS:** None
ACCURACY OF LOCATION: 18" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: Yes **ISSUE PERMITS:** No

KANSAS

LEGISLATION: Yes, Statute 66-1801-66-1814 - 07-01-93 **DATE:** 1993
PARTICIPATION: Mandatory **PROTECTS:** All Utilities Except water and sewer
POSITIVE RESPONSE: Yes
EXEMPTS: **ACCURACY OF LOCATION:** Within 24"
EMERGENCY CLAUSE: Yes **NOTIFICATION TIME:** 2 - 10 working days
COLOR CODE: Yes **PROTECTION/EXCAVATION:**
PENALTY CLAUSE: Yes **ISSUE PERMITS:** No

CURRENT DAMAGE PREVENTION LAWS

KENTUCKY

LEGISLATION: Yes, HB 613 effective 1/1/95 **DATE:** 1994
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: No
EXEMPTS: Excavation by operator on own easement; Routine road maintenance; Non-powered hand tools; Animal power; Agricultural; Residential Property; Grave in cemetery; Solid waste disposal site; Coal mining
ACCURACY OF LOCATION: 18" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Careful and prudent manner
PENALTY CLAUSE: Fines; cost of repair **ISSUE PERMITS:** No

LOUISIANA

LEGISLATION: Yes, ACT 923, Amended 1992 and 1995 **DATE:** 1988
PARTICIPATION: Mandatory must participate in a regional notification program
POSITIVE RESPONSE: Utility operators must mark or provide information regarding location of underground or submerged utilities.
PROTECTS: All owners/operators of UG and submerged facilities who participate in damage prevention program
EXEMPTS: Cable TV from participation, but must call in locate requests. Political subdivisions if they have opted out, but must call in locate requests
ACCURACY OF LOCATION: 18" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 to 120 hours in advance **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Yes **PENALTY CLAUSE:** Yes
ISSUE PERMITS: No

MAINE

LEGISLATION: Yes, Chapter 437 **DATE:** 1991
PARTICIPATION: Mandatory **PROTECTS:** Gas, Oil, Telephone, Electric, Cable TV
POSITIVE RESPONSE: No **EXEMPTS:** None
ACCURACY OF LOCATION: 36" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: $50 - $100 **ISSUE PERMITS:** Yes

MARYLAND

LEGISLATION: Yes, Article 78, Section 28A **DATE:** 1974
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** None
ACCURACY OF LOCATION: 18" on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Excavate in careful and prudent manner
PENALTY CLAUSE: $1000 or 10 times the cost of damage
ISSUE PERMITS: No

CURRENT DAMAGE PREVENTION LAWS

MASSACHUSETTS

LEGISLATION: Yes, Chapter 82, Section 40 **DATE:** 1980
PARTICIPATION: Mandatory
PROTECTS: Gas, Electric, Telephone, CATV and Regulated Water Utilities
POSITIVE RESPONSE: No **EXEMPTS:** None
ACCURACY OF LOCATION: None **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 72 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: First $200, Second $500, Subsequent $1000
ISSUE PERMITS: Yes

MICHIGAN

LEGISLATION: Yes, Public Act 53 as Amended **DATE:** 1975, 1989
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** Non-powered hand tools; D.O.T.
ACCURACY OF LOCATION: 18" on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 3 working days **COLOR CODE:** No
PROTECTION/EXCAVATION: Hand Dig Test holes
PENALTY CLAUSE: Up to $5000 fine and/or 1 year in jail, injunctive relief. May be enjoined from work in state **ISSUE PERMITS:** No

MINNESOTA

LEGISLATION: Yes, Chapter 216D **DATE:** 1987
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: No
EXEMPTS: None if using power tools; otherwise agricultural; drainage tile; extraction of minerals; grave in cemetery; normal road maintenance with no grade change; growing crops less than 18' deep; landscaping and gardening less than 12"
ACCURACY OF LOCATION: Within 24" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Excavation in careful and prudent manner
PENALTY CLAUSE: Liability release misdemeanor **ISSUE PERMITS:** No

MISSISSIPPI

LEGISLATION: Mississippi Statute 77-13-1 **DATE:** 1985
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** None
ACCURACY OF LOCATION: Correct Location **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: **PENALTY CLAUSE:** Civil Penalties
ISSUE PERMITS: No

MISSOURI

LEGISLATION: Yes, Chapter 319, RS Mo 1992 **DATE:** 1976
PARTICIPATION: Voluntary except for gas companies and pipelines
PROTECTS: All Utilities **POSITIVE RESPONSE:** Yes

CURRENT DAMAGE PREVENTION LAWS

MISSOURI (continued)

EXEMPTS: Agricultural
ACCURACY OF LOCATION: Approximately location
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Excavate in careful and prudent manner
PENALTY CLAUSE: Yes
ISSUE PERMITS: No

MONTANA

LEGISLATION: Yes, Chapter 180, 6-69-4-501 Montana
DATE: 1971, 1991
PARTICIPATION: Mandatory
PROTECTS: Utilities in Public and Private Right of way
POSITIVE RESPONSE: Yes
EXEMPTS: Emergency repairs to lines or streets, but liability for damage not waived.
ACCURACY OF LOCATION: 18Ó either side of facilities.
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Hand dig 18" either side of facilities.
PENALTY CLAUSE: Liable damages - Civil penalty
ISSUE PERMITS: No

NEBRASKA

LEGISLATION: Yes, One Call Notification System Act Section 76-2301 - 76-2330
DATE: 1995
PARTICIPATION: Mandatory
PROTECTS: All operators of underground facilities
POSITIVE RESPONSE: Yes
EXEMPTS: Normal road maintenance; Agricultural; Digging of graves and landfills; Railroad; Hand digging around base of pole for inspection
ACCURACY OF LOCATION: 18" either side
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2-10 business days
COLOR CODE: Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: Yes; Gas and hazardous liquids $10,000 per day maximum of $500,000; Others $500 per day maximum of $5,000
ISSUE PERMITS: No

NEVADA

LEGISLATION: Yes, NRS 455.080-NRS 455.180
DATE: 1987
PARTICIPATION: Mandatory
PROTECTS: All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: D.O.T.
ACCURACY OF LOCATION: 30" either side
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 working days but not more 14 calendar days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Expose with hand tools
PENALTY CLAUSE: $1,000-$100,000
ISSUE PERMITS: No

NEW HAMPSHIRE

LEGISLATION: Yes, RSA 374, Section 47 thru 56
DATE: 1983
PARTICIPATION: Mandatory
PROTECTS: Gas, Electric, Cable TVand Public Water Utilities
POSITIVE RESPONSE: No
EXEMPTS: None
ACCURACY OF LOCATION: 36"
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 72 hours
COLOR CODE: Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: $500
ISSUE PERMITS: Yes

CURRENT DAMAGE PREVENTION LAWS

NEW JERSEY

LEGISLATION: NJSA 48:2-74 thru 91 **DATE:** 1994
PARTICIPATION: Mandatory **PROTECTS:** All Underground Facilities
POSITIVE RESPONSE: Yes **EXEMPTS:** Non-Forced Sewers
ACCURACY OF LOCATION: 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 3-10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Hand dig 2' either side of Underground Facility
PENALTY CLAUSE: Yes **ISSUE PERMITS:** No

NEW MEXICO

LEGISLATION: Yes, NMSA Chapter 62, Article 14 HB 65 - 1991 **DATE:** 1978
PARTICIPATION: Volunteer **PROTECTS:** All Member Utilities
POSITIVE RESPONSE: No **EXEMPTS:** None
ACCURACY OF LOCATION: 12" Horizontal **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Maintain 18" from cutting edge
PENALTY CLAUSE: $500 **ISSUE PERMITS:** No

NEW YORK

LEGISLATION: Yes, Code, Rule 753 as revised 1995 **DATE:** 1997
PARTICIPATION: Mandatory **PROTECTS:** All Utilities, Municipalities
POSITIVE RESPONSE: Yes **EXEMPTS:**
ACCURACY OF LOCATION: Within 2 feet of the edge of facility
EMERGENCY CLAUSE: Yes **NOTIFICATION TIME:** 2-10 days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Hand dig test holes; No power equipment within 4" until verification
PENALTY CLAUSE: $500 first violation & $500 each violation on same project-increased 2/95-pending legislative review **ISSUE PERMITS:** No

NORTH CAROLINA

LEGISLATION: Yes, Chapter 785, SB 168 **DATE:** 1986
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: No **EXEMPTS:** None
ACCURACY OF LOCATION: 2.5' either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours to 10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Excavate in careful and prudent manner
PENALTY CLAUSE: No **ISSUE PERMITS:** No

NORTH DAKOTA

LEGISLATION: SB 2036, Sect. 11-18-16 Repealed by SB 2359 Eff. 3-1-98
DATE: 1973, 1995 **PARTICIPATION:** Mandatory
PROTECTS: All Utilities **POSITIVE RESPONSE:** Yes
EXEMPTS: Opening a grave in a cemetery; Agricultural less than 18" in depth; Normal maintenance of roads and streets: Normal repair and maintenance of Railroad right of way.

CURRENT DAMAGE PREVENTION LAWS

NORTH DAKOTA (continued)

ACCURACY OF LOCATION: 2' on other side of the UG facility except for UG facilities
EMERGENCY CLAUSE: Yes, used to convey water.
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Avoid damage and minimize interference to underground facility. Careful and prudent manner.
PENALTY CLAUSE: Yes **ISSUE PERMITS:** Yes

OHIO

LEGISLATION: Yes, Ohio S.B. 174, 2 tier legislation 1 53.64, 3781.25-32
DATE: 1988, 1990 **PARTICIPATION:** Mandatory
PROTECTS: All Utilities **POSITIVE RESPONSE:** No
EXEMPTS: Private Septic Systems; Mining; Agricultural less than 12" in depth; Property owners
ACCURACY OF LOCATION: 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours to 10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: **ISSUE PERMITS:** No

OKLAHOMA

LEGISLATION: Yes, Title 63, Section 142-1-11, HB 1029-1982 **DATE:** 1981, 1982
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** Certain agencies under certain conditions
ACCURACY OF LOCATION: 2' on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Hand dig test holes; No power equipment until line is exposed and protected within the four-feet wide strip.
PENALTY CLAUSE: No **ISSUE PERMITS:** No

OREGON

LEGISLATION: Yes, ORS 757.541-571 repealed by SB 559 Eff. July 1, 1997
DATE: 1987, 1995 **PARTICIPATION:** Mandatory
PROTECTS: All Utilities **POSITIVE RESPONSE:** Yes
EXEMPTS: Private Property not within right of way or easement; Routine Road Maintenance less than 12"; Agricultural
ACCURACY OF LOCATION: 24" outside the edge of the facility
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: (Effective July 1, 1997) 2 days - life of the project. Marks maintained by Excavator. **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Use responsible care and hand dig
PENALTY CLAUSE: Yes **ISSUE PERMITS:** No

PENNSYLVANIA

LEGISLATION: Yes, ACT 287 as amended by ACT 187 of 1996 **DATE:** 1974, 1996
PARTICIPATION: Mandatory **PROTECTS:** All Underground Facility Owners
POSITIVE RESPONSE: Yes through One Call Center
EXEMPTS: Agricultural; D.O.T. above 24Ó and Local Muni's above 18"; Extraction of natural resources

CURRENT DAMAGE PREVENTION LAWS

PENNSYLVANIA (continued)

ACCURACY OF LOCATION: APWA/ULCC Standards
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: Constr. phase-3-10 working days; Design phase-not less than 10 nor more than working 90 days **COLOR CODE:** APWA/ULCC Standards
PROTECTION/EXCAVATION: Hand dig test holes; careful and prudent techniques
PENALTY CLAUSE: Min. $2,500, no more than $2,5000 + up to 90 days jail; citiations for minor infractions ($100-$500 fines after third warning) enforced by the Department of Labor & Industry **ISSUE PERMITS:** Yes

RHODE ISLAND

LEGISLATION: Yes, Section 39- 1.2 **DATE:** 1984
PARTICIPATION: Mandatory
PROTECTS: Electric, Gas, Telephone and Cable TV and Regulated Water Utilities
POSITIVE RESPONSE: No **EXEMPTS:** None and Regulated Water Utilities
ACCURACY OF LOCATION: 18" **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Detailed Precautions
PENALTY CLAUSE: First $200, second $500, Subsequent $1,000
ISSUE PERMITS: Yes

SOUTH CAROLINA

LEGISLATION: Yes, HB 4020 **DATE:** 1978
PARTICIPATION: Volunteer **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** Conditional
ACCURACY OF LOCATION: 2.5' or 30" either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 3 working days minimum; 10 days maximum.
COLOR CODE: Yes
PROTECTION/EXCAVATION: Plan excavation to avoid damage to or minimize interference; maintain clearance; provide support as required by operators.
PENALTY CLAUSE: $1,000 maximum **ISSUE PERMITS:** No

SOUTH DAKOTA

LEGISLATION: Yes, HB 639, amended 3/4/93 by HB 1 205 **DATE:** 1977, 1993
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes
EXEMPTS: Tilling of soil and gardening up to 12"; Agricultural; Road and ditch maintenance; Grave in cemetery; Planned Sanitary Landfill
ACCURACY OF LOCATION: Accurate **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2 days **COLOR CODE:** No
PROTECTION/EXCAVATION: **PENALTY CLAUSE:**
ISSUE PERMITS: No

TENNESSEE

LEGISLATION: Yes, TCA 65-31-101 **DATE:** 1978
PARTICIPATION: Gas Systems are mandated to belong, all other utilities are volunteer
PROTECTS: All Utilities **POSITIVE RESPONSE:** Yes

CURRENT DAMAGE PREVENTION LAWS

TENNESSEE (continued)

EXEMPTS: None
ACCURACY OF LOCATION: 2' on either side
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 3-10 days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Maintain clearance
PENALTY CLAUSE: $1,000 + damages
ISSUE PERMITS: No

TEXAS

LEGISLATION: No
DATE:
PARTICIPATION: Volunteer
PROTECTS:
POSITIVE RESPONSE: No
EXEMPTS:
ACCURACY OF LOCATION:
EMERGENCY CLAUSE: No
NOTIFICATION TIME:
COLOR CODE: Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE:
ISSUE PERMITS: No

UTAH

LEGISLATION: Yes, U.C.A. 54-8a-1 et. seq.
DATE: 1977
PARTICIPATION: Mandatory
PROTECTS: All participating utilities
POSITIVE RESPONSE: Yes
EXEMPTS: Private tilling of soil; Government agencies
ACCURACY OF LOCATION: 2' either side
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 days
COLOR CODE: Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: $500 or $1,000
ISSUE PERMITS: No

VERMONT

LEGISLATION: Yes, 30 VSA, Chapter 86
DATE: 1988
PARTICIPATION: Mandatory
PROTECTS: Gas, Electric, Cable TV and Telephone
POSITIVE RESPONSE: No
EXEMPTS: None
ACCURACY OF LOCATION: 18"
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 48 hours
COLOR CODE: Yes
PROTECTION/EXCAVATION:
PENALTY CLAUSE: Up to $1,000
ISSUE PERMITS: Yes

VIRGINIA

LEGISLATION: Yes, Chapter 890
DATE: 1980, 1994
PARTICIPATION: Mandatory
PROTECTS: All Utilities
POSITIVE RESPONSE: Yes, Excavator-Operator Ticket Information Exchange System
EXEMPTS: Property Owners hand digging; Agricultural; Railroads; Routine road maintenance; Mining; D.O.T.; Emergency
ACCURACY OF LOCATION: Within 2 feet either side
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 48 hours good for 15 working days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Shall take all reasonable steps necessary; Hand digging
PENALTY CLAUSE: Yes
ISSUE PERMITS: No

CURRENT DAMAGE PREVENTION LAWS

WASHINGTON

LEGISLATION: Yes, Chapter 144, Title 19 RCW - 1990 **DATE:** 1984, 1990
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: No **EXEMPTS:** Excavation of less than 12"
ACCURACY OF LOCATION: 2' on either side **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 2-10 working days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Excavation in a careful and prudent manner
PENALTY CLAUSE: $1,000 + treble damages **ISSUE PERMITS:** No

WEST VIRGINIA

LEGISLATION: HB 108; Chapter 24C UG Facilities Damage Prevention
DATE: 1996, July 15 **PARTICIPATION:** Mandatory except for any
PROTECTS: All participating utilities
POSITIVE RESPONSE: No privately owned public water utility regulated by the public service commission, any state agency, any municipality or county, or any municipal or county agency may be voluntary members.
EXEMPTS: Underground or surface mining operations; tilling of soil for agriculutral purposes; domestic gardening; routine maintenance of paved public roads or highways by employees of state, county or muicipal entities or authorities which perform all work within the confines of traveled portion of the paved public way and excavate is less than 12".
ACCURACY OF LOCATION: 24" + or - **EMERGENCY CLAUSE:** Yes
NOTIFICATION TIME: 48 hours excluding weekends and holidays
COLOR CODE: Yes
PROTECTION/EXCAVATION: In a manner to avoid damage including hand digging; report immediately any break or leak; maintain a clearance between each UG facility and the cutting or point of any powered equipment, etc.; protect and preserve markers, stakes and other designations identifying the location of UG facilities; provide such support for ug facilities in the location of the work site
PENALTY CLAUSE: No **ISSUE PERMITS:** No

WISCONSIN

LEGISLATION: WI ACT 135 **DATE:** 1995
PARTICIPATION: Mandatory
PROTECTS: All Owners of Underground & Overhead Facilities
POSITIVE RESPONSE: Yes **EXEMPTS:** & Overhead Facilities
ACCURACY OF LOCATION: Mark in manner for excavator to locate
EMERGENCY CLAUSE: Yes **NOTIFICATION TIME:** 3 days
COLOR CODE: Yes
PROTECTION/EXCAVATION: Maintain 18" clearance cutting edge-stake
PENALTY CLAUSE: $2,000 **ISSUE PERMITS:** No

CURRENT DAMAGE PREVENTION LAWS

WYOMING

LEGISLATION: Yes, Wyoming Statute 37-12-301 **DATE:** 1996
PARTICIPATION: Mandatory **PROTECTS:** All Utilities
POSITIVE RESPONSE: Yes **EXEMPTS:** Wyoming Statutes 37-12-305 A-G
ACCURACY OF LOCATION: 24 " either side of edge of known
EMERGENCY CLAUSE: Yes
NOTIFICATION TIME: 2 full business days **COLOR CODE:** Yes
PROTECTION/EXCAVATION: Excavation in careful and prudent manner
PENALTY CLAUSE: If damage occurs, up to $5,000 in Civil Penalty
ISSUE PERMITS: Yes

Appendix D

Reports of Workshop Groups on Excavation Damage Prevention

The reports in this appendix were reproduced from the following publication:

> National Transportation Safety Board. 1995. Proceedings of the Excavation Damage Prevention Workshop; 1994 September 8–9; Washington, DC. Report of Proceedings NTSB/RP–95/01 (p. 175–183). Washington, DC. Appendix A.

Workshop Group Reports

During the afternoon and next morning of the workshop, four work groups were each given a different area to address. Each group had a facilitator and a panel of about 20. Each panel was comprised of representatives from communication, electric, water/ sewer, pipelines, excavators, Federal government, State government, notice centers and others. The fluid audience of 25 to 125, in each work group, had the opportunity to participate in every session, and sometimes it was lively. The area addressed by each group was:

Group 1 - Notification Center - What are the essential elements of effective one-call notification systems?
Group 2 - Buried facility operator - What responsibilities should buried facility operators have?
Group 3 - Excavators - What responsibilities should excavators have?
Group 4 - Program and administration - How should the program be administered?

In each group was a court reporter to document conversations and a laptop computer operator to record and then display so all could see each idea under consideration by the group. The results of each group were printed at the end of the first night to help the groups the next day. At the end of the group meetings, the notes were presented (using an overhead projector) to the plenary session, and handed out at the completion of the workshop. The results of the groups, as handed out are as follows:

GROUP 1 - One call

Definition:
A one-call notification system is a communication system established by two or more underground network owners or operators to provide one telephone number for excavators, be they contractors, homeowners, utilities, public agencies, or others, to call for notification of their intent to use equipment for excavating, tunnelling, demolition, or otherwise disturbing the subsurface of the earth. This below-ground protection system provides participating members an opportunity to identify and mark their facilities in the vicinity of proposed activity. The notification also allows the owners of underground facilities to provide any necessary information about the facilities and to post a construction watch, if desired.

MUST HAVE:

* All owners of buried facilities shall register their facilities except those owners of private facilities restricted to their property and their use.
* All members of the digging community shall use the service.
* Pro-active public awareness, education and damage prevention activities incorporating a broad spectrum of available opportunities.
* Specifically defined geo-political service area with no over-lap.
* Toll free access nationwide.
* Hours of full operation compatible with digging community with provision for 24-hour access to the system.
* Voice Record of all incoming calls.
* Retention of voice tapes according to applicable statutes.
* Provide and advise caller of ticket number for each locate request, and the names of facility owners who will be notified.
* Be able to provide a printed copy of any ticket for a period of time determined by any statute of limitations.
* Provide timely transmission of notifications to facility owners.
* Be able to provide regular statistical, financial and administrative reports.
* Allow input to operational procedures from facility owners and digging community.
* Documented operating procedures, human resources policies, and training manuals.
* User friendly for entire digging community.
* Cost effective.
* Promote recognition, awareness and acceptance of responsibilities of facility owners and digging community, including a users guide.
* Formal agreements with members.
* Documented owner verification of data submitted by facility owners.
* Sufficient flexibility to incorporate local requirements.
* Computer and communications systems sufficiently flexible to accommodate growth and change.
* Accept and process locate requests placed within the locally accepted advance notice period.
* Advise callers of any limitations on service or system.
* Accept and process short notice, priority and emergency locate requests.

SHOULD HAVE:

* No cost to users of the system.
* Contingency plan
* Foster cooperation and enhance relationships between digging community and facility owners, including the development of a means of communicating the owner response to the excavator.
* Regular communications with customers.

* Determine and maintain quality of telephone service factors acceptable to the users of the system.
* Employ mechanisms to reduce over-notification.
* Governed by non-profit corporation.
* Capability of tracking the origin or locate requests by various criteria -member, contractor, homeowner, municipality.
* Cooperative working relationships with agencies and associations with mutual areas of interest or concern, including membership in OCSI and active participation in utility coordination and damage prevention committees.
* Pro-active management.
* Machine readable notifications.
* Toll free fax access.

COULD HAVE:

* 24 hour staffed operation.
* Accept and process locate requests for design purposes.
* Management of damage incident database.
* Facilitate appointment plan.
* Addition of aerial facilities.
* Do locating on contract basis.
* Provision for "no locate required".
* Cellular "Star" number for no charge access.
* Remote entry by major users.
* "Interactive voice" tracking of locate status - positive response.

GROUP 2: Buried facility operator

What responsibilities should buried facility operators have?

Should the American Public Works Associations' published "Guidelines for Uniform Temporary Markings of Underground Facilities" continue to be the recognized marking code?

* Uniform Color Code should be used to temporarily mark facilities.
* Markings should include facility owner identification.

What responsibilities should buried facility operators have?

* Buried facility operators should advise excavators/contractors when marking can't be performed in compliance with normal state time frame or make a reasonable attempt to advise excavator/contractor when operator has no facilities in area?
  - Partnership approach.
  - Positive response not required for ALL situations.

How?
* Telephone/fax/cellular phone/means by which contractor supplies. (voice mail?)
* One-call as conduit.

What should the optimum/minimum response times for marking facilities be?
* No one size fits all.
* No decision reached on this question.

What accuracy standard should be used for operator marking?
* Need understanding of "tolerance zone".
* Use standards as they exist along with tolerance zone education.

What coordination/communications with excavators should operators have relative to excavation precautions and emergency notifications?
* Provide information to known emergency services, to include anticipated response times.
* Have established procedures for emergency notification.

Should depth of facility be provided?
* NO.

What role should buried facility operators have for educating excavators/contractors/public on use of one-call & working safely adjacent to buried facilities?

* One-call programs should have systematic programs to promote use & function of system: statewide & national.
* Additional educational efforts by individual operators should support the one-call program & also provide facility-specific education.
  (Contractor/contractor associations/insurance companies ....should share in responsibility of training employees.)
* Mechanism to ensure message is received by public & encourage feedback (program effectiveness analysis).
* Any campaign advertising one-call should be coordinated with appropriate one-call facility.
  Working adjacent to buried facilities
* Facility owners take responsibility for the education of their employees & subcontractors.

What type marking equipment should be used?
* Use clearly identifiable materials appropriate to environment & conditions.

When excavation show errors in mapping information, should operators be required to update maps?
* YES.

What facility owners should be in the one-call system?
* All owners/operators should be full participating members in a one-call system.

Which buried facility owners/operators should participate in damage prevention?
* Any buried facility owner should be involved in a damage prevention program.

What actions should operators take for long-term projects?
* Advance & continuing coordination with documentation between operators & excavators (such as temporary markings).
* Follow-up reports/communications between company & excavator.
* Support & attend preconstruction meetings for major projects.
* The need may exist for excavators to update ticket through one-call.

How will customer-owned services lines get marked?
How will yard lines get marked?
* Facility owners should accept responsibility for marking up to a predetermined point, i.e., meter, interface device, etc.
* [CT state statute allows utilities to mark out customer-owned service lines with a hashed/broken mark which avoids liability for the utility but allows for a best guess locate of a facility they are not responsible for.]
  [Locate if locatable...no liability?]
  [Pool heaters/gas grills/gas lamps? Educate homeowner/ public.]

How will abandoned Facilities get marked?
* As a best practice, utilities should be encouraged to maintain future abandoned facilities on facility records.

Standardized markings at time of installation?
[Can provide additional liability protection.]

Excavator Premarking.
* Encourage white line marking where applicable & practicable.
* To improve communications & efficiencies in facilities markings, we encourage the use of white-lining proposed excavations.
* Extensive excavation plans should be submitted.
* If premarking is not used, it is the excavator's responsibility to clearly & adequately identify the area of the intended excavation.

Workshop group three - Excavators

Which excavators should be required to notify the one call system?
* The panel recommends that no excavators be exempted from calling the one-call system.

Should the area to be excavated be pre-marked by the excavator before owners mark their facilities?

* Pre-marking the proposed excavation areas has been demonstrated to enhance the safety of excavation activities.

What damage to facilities should excavators report & to whom?

* The panel recommends that any contact or other activity which impacts the integrity of an underground facility be reported.

To whom?

* These reports should be made to the owner, operator and/or one-call system.

How should excavators determine the depth of buried facilities?

* The panel recommends that excavators use non-mechanized hand tools or tools specifically designed to safely expose an underground facility to determine its exact location.
  The panel further recommends that excavators and underground facility owners work together to develop installation standards and new depth location technology.

What operation of machinery should be permitted in marked areas? Under what circumstances?

* The panel recommends that the operation of excavation machinery be permitted in marked areas as required or necessary once the underground facility is exposed and adequately protected.

What role should excavator associations have in educating excavators, equipment operators and the public in working safely adjacent to buried facilities?

* The panel recommends that excavator associations work in conjunction with facility owners, operators and one-call systems to include underground facility damage prevention training as part of safety training.

What actions must excavators take to protect underground facilities?

* The panel recommends that excavators take any and all prudent and reasonable steps necessary to protect the integrity of the underground facility in cooperation with facility owners and operators.

Should excavators be required to advise the center as to length of time for completing the reported project?

* The panel recommends that excavators notify the one-call centers as to the approximate length of time for the project.

Should there be a time limit on the validity of the ticket issued by the one-call center?

* The panel recommends that state laws and regulations define starting times and lengths of time when tickets are valid.

Other recommendations:

* The panel recommends that the standardized color code be limited to the marking of underground facilities at the job site.

The panel further recommends that the ULCC look at developing other color codes for additional circumstances.

Program and Administration - Group 4

Federal role in damage prevention
- * Set minimum guidelines and encourage standards that a State may set in conformance with the national guidelines
- *Determine what went wrong and how do we fix it
- * Promote technology transfer
- * Comprehensive participation driven by federal law.

Local & State role in damage prevention
- * Monitor the levels of construction activity and damage occurrence
  1. To measure effectiveness
  2. To target need for improvement
- * Damage going down with construction increasing
- * Mandatory participation
  1. Facility operator
     federal-
     state-
     local-
  2. Excavator
     federal-
     state-
     local-

Enforcement
- * Self policing partnerships
- * Enforcing penalties, ability to recover costs
  - * Specific Agency responsibility for authority

Education
- * An equal partnership between facility owners & the contractors
  - a. Targets of education
    1. People moving the earth
    2. Locators
    3. Public
    4. Survey organizations
    5. Regulatory authorities
    6. Engineers & Designers
    7. Zoning & Siting Boards
    8. Attorneys, Legislators & Judges
  - b. Format of educational objectives
    1. Training

2. Awareness
3. Benefits of using one-call for
   a. Engineers & designers
   b. Contractors
4. Safety & responsibility
5. Penalties & liability
6. Emergency response

c. Methods

Positive incentives a. Enhanced personal safety at the work site
b. Cost effective to the excavator and facility owner
c. Insurance discounts for damage prevention programs
d. Reduce liability for self reporting (NEB.)
e. Preserving our infrastructure
f. Pre-marking sites of proposed construction
g. Protecting the Environment

Where is the data? a. Facility owners (may or may not report)
b. Insurance
c. Associations
d. One-Call operation

Concerns of Group 4* Universal participation

1. Define minimum risk which requires level of participation in the program within each state
2. Flexibility for alternative procedures that meet the spirit and intent of the program by mutual agreement of excavator and operator on a case-by-case basis.

* Create positive incentives for damage prevention programs.
* Educate all stakeholders
* Establish clearly defined federal, state, and local roles.
* Ensure membership control of One Call Centers.
* Retain the strength of current damage prevention programs
* Courage to continue
* Establish, publish, and distribute procedures for dealing with violations and funding.
* Requirements of the damage prevention program are balanced for:
  1. Facility owner
  2. Excavator
* Team work to solve problems
* Practical Considerations
  1. Remember that law affects all areas of the country
  2. Administration of program will be as simple and as streamlined as possible with a minimum of government oversight
  3. Sensitive to cost impacts for all stakeholders

* Why do damages continue to occur even when comprehensive programs are in place?
    1. Recommend further research to accomplish continuous improvements.
    2. On going data gathering system (i.e. data tracking)
* Geographic boundaries will decide who has responsibility over interstate facilities.
* Encourage competency reviews for owners and excavators.
* Write rules in a way that encourages creativity.
* Require single one-call systems in each geographic area.
* Establish criteria for new underground facilities to be locateable without excavation.

Appendix E

Example of Universal Damage Report Form

The form shown in this appendix was developed by the Alberta One-Call Corporation in Calgary, Alberta, Canada.

FACILITY DAMAGE REPORT

Report No.	Entered

01 Facility Owner	02 District/Office	03 Ref/Serv/Tap No.	04 Date (YY/MM/DD)

05 Site Location (Street Address/Legal Land Description/Lot, Block, Rural Subd'n)	06 Municipality/M.D./I.D./County

Area ☐ 07 Urban ☐ 08 Rural

Site ☐ 09 Private Property ☐ 10 Easement/ROW/Lease ☐ 11 Road Allowance ☐ 12 Lane ☐ 13 Other Public Property

Plant Damaged ☐ 14 Trunk ☐ 15 Main ☐ 16 Service ☐ 17 Underground ☐ 18 Surface ☐ 19 Aerial

Type of Incident

☐ 20 Dig Up ☐ 21 Near Miss ☐ 22 High Load ☐ 23 Vandalism ☐ 24 Animal ☐ 25 Natural Elements ☐ 26 Thaw-Deliberate ☐ 27 Fire/Water Damage ☐ 28 Vehicle Accident-Identified ☐ 29 Vehicle Accident - Not Identified ☐ 30 Other _____

Activity

☐ 31 Backhoe/Trackhoe Excavation ☐ 32 Bobcat/Loader Excavation ☐ 33 Trencher Excavation ☐ 34 Grader/Dozer/Scraper Excavation ☐ 35 Ditch Shaping ☐ 36 Saw Cutting/Jack Hammer ☐ 37 Blasting/Vibrosis ☐ 38 Demolition/Breakout ☐ 39 Snow Removal ☐ 40 Cable/Pipe Plowing ☐ 41 Deep Tillage ☐ 42 General Agriculture ☐ 43 Landscape/Tree Planting ☐ 44 Vertical Augering/Drilling ☐ 45 Horizontal Auger//Bore/Push ☐ 46 Driving Bars/Stakes/Posts/Anchors ☐ 47 Hand Excavation ☐ 48 Other _____

DAMAGED BY

☐ 49 Landowner/Tenant ☐ 50 Municipality ☐ 51 Prov. Gov't Dept. ☐ 52 Fed. Gov't Dept. ☐ 53 Indian Band ☐ 54 Elec/Gas/Tel/Utility ☐ 55 Elec/Mech Contractor ☐ 56 Drilling Contractor ☐ 57 Utility Contractor ☐ 58 Excavation Contractor ☐ 59 Landscaper ☐ 60 Pipeliner ☐ 61 House Builder ☐ 62 Irrigation District ☐ 63 Railway ☐ 64 General Contractor ☐ 65 Fence/Sign Contractor ☐ 66 Well Site Contractor ☐ 67 Surveyor/Engineer ☐ 68 Seismic Contractor ☐ 69 Concrete/Paving Contractor ☐ 70 Road/Grading Contractor ☐ 71 Sewer/Water Contractor ☐ 72 Petroleum/Resource Co. ☐ 73 Other _____

74 Company Name	75 Contact

76 Mailing Address	77 Phone

78 Working For

Locates Requested? ☐ 79 Yes ☐ 80 No ☐ 81 N/A | Locates Done? ☐ 82 Yes ☐ 83 No | Locates Accurate? ☐ 84 Yes ☐ 85 No | Hand Exposed? ☐ 86 Yes ☐ 87 No

88 Locate Ticket No.	89 Date Located	Facility Marked By	Contact Authorized?	Damage Preventable?
		☐ 90 Flags ☐ 91 Paint ☐ 92 Stakes ☐ 93 Maps ☐ 94 Verbally ☐ 95 Not Marked	☐ 96 Yes ☐ 97 No	☐ 98 Yes ☐ 99 No

Appendix F

Industry Practices and Procedures for Excavation Damage Prevention

The guidelines in this appendix were reproduced from the following publication, with the permission of the National Utility Locating Contractors Association:

> National Utility Locating Contractors Association. 1997. Excavation Practices and Procedures for Damage Prevention: A Guide for Protection of Underground Facilities. Spooner, WI. 8 p.

EXCAVATION PRACTICES & PROCEDURES FOR DAMAGE PREVENTION

A Guide for Protection of Underground Facilities

NATIONAL UTILITY LOCATING CONTRACTORS ASSOCIATION

P.O. Box 27
Spooner, WI 54801
(715)635-6004
Fax (715)635-7977

Dear Contractor:

NULCA is involved with a committee to develop and test excavation standards procedures that may assist in the reduction of facility damages. We would like to solicit your comments to help develop these procedures. We believe that this would be a great tool in accomplishing our goal.

We also believe that it is very important to obtain comments and/or ideas from all people involved in the excavation industry and that we get the endorsement of these people in order to put these procedures in place.

Please take the time to review the attached "NULCA Excavation Practices and Procedures for Damage Prevention" document and distribute these through your company for feed back. We value your feed back and appreciate your assistance. Please direct all comments to the NULCA office at P.O. Box 27, Spooner, WI 54801, telephone: (715)635-6004 or fax: (715)635-7977.

Thank You.

GEM/sp

NULCA
EXCAVATION PRACTICES AND PROCEDURES FOR DAMAGE PREVENTION

Revised September 17, 1997

Objective:

- The industry's objective is to manage an accident free work place so that no one is injured and we work within operating budgets to insure that the job is completed on time and profitably by utilizing good standards and practices.

- Most damages are avoidable if excavating and locating procedures are followed. Those that effectively implement the guidelines described below, as part of their normal daily routine, will significantly reduce the potential for an accident.

- Federal O.S.H.A. rules and legislation in most states require contractors who plan to excavate to notify the appropriate One Call Center and non-member facility owners before the job begins. Additionally, there should be no excavating of any kind, mechanical or by hand, without first obtaining locates of those facilities. If private lines exist, they too must be properly located. (Property managers or owners of private facility systems can assist in calling for locates.)

Preplanning of excavation project:

Identify Facilities - Large Projects

- The proposed excavation area should be pre-marked with white paint prior to notifying One Call for locates.
- A pre-construction meeting with facility owners to review excavation area should be held.
- Obtain as-builts/maps from facility owners.
- Have sub-surface facility engineering performed if feasible.
- Photograph of excavation area.
- Obtain a ticket and document the locate request number. Acquire and retain the sketch of the locate if supplied by the facility owner.
- Make sure request numbers are valid and that they are issued in your company's name.
- If there is a "high priority" facility line in excavation area, make arrangements for the locator to be on the job site during the excavation (i.e., high pressure gas, fiber optic, high voltage electric, major pipe and water lines, etc.). If locator or facility owner refuses to be present, then document this response to the ticket request.
- Ensure that all known non-member facility owners have been contacted.

Identify Facilities - Small Projects

- If necessary and if possible, the proposed excavation area should be pre-marked with white paint prior to notifying One Call for locates.
- Retain documentation of the locate request number including a sketch of the locate if supplied by the facility owner both in the field and in the office.
- Make sure request numbers are valid and that they are issued in your company's name.
- If there is a "high priority" facility line in dig area? Make arrangements for the locator to be on the job site with you during the excavation. If locator or facility owner refuses to be present, then document this response to the ticket request.

- Ensure that all known non-member facility owners have been contacted for locates.

On the job site:

- Once on the job site, begin job preparation by reviewing list of non-member/member of facility owners that are in your excavation area and make sure that locate marks for all facilities are present. Consult your color chart if necessary to ensure all facilities have been located.
- Have color charts in the hands of all excavators. Consult your color chart if necessary to ensure all facilities have been located.
- If a "high priority" facility is in the excavation area, make sure the locator is on site. If not, consult color chart for facility contact numbers and call the facility company and document response.
- Account for all feeds to houses or buildings before you excavate. You should be able to see them in the air or marked on the ground.
- Identify or have locate all private facilities that have not already been located. This includes propane and private lines, sprinklers, etc. Look for sewer vents on the roof of the house, look for sprinkler heads, turn on the system if necessary. Look for physical evidence that facilities have not been located.
- Sketch the location and document the depth of all public and private facilities on your work order for future reference.
- If no sketch exists of all other facilities, draw a sketch of marks with measurements of fixed objects if possible for future reference.
- Expose all facilities that you will be crossing. All major facilities (i.e., high pressure gas, fiber optic, high voltage electric, major pipe and water lines, etc.) should be exposed every 100 feet if parallel within 5 feet of excavation area when possible.
- If there are no locates, if marks are incomplete, or if exposing indicates locates are not accurate, ***DO NOT DIG***. Contact the facility owner to complete the locates.
- Once you have verified the location of all lines and you have completed the Job Check List, you can begin to excavate.

Remember to document the sketch of your dig site before you start excavating.

Excavating:

- **You should hand dig (or other means such as vacuum excavating) within 5 feet of any pedestal, closure, riser guard, pole (with riser), meter or other structure.**
- **Hand dig (or other means such as vacuum excavating) within 24 inches of any and all other locate marks.**
- **If you must use mechanical equipment within 24 inches of a mark, you should expose the line first.**
- **If you are paralleling a line, you should expose every 100 feet to verify the location and depth of the line. If the locate is not accurate, the facility owner should be contacted immediately.**
- **If using a boring machine, you should bore away from all facilities. If you must cross a facility, expose the line to verify location and depth. This may require changing the bore route or depth to avoid the facility. Keep marks visible and fresh at all times.**
- **Carefully follow all shoring and safety standards, including support of exposed underground facilities.**

Backfilling:

- **Prior to backfilling, contact facility owner to inspect exposed facility, if necessary.**
- **All lines exposed during excavation must be supported to prevent damage, stretching, kinking, etc.**
- **All lines should be "shaded" meaning clean, good fill dirt placed around the lines to prevent possible damage.**
- **All backfill dirt must be "clean fill" free of large rocks, sharp objects, and large chunks of hard packed dirt or clay.**
- **No cable or personal trash and no abandoned lines or pieces of lines should be backfilled into the trench.**

If a damage does occur:

- If the damage involves a potential risk to life, health or significant property damage, the excavator shall call 911.
- All damages, including kinking or sheath damage, however slight, must be reported immediately to a supervisor and to the facility owner or operator.
- Photographs should be taken and reports completed to help document the damage and assist in resolving any claim that may be filed.
- If a water line, other than a main, is damaged, you should attempt to stop the flow of water if possible.
- If a gas or power line is damaged, it may be necessary to leave the area immediately and notify others in the area. ***REMEMBER, SAFETY FIRST!!! FOLLOW COMPANY SAFETY STANDARDS AND PROCEDURES.***
- Complete Damage Investigation Report (example attached) and submit to your supervisor.

Accountability:

Companies should consider disciplinary action, suspension or termination in any of the following situations:

- Digging without obtaining locates.
- Excavating, including hand digging, without locates for any or all facilities or private lines.
- Any "at fault" damage.
- Failure to check paperwork or equipment before leaving the shop.
- Failure to utilize the job check list provided.

Obtain and learn the laws and regulations that pertain to excavating in your state.

Everyone should incorporate these procedures into their daily routine. By utilizing these procedures, it will increase your productivity and efficiency, not to mention the obvious safety benefits.

The suggested Minimum Excavation Procedures set forth in this pamphlet are designed for companies to adopt as part of the ongoing procedures for underground facility damage prevention. Obviously, as standards, they can only be used as guidelines by a company and should not be considered to be in lieu of other appropriate practices or safety standards that may be necessary under the circumstances. Due to the inherently individualized nature of excavation, NULCA assumes no liability as to whether any particular procedure is sufficient in any circumstance due to the type of excavation, subsurface conditions, underground facilities and the construction techniques present, regional differences in construction practices, nature of facilities, the type of equipment used, and a series of other variables must always be considered in connection with any excavation project.

NULCA, has used its best efforts to prepare this information accurately as of the date of publication. NULCA cannot be held responsible for typographical errors, changes that occur after the date of this publication, or any subsequent to federal, state and local regulations that could affect these standards.

PRE-EXCAVATION
CHECK LIST
DO NOT DIG WITHOUT LOCATE MARKS

Please complete and sign this sheet prior to excavation taking place.

BEFORE YOU LEAVE THE SHOP

- ☐ Check to see if locate has been completed (look at due date).
- ☐ Make sure you have a field sketch or if one was left at job site.

If you do not have what you need as listed above, do not leave the shop. See your Supervisor

ON THE JOB SITE

Pre-Survey (checking for locates)

- ☐ Check for field sketch.
- ☐ Check for all facility marks on ground, review color codes if in doubt.
- ☐ Verify all service feeds from buildings and homes and that they have been located and/or that they are aerial.
- ☐ Draw a sketch of the marked facilities for future use.
- ☐ Check for any visible signs of pedestal, riser, new trench lines that may have been missed in your dig area.
- ☐ Check to make sure that dig area is defined and is same on locate sketch when possible.
- ☐ Check for any private facilities not located. If they are not located, locate them or contact someone to get them located.
- ☐ If there are high priority facilities in your dig area, make sure facility owner/locator is on job site and/or has been contacted for advise.

If lines are not located completely, consult locate card and contact responsible party

Private Utilities

- ☐ Ask for assistance from homeowner and utilize locating equipment and common sense.
- ☐ Locate septic lines.
- ☐ Locate water yard lines.
- ☐ Locate private power lines to sheds, wells, invisible fences, etc.
- ☐ Locate private gas or propane lines.
- ☐ Locate sprinkler lines and heads and drip systems.
- ☐ Draw a sketch of locations for all private facilities on job site.

EXCAVATING

- ☐ Maintain 24 inches from marks. If digging with 24 inches, expose to verify location and depth.
- ☐ Expose all major facilities within 5 feet or work area.
- ☐ If paralleling, expose to verify location and depth every 100 feet.
- ☐ Hand dig within 5 feet of peds, pole risers, meters or other structures.
- ☐ Bore away from facilities.
- ☐ Verify depth of any facilities boring across, change route or depth as required, notify supervisor.
- ☐ No placement of excavated dirt on locate marks, flags, whiskers, etc.
- ☐ Support all lines exposed during excavation to avoid kinks or other damage

BACKFILLING

- ☐ Shade all lines placed or exposed with good fill dirt.
- ☐ Verify all fill dirt is free from rocks, cable trash, crew trash, and large dirt clods.

PLEASE DIG SAFELY

As an excavator, you are responsible for verifying that all facilities within the dig area have been located.

You are responsible for locating all private facilities. Have the homeowner assist you if needed.

Failure to comply with the procedures listed above may result in disciplinary action up to and including termination

COMPLETED BY _____ **DATE**_____

_____of_____

CONSTRUCTION FACILITY DAMAGE REPORT

DATE OF REPORT _____ DATE AND TIME OF DAMAGE _____
ADDRESS _____ TICKET # _____
DATE OF LOCATE _____ NAME OF LOCATE COMPANY _____
FACILITY OWNER _____ FACILITY DAMAGED _____ SIZE _____
LIVE OR ABANDONED _____ LOCATE ACCURATE YES ____ NO_____
MEASUREMENT OFF BY ____FEET____INCHES LOCATES____PAINTED ____ FLAGGED
PICTURES TAKEN _____YES _____NO HOW MANY TAKEN _____
LOCATE SKETCH ATTACHED _____YES____NO WAS LOCATE SKETCH ON JOB SITE ____YES ____NO
WAS HAND DIG COMPLETED 24" EACH SIDE OF MARK _____
WAS LINE FOUND AND EXPOSED BY HAND _____ DAMAGE BY HAND OR MACHINE _____
CAUSE CODE _____ ACTION CODE FOR EMPLOYEE _____
NAME OF PERSON WHO CAUSED DAMAGE _____#_____
NAME OF EMPLOYEE'S SUPERVISOR _____#_____

RESOLUTION: TO BE FILLED OUT IF AT FAULT
WHAT HAPPENED TO CAUSE THIS DAMAGE _____

WHY DID THIS HAPPEN _____

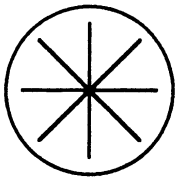
WHAT IS BEING DONE TO INSURE THIS WILL NOT HAPPEN AGAIN _____

CAUSE CODES LOCATE ERROR

E01	Facility not marked
E02	Abandoned facility
E03	Mark off, but facility was not damaged
E11	Locate marks off

CAUSE CODES EXCAVATOR ERROR

D02	Out of dig area
D03	No locate requested
D04	Expired locate
D05	Digging prior to locate
D06	Hit on locate - within 18" of mark
D07	Marks destroyed - drawing incorrect
D08	Unable to investigate/not notified
D09	Found all cables marked This cable wasn't marked



INDICATE NORTH

COMMENTS ON DAMAGES: _____

EMPLOYEE SIGNATURE _____ DATE _____
SUPER _____ DATE _____
MANAGER _____ DATE _____

OK TO PAY: _____ DATE ___/___/___ DEPT. CODE ___/___/___
OWNERS SIGNATURE

CLAIM NUMBER: _____ AMOUNT PAID: _____
CHECK NUMBER: _____ P.O. NUMBER: _____

WHITE: DAMAGE FILE YELLOW WITH P.O. PINK EMPLOYEE FILE

Appendix G

NTSB Safety Recommendations Related to RSPA Accident Data

Safety Recommendation No.: P-78-58
Date Issued: October 15, 1978
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Superseded, September 9, 1987
Recommendation:

Publish a plan that describes how the OPSO will use accident report data to formulate safety regulations and to develop a safe service life model for pipelines.

Safety Recommendation No.: P-78-59
Date Issued: October 25, 1978
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, May 23, 1989
Recommendation:

Redesign the Liquid Pipeline Accident Reporting System to include data similar to that collected in the Natural Gas Accident Reporting System.

Safety Recommendation No.: P-78-60
Date Issued: October 25, 1978
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, May 23, 1989
Recommendation:

Provide clear instructions and definitions to ensure the accuracy and consistency of the data recorded on the liquid pipeline accident report forms.

Safety Recommendation No.: P-78-61
Date Issued: October 25, 1978
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, May 23, 1989
Recommendation:

Computerize the redesigned Liquid Pipeline Accident Reporting System. Include the capability to (a) compute the historical accident/leak rate-per-mile of pipe for each carrier as well as the nationwide rate; (b) make periodic comparisons of each carrier's accident/leak rate against the nationwide accident/lead rate; (c) compute and plot selective accident/leak rates based on pipeline parameters such as age, specified yield strength, depth of cover, product transported, etc.; (d) selectively retrieve and summarize accident/leak data pertaining to any given accident or classification of accidents; and (e) produce summarized reports reflecting the above-listed information.

Safety Recommendation No.: P-78-62
Date Issued: October 25, 1978
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, April 4, 1979
Recommendation:

Conduct audits of the completed liquid pipeline accident reports to ensure that mandatory data are provided.

Safety Recommendation No.: P-80-61
Date Issued: August 20, 1980
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, May 31, 1989
Recommendation:

Develop and publish for public comment a formal data analysis plan for the pipeline data system.

Safety Recommendation No.: P-80-62
Date Issued: August 20, 1980
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, October 7, 1981
Recommendation:

Expedite the proposed creation of an Office of Regulatory Planning and Analysis and define responsibilities for developmenet and management of a pipeline data analysis plan.

Safety Recommendation No.: P-80-63
Date Issued: August 20, 1980
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Unacceptable Action, March 17, 1986
Recommendation:

Postpone promulgation of proposed, revised pipeline data forms until development of a data analysis plan and coordination of the forms with the plan.

Safety Recommendation No.: P-80-64
Date Issued: August 20, 1980
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Reconsidered, October 7, 1981
Recommendation:

Develop explicit directions for completion of the present data forms to improve the quality of the information collected on these forms. Assure that terms not universally accepted across the pipeline industry are defined.

Safety Recommendation No.: P-80-65
Date Issued: August 20, 1980
Recipient: Research and Special Programs Administration
Status and Date Status Assigned: Closed—Acceptable Alternate Action, March 17, 1986
Recommendation:

Train existing personnel to more effectively validate incoming leak report forms.