3. STATE AND LOCAL LAWS AND REGULATIONS

A number of states and localities have developed laws or regulations apropos to the control of excavating for or near underground utilities. As would, or should be expected, the quality of these laws or regulations varies widely. Naturally enough the regulations that impose the least control on the utilities and contractors are preferred by them. A factor that should be considered is the capability to enforce compliance. The OSHA and the State of New York both have codified regulations. Neither the OSHA regulations nor the New York code 53 are enforced actively. Laws that are not enforced accomplish little.

3.1 Raison d'etre for State Regulations

The necessity for a general regulation of utilities is accepted in most quarters. Since the health and economic well being of the populace is at stake, it is believed that the general overseer, a governmental body, should exercise at least oversight in regard to utility operations. If a utility underground facility suffers dig-in type of damage, the results can range from: unnoticed, if a water line is leaking, to inconvenience, if the sewer line cannot be used, or a telephone call must be delayed; to danger, if a natural gas pipeline rupture results in a fire.

The probability of a resultant fire from many gas line dig-ins is the most important reason for the regulational developments of the past decade. An argument can be made (and is) that if there is too much regulation concerning excavation that the cost of excavating will rise without a concomitant reduction in outside party damages. This hypothesis essentially poses that the utility industry is now at or near a condition where a lot more care and expense produces little in the way of damage reduction.

There are not enough available data to render either a positive or negative verdict on the relationship between the reduction in accidents and the cost increase incurred for less damage during excavation. Data have not been collected for a variety reasons: the existence of records might be harmful if the utility is sued; a mutual agreement exists to repair the damage that one utility inflicts on the other, without cross billing; there is refusal to collect for damages because the collection process would be resented by potential customers.

There is little argument with the hypothesis that a possible danger cannot be allowed to exist, because of deterred action. It does not necessarily follow that a significant reduction in dig-in damages can only be attained by slowing the excavation rate drastically. At the present time the market place dictates which excavator is employed. If the excavator overbids frequently he will be forced out of the business. However, if he regularly bids low he is either more efficient or he takes more chances than his competitors. No reference has been found to studies by utilities for determining realistic excavation costs.

The many statutes and models for statutes that are discussed are superficially quite similar. In most respects they seem to require the same responses, and in a few cases they differ significantly. The main source of disagreement with the first two OPSO model statutes had been with the OPSO continued drive to require various forms of record development. Complete record-keeping adds expenses, but it can also make possible more effective damage control.

3.2 Existing State Laws and Regulations

Numerous state and local laws and regulations exist. The status of regulations at the end of 1976 is listed in Table 3.1. The states have taken various approaches to the problem of regulating excavators. Some states have statutes enabling the formation of one-call systems, i.e., Michigan has State Statute Number 53. One state has used the state regulatory agency to require the utilities to join a one-call system; i.e., the Illinois Commerce Commission is requiring all utilities under its purview to join the statewide one-call system.

TABLE 3.1 STATUS OF PIPELINE/UTILITY DAMAGE PREVENTION LAWS (AND ONE-CALL SYSTEMS) IN THE 50 STATES AND D.C., 1976

State	Statewide Coverage One-Call	Localized Coverage One-Call	Legislation
1. Alabama	X		Proposed
2. Alaska		None	Proposed
3. Arizona		X	Enacted
4. Arkansas		None	Proposed
5. California		X	Municipal Code Enacted
6. Colorado		X	Enacted
7. Connecticut	X		Enacted
8. Delaware	X(2)		Proposed
9. District of Columbia	X		Proposed
10. Florida		X	Proposed
11. Georgia		X	Enacted
12. Hawaii		None	None
13. Idaho		X(2)	None
14. Illinois		X	ICC Regulation
15. Indiana		X(2)	None
16. Iowa		None	None
17. Kansas		None	None
18. Kentucky		X(2)	Proposed
19. Louisiana		X	None
20. Maine	X(2)		None
21. Maryland	X(1)(2)		Enacted
22. Massachusetts	X(2)		Enacted
23. Michigan	X		Enacted
24. Minnesota		None	Enacted
25. Mississippi		None	None
26. Missouri		None	Enacted
27. Montana		None	Enacted
28. Nebraska		X	None
29. Nevada		None	Enacted
30. New Hampshire	X(2)		None
31. New Jersey	X		Enacted
32. New Mexico		X	Enacted
33. New York		X	Enacted
34. North Carolina		None	None
35. North Dakota		None	Enacted
36. Ohio	X(1)(2)		Proposed
37. Oklahoma		None	None
38. Oregon		X	None
39. Pennsylvania		X	Enacted
40. Rhode Island	X(2)		Enacted
41. South Carolina		None	~~None~~
42. South Dakota		None	Enacted
43. Tennessee		X	Enacted
44. Texas		X	Proposed
45. Utah		X	Proposed
46. Vermont	X(2)		None
47. Virginia	X(1)(2)		Proposed
48. Washington		X(2)	None
49. West Virginia	X		None
50. Wisconsin		X	Enacted
51. Wyoming		None	None

(1) Statewide coverage with multiple one-call systems
(2) One-call system includes more than one state

Out of the total of 50 states and the District of Columbia all but 15 have some area of one-call system coverage. The New England states are all in the single one-call system Dig-Safe. Many of the states have or plan statewide coverage. Some states have a single one-call system such as the system in Houston, Texas.

As of September 1976, 35 states have one-call systems in operation. Of the states that have one-call systems, 43 percent have statewide coverage while the remaining 57 percent have localized coverage. Within a state, also there are sometimes operating multiple one-call systems. For example, in the state of Washington, there are 19 organized one-call systems covering separate localized areas. There are, however, areas in the state which are not covered. Of the 15 statewide coverage one-call systems, 12 have a statewide one-number system while the remaining three have two or more numbers in the state.

Some one-call systems operate across state boundaries. In the northeast, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont have formed a joint damage prevention program where two telephone numbers cover the entire area. With the exception of Massachusetts and Rhode Island, these states do not have any state statutes pertaining to underground facility damage prevention. The states of Indiana, Kentucky, and Ohio have formed a joint call system which covers a portion of each of these states. Ohio does not have a state statute. During April 1977 Ohio was contemplating an all-voluntary statewide one-call system.

In the state of Idaho, two coordinating councils have been formulated which overlap into Washington. Neither of these two states have enacted state legislation. Delaware, Maryland, and Virginia have cooperated and formed a one-call system covering a portion of each state. Maryland is the only one of the three to have enacted a state statute. From this it might appear that some state statutes are inhibiting the cooperation (at least between states) that might have evolved without the statute. This, however, does depend on the flexibility of the requirements in the statute.

Of the 35 states which have one or more one-call systems in operation, 54 percent have enacted legislation, 20 percent have proposed legislation, and 26 percent have no legislation enacted. Therefore, almost half of the one-call systems in operation are in jurisdictions where there are no statutory requirements. The fact that approximately one-half of the one-call systems are in states that do not have damage prevention laws should not be taken to imply that statutes do not have an effect.

Tampa Florida has a one-call system, "Call Candy". Florida had legislation pending, but it was not passed. One utility withdrew from Call Candy because "since it was not required to be in, it would not pay the cost".

Many existing one-call systems came into being somewhat as a result of federal agency activities. The all-voluntary one-call system development has been actively encouraged by the NTSB. The OPSO has presented model statutes to the states for consideration. Model statute development may have stimulated the formation of some voluntary one-call systems. Most of the state laws proposed or enacted enable or require the development of a one-call system.

3.3 Statute Evaluations

The OPSO 1977 model statute, the Michigan Code 53, the New York Code 53, and the APWA guidelines for preparing damage prevention laws are evaluated in this subsection. The four statutes are reproduced and included in the appendix to be available for cross-reference during the evaluation.

In Table 3.2 the 1974 and 1977 OPSO Model Statutes are compared. The major changes in model statute development from 1974 to 1977 are: the utilities must file with a pertinent county or other office, not the Recorder of Deeds; Operator Associations (one-call) are specifically allowed; intent to excavate must be filed 3 to 10 days prior to excavation instead of 5 to 30 days; and minor legal definitions and requirement changes were made. Table 3.3 is a brief comparison between the New York State law (Rule 53) and the OPSO 1977 Model Statute.

TABLE **3.2 COMPARISON OF OPSO MODEL STATUTES 1974 AND 1977**

Section and Item*	1977	1974
1. Purpose	Increase safety, decrease damage more narrative defining underground	1. Increase safety, decrease damage
2. Definitions	Operator is defined as utility operator; utility defined as facility including underground	2. Utility operator; utility line defined as underground facility
3. Permits	Does Not relieve responsibility	**57.** Requires action by permit issuing Public Authority
4. Prohibition	Excavation is regulated	§5(a) Excavation is regulated
5. Filing Requirements	5(a) Little change, file with pertinent clerk	**4.** File with Recorder of Deeds
5(b) Changes in Filed Information	Requires notification of changes down to geographical section level	No Change
6. Notice of Intent to Excavate	Notice includes: written <u>or</u> telephone notice, 3 to 10 days; operator associations specifically allowed	5. Notice includes: written note 5 to **30** days, no specific mention of operator associations
7. Operator Associations	Defines responsibilities	No mention
8. Response to Notice	Defines locating effort required and specifies 2 days in advance	**54.** Defines locating effort and specifies immediate response to location request
9. Emergency Excavation of Demolition	Defines reasonable guidelines including operator association	§5(b) Similar but does not mention operator associations
10. Precautions to Avoid Damage	Guidelines for excavation	No mention
11. Damage Reports	11a and 11b are essentially the same as 6a, b, and c	
12. Civil Penalties	(States Attorney to bring action) Specifically states this act does not effect civil remedies for personal injury	58. District Attorney to take action
13. Severability	Little Change from §9	
14. Effective Date	Gives 120 days for organization, but requires immediate filing by utilities	§10. Gives 120 days for organization
15. Recordkeeping	Implies good location records must be developed	

* The format of **1977** model is followed

TABLE 3.3 COMPARISON OF 1977 OPSO MODEL STATUTE VERSUS NEW YORK STATE LAW AND RULE 53

Item	New York State Law and Rule 53	OPSO Proposed Model Statute
Purpose	Same	Same
Definitions	Generally similar	Generally similar
Central Registry of Operators	By township	By section
Notification	Excavator determines who operators of underground systems are from Central Registry and is responsible for notifying them	Requires designated group to notify operators of planned excavations
Informing Excavator of Location of Underground Facilities and Mark-out	Generally Similar	Generally Similar
Notice of Excavation or Blasting	48 hr to 10 days oral or written to operators of underground systems	3 days to 10 days written to pertinent body
Emergency	Notice as soon as possible; can start excavation before notice	Generally similar
Reports of Damage	Generally similar	Generally similar
Permit Issuance	No requirement	Obtaining permit does not relieve statute requirements
Civil Penalty	$500 - $5000	$1000

The Michigan Public Act 53, Public Utilities, Excavating or Discharging Explosives Notice is quite similar to the OPSO Model Statute 1977. The Michigan law states that if two or more operators form an association to receive calls that all public agency-owned utilities must cooperate and share the costs of the one-call system; the OPSO model states that an operator association (one-call) may be formed. The Michigan law allows for grandfather clause operations; the OPSO model does not. The Michigan law permits enjoining of chronic offenders from continuing to excavate, along with a possible $1000 fine; the OPSO model only proposes the $1000 fine as a penalty.

Table 3.4 shows the area of agreement and disagreement between the 1974 OPSO Model Statute and the APWA Sample State Statute. The table also cites concurrence or disagreement with various statutes or other regulations that existed in mid-1976.

Table 3.5 is a list of questions which were developed for the comparative evaluation exhibited in Table 3.4. Twenty-three state statutes proposed or enacted, one city ordinance, and three model statutes were comparatively evaluated (see column 2 of Table 3.4).

A major difference between the OPSO model and the APWA model concerns the center of activities. The APWA model defines a Notification Center as "any organization among whose purposes is the dissemination to one or more operators the notification of planned construction activities in a specified area". OPSO relegates these duties to the Recorder of Deeds (Director of Public Works, or other designed public official). A subsequent OPSO statement (Ref. 5) clarifying the 1974 Model Statute pointed out that organized one-call systems could act as the designated public official. The OPSO model, along with defining a public agency as the center of activities is much more specific in its duty requirements.

One aspect of the locating process coincident in both models is the requirement that the excavator take action to notify the operators of utilities within the proposed area of excavation. The details of the notification process is where many differences between the two models lie.

The APWA model in addition to the excavator notification, takes one step back further into the chain of events by requiring the project originator to provide information on utilities to the excavator. The project originator may be the architect, designer or engineer. This person is required to furnish the excavator or contractor with the names of all the operators of underground facilities and the means through which each can be communicated as part of the project details made available prior to the start of any excavation or demolition.

TABLE 3.4 COMPARISON OF 1974 OPSO MODEL STATUTE AND APWA SAMPLE STATE STATUTE* (AND OTHER STATUTES)

QUESTIONS	ANSWERS Totality of Answers from Statutes Analyzed	OPSO	APWA
NOTIFICATIONS			
1. Is a central registry of utilities, central coordinating council, notification center, or similar organization defined in the statute?	No: 26% Yes: 74% a. County Clerk b. Recorder of Deeds c. Public Service Commission d. Notification Center	Yes Recorder of Deeds (Director of Public Works, Public Utilities Commissioner)	Yes Notification Center
2. Is the central registry of utilities or similar organizations required to:			
a. Maintain files of submitted notices of excavation?	a. No: 58% Yes: 15%	Yes Yes	Yes Yes
b. Maintain files of utility information (geographical boundaries, personnel contacts, etc.)?	b. No: 8% Yes: 65%	No	No
c. Maintain accurate locations of underground facilities possibly in the form of maps?	c. No: 58% Yes: 15% Not applicable: 23% Not specified: 4%		
EXCAVATORS			
1. Are there any persons or organizations exempt as an excavator as stated in the statute? If so, who?	No: 74% Yes: 26% a. Gas companies working of their own gas lines b. Excavation done by private resident on his own property	No	No

* This comparison was completed prior to the development of the 1977 Model Statute and is included here for general guidance. In column 2: the 27 statutes evaluated were perused and each of the questions was tallied; the applicable percentage; yes, no, etc., are listed.

TABLE 3.4 (contd)

QUESTIONS	ANSWERS: Totality of Answers from Statutes Analyzed	ANSWERS: OPSO	ANSWERS: APWA
	c. Excavation with hand tools by property owner on his own property d. Direct employees of a utility company e. Public service co. or employee, state, town, city, or borough em- ployee regularly en- gaged in the mainten- ance and repair f. Individual employed by an excavator where such individual has no super- visory authority, other than the routine direc- tion of employees, any person performing excava- tion or demolition work on property of which he is the record owner where there are no underground facilities not operated by him and work is not within 15' of the bound- aries of such property g. State highway depts., state DOT and highway organizations		
2. What are the allowable time limits for the excavator's notification?	a. 2 days–3 months b. 5 days–10 days c. 2 days– d. 3 days–	5 days - 30 days	2 days - 10 days

TABLE 3.4 (contd)

QUESTIONS	ANSWERS Totality of Answers from Statutes Analyzed	OPSO	APWA
	e. Reasonable advance notice f. Not specified g. 1 day- h. 5 days-30 days i. 2 days-10 days j. 10-days-14 days k. 1 month-		
UTILITY OPERATORS			
1. Does the statute appply to all underground structures operated by utilities, including: electrical lines, communication lines, gas, oil, water, sewerage, and other similar commodities? If not, list exemptions.	Yes: 81% No: 19% a. Applies only to "pipeline facilities carrying gas" b. Just pipes conveying combustible gas c. Gas only d. Just hydrocarbon pipelines	Yes	Yes
2. What are the allowable time limits for the utility operator to respond to a notification of excavation?	a. At least 1 day prior (15%) b. Within 5 days c. Within 2 days (30%) d. Reasonable advance notice e. Not specified f. As promptly as practical g. Within 4 hours	Respond immediately	Within 2 days

TABLE 3.4 (contd)

QUESTIONS	ANSWERS: Totality of Answers from Statutes Analyzed	OPSO	APWA
	h. Within 3 days i. Does not apply j. To respond immediately k. Before commencing work l. At least 1 hour		
PENALTIES			
1. What is the maximum penalty for the first violation?	a. $1000/offense and/or 90 days max. imprisonment b, $100-$1000 c. Charge for misdemeanor d. $1000 first offense e. $100-$1000 and/or 90 days max. imprisonment f. $500/offense + cost of repair g. $1000/offense + cost of repair h. $1000 + cost of repair + cost of attorney's fees i. $1000 or 1 year imprisonment + damages j. $50 k. $500/incident + 1.5 times damages l. Not specified m. $100/offense n. $1000/day if no damage resulted; $2000/day if damage resulted	$1000/offense	Must prove negligence as determined by courts and can be barred from excavating within the state

TABLE 3.4 (contd)

QUESTIONS	ANSWERS: Totality of Answers from Statutes Analyzed	OPSO	APWA
	o. Must prove negligence as determined by courts and barred from excavating within the state p. $300 and/or 30 days imprisonment q. Revocation of permit or license		

DEFINITION OF TERMS

- Excavation

OPSO	APWA
The model implicitly exempts human powered tools by using the term "mechanized equipment" in its definition. No mention is made of agricultural activities which implies that it is included in its definition of excavation.	Explicitly states exemptions such as: the movement of earth by tools manipulated only by human or animal power and the tilling of soil for agricultural purposes shall not be deemed excavation.

(The major difference is the specific exemption of agricultural activities by the APWA model; both attempt to explicitly list all of the various types of activities. Possibly the anticipated excavation rate could be used as a criterion of definition.)

- Person

OPSO	APWA
Specifically includes public agencies and their employees, etc.	Does not include public agencies

(The APWA model includes a separate definition of the term Public Agency which is possibly less inclusive that the OPSO definition of Person.)

TABLE *3.4* (concl)

o Utility Operator

OPSO	APWA
The model lists the various uses to which underground pipelines are put together with commodities carried.	This model lists essentially the same commodities but also adds the inclusive term "and other similar commodities".

(The APWA may be more inclusive from a legal viewpoint.)

o Damage

OPSO	APWA
"Substantial weakening" is the key phrase.	"Necessitate repair" is the key phrase.

● Blasting

OPSO	APWA
Explosive devices for excavation	

o Demolition

OPSO	APWA
	Explosive devices are considered along with other tools.

(Both the **OPSO** and the APWA models include blasting and demolition in other term definitions.)

o Utility Line - **OPSO**

o Underground Facility - APWA

(The two definitions are essentially the same.)

o Operator

OPSO	APWA
	Person who operates a utility

(The use of "person" in the above definition of operator, considering the APWA definition of person, puts public utilities in a gray area. The **OPSO** specific definition of person eliminates this confusion.)

o Excavator

o Mechanized Equipment

o Working Day

(The **OPSO** model specifically defines these while the APWA model does not.)

TABLE 3.5 **QUESTIONS ABOUT** STATUTES USED TO DEVELOP INFORMATION IN SECOND COLUMN OF TABLE *3.4* EVALUATION **REGARDING** UNDERGROUND UTILITIES DAMAGE PREVENTION

NOTIFICATION REQUIREMENTS

1. Is a central registry of utilities, central coordinating coucil, notification center, or similar organization defined in the statute?
2. Does the statute require that the central utility coordinating organization (if one is established) be registered in the state?
3. What is area of jurisdiction of above organization?
4. Is the recipient of the notice of excavation:

   a. the above mentioned organization, i.e., central registry, etc.?
   b. the individual utilities involved?
5. Are the requirements of the notice of excavation specified? (detailed/general)
6. Is a telephone communication sufficient for compliance with the notification procedure?
7. Is the central registry of utilities or similar organization required to:

   a. maintain files of submitted notices of excavation?
   b. maintain files of utility information (geographical boundaries, personnel contacts.....)?
   c. maintain accurate locations of underground facililities possibly in the form of maps?

EXCAVATOR

1. Are there any persons or organizations exempt as an excavator as stated in the statute? If so, who?
2. Does the statute require the excavators and contractors to register with the state?
3. Is the acquisition of a permit for excavation contingent on compliance with the notification process dictated in the statute?
4. Is the excavator required to initiate a notification process prior to excavation?
5. Is the excavator required to obtain or consult a master list of utilities or maps?
6. Is the excavator required to notify each and every utility within the proposed area of excavation?
7. What are the allowable time limits for the excavator's notification?
8. Are there directives in the statute requiring the excavator to obtain some form of verification after supplying notification but prior to starting work?

TABLE 3.5 (contd)

9. Is the project originator, architect, designer, or engineer required to furnish the contractor or excavator with information regarding the pertinent utilities?
10. Is tilling the ground with farm machinery excluded from the definition of excavation as stated in the statute?
11. Is the use of hand tools or animal powered tools exempt in the definition of excavation as stated in the statute?
12. Is demolition of above ground structures included in the statute?
13. Are procedures specified for excavating near underground facilities with regard to distance limits and types of equipment?
14. Are there provisions in the statute in the event that the excavator cannot locate the underground facilities from the markings provided?
15. Are there requirements in the statute for the excavator to provide support for uncovered facilities?
16. Is the excavator required to inspect for possible damage any facility that is uncovered or exposed prior to backfilling?
17. Are there requirements stated in the statute for backfilling operations or excavated areas?
18. If a previously damaged underground facility is discovered or a hazardous condition is observed by the excavator, is the excavator required to immediately notify the utility operator?
19. Are special procedures for emergency excavations provided for in the statute?
20. If damage to an underground facility results from actions by the excavator, is the excavator required to immediately notify the utility operator?
21. Should damage occur, is the excavator required to contact emergency personnel (police, fire department)?
22. Should damage occur, is the excavator required to take immediate action to protect the public and property and to minimize the hazards while waiting for emergency personnel or the utility operator to ariive?

UTILITY OPERATOR

1. Does the statute apply to all underground structures operated by utilities, including: electrical lines, communication lines, gas, oil, water, sewage, and other similar commodities? If not, list exemptions.
2. Is the utility operator required to supply a central organization with up to date information regarding geographical boundaries where the utility is operating, personnel to contact for notifications or emergencies and other similar information?
3. Does the statute require the utility to maintain and provide maps of the location of its underground facilities?

TABLE 3.5 (concl)

4. Is the individual utility operator that is served with a notice of excavation required to initiate action to provide the excavator with the location of underground facilities prior to commencing excavation?
5. Is the utility operator required to maintain records or notices of proposed excavations and replies to such notices?
6. What are the allowable time limits for the utility operator to respond to a notification of excavation?
7. Are procedures for marking underground facilities as specified in the statute?
8. Is the adoption of a standardized color coding scheme required for marking the location of underground facilities?
9. Is the utility operator required to communicate to the organization originating the notice that either there are no underground facilities near the area to be excavated that the utility operates or the utility locations have been marked?
10. Upon receipt of a notification of damage is the utility operator required to promptly dispatch personnel to effect repairs?
11. Is the utility operator required to perform inspections for all notifications of damage?
12. Is it required that the repair of a damaged facility be performed by the utility operator or qualified personnel authorized by the operator?

PENALTIES

1. Are penalties for noncompliance specified in the statute?
2. What is maximum penalty for first violation?
3. Is there provision for additional penalties for willful damage?
4. Are there progressive penalties for additional offenses?
5. Can an injunction or mandamus be issued to halt excavation if unsafe practices are being used?

These requirements for actions by the project originator could be helpful to the excavator. However since the excavator is still required to verify and since no liabilities of the excavator are removed this action requirement is really a dilution of authority of the statute.

In both models a central agency of organization is proposed to receive notifications and/or inquiries for utility information. The APWA model designates a notification center for this purpose and the OPSO *1974* model designates the Recorder of Deeds (or other designated public official) as being responsible. The primary difference in responsibilities of these two organizations is that in the OPSO model the Recorder of Deeds receives, files, and passes on to each utility the notices of excavation as received from the excavators. In the APWA model, the notification center is not involved with the actual notices. They only furnish information about the utilities. It is left up to the excavator to initiate the actual notices to each utility from the information received from the notification center.

The details and jurisdiction of the notification center in the APWA model is left unclear, No mention is made as to who will or should be the head of the notification center (Director of Public Works, Public Utilities Commissioner?). No mention is made as to the jurisdiction of the notification center whether county, city, state, or other political/geographical subdivision. All that is said is that the notification center is an organization whose purpose is the dissemination to one or more utility operators the notification of planned construction activities in a specified area. The notification center is required to file the following information as received from the utilities within its jurisdiction: a description, map or record of the areas in which the utility has underground facilities, the name of the utility, and the title, address, and telephone number of the utility representatives designated to receive notices.

In effect, the Recorder of Deeds in the OPSO *1974* model can constitute a one-call system. The notification center in the APWA model does not. However, in section 10 of the APWA model, the value of voluntarily establishing local utility coordinating committees and one-call notification centers is recognized and encouraged. The voluntarily established organization must still file with the Notification Center defined previously, the geographical area served and a list of the names and addresses of every member and participating utility. The details of the notice of excavation, who is required to bear the costs, and the necessary records to be kept are all specified for the voluntary organization. The OPSO model contains no such recommendations or Specifications for voluntarily established notification organizations.

In the OPSO 1974 model, the responsibilities of the utility operator in filing notices to the Recorder of Deeds is clearly specified.

a. Within 30 days of the effective date of this act, each utility operator shall file with the Recorder of Deeds in each county wherein its utility lines are located a written notice containing the following information:

   (1) The name of the utility operator.

   (2) A list of every city, village, borough, township or district wherein its utility lines are located.

   (3) The name, address and telephone number of the person to whom telephonic or written inquiries concerning the precise location of its utility lines may be addressed.

b. Changes in any of the information contained in a written notice filed in section (a) above shall be filed with the Recorder of Deeds within five working days of the change.

In the APWA model the details of the utility notice are not specified. Procedures for filing changes in any information are not specified.

Both model statutes contain the proviso that obtaining a permit for excavation or blasting is conditional on compiying with the requirements of the notification process in the statute.

The details of the excavator notice to either the Recorder of Deeds for the OPSO model or the individual utilities for the APWA model differ slightly. In both models the specifications regarding the content of the notices are clearly stated. For the APWA model the time limits for filing the notice with the utilities are "not more than ten days and not less than forty-eight hours, excluding Saturdays, Sundays, and legal holidays, prior to the commencement of work". For the OPSO model, the time limits for filing the notice with the Recorder of Deeds are "at least five but not more than 30 working days prior to commencement of the excavation or blasting".

The response time for the utility operator in the APWA model is "within forty-eight hours, excluding Saturdays, Sundays, and legal holidays, unless otherwise agreed" after receiving the notice. In the OPSO model the utility operator, after receiving notice from the Recorder of Deeds, is required to immediately supply the excavator with the desired information.

Both the OPSO and the APWA models require the utility operator to supply information to the excavators.

OPSO (1974)	APWA
The location and description of any of its utility lines which may be damaged as a result of the excavation or blasting.	The utility operator must determine if his underground facilities do or do not exist within the area of excavation, and communicate this information to the person of public agency originating the notice prior to the commencement of work.
The location and description of any utility line markers indicating the location of the utility lines.	The utility operator is required to locate and mark or otherwise provide the operator's underground facilities in a manner as to enable the excavator to employ hand-dug test holes to determine the precise location of the underground facilities in advance to excavation.
Any other information that would assist the excavator in locating and thereby avoiding damage to the utility lines.	
The utility operator shall provide adequate temporary markings indicating the location of the utility line where permanent utility line markers do not exist.	

(If the APWA model is interpreted to require hand-dug test holes this requirement will add to the cost uneconomically).

The APWA model also contains directives for abandoned facilities which are not considered in the OPSO model. (See the later APWA guidelines in the appendix for modification of this concept.) In this clause the utility operator is required to maintain records of abandoned facilities until the facilities have been physically removed, The utility operator must also convey whether the facility is abandoned or not in responding to a notice of excavation. This appears to be a logical stipulation since, if the excavator did not know the facility was abandoned, an unnecessary degree of caution might be exercised causing delays. Also, if damage resulted and the excavator followed the recommended practices for excavation and emergency procedures, further unnecessary delays would be incurred.

The APWA model contains a special provision for demolition of buildings which requires that the utility operator be given reasonable time, not to exceed thirty calendar days, to protect, abandon or remove his facilities. The OPSO model contains no special provision for demolition work.

The APWA model contains another provision restricting the use of power or mechanized equipment directly over marked routes of utility locations. This provision is amended if the excavator first determines the precise location of the facility and then manually exposes it taking proper precautions to protect the facility to avoid damage. An exception is made for using power equipment for the removal of pavement or masonry. These aspects are not addressed in the OPSO model.

A very important difference between the two models concerns excavator activities after a pipeline is damaged. The APWA model recommends prohibition against backfilling until specifically authorized by the utility.

With regard to penalties, OPSO specifies a civil penalty of $1000 for each violation of the act. The APWA model refrains from specifying any civil penalties. But a person who damages the facilities of an operator <u>and</u> who fails to comply with the provisions of the APWA model statute may be enjoined from engaging in any further excavating type work within the state.

3.4 Efficacy of Statutes and Regulations

There are two major requirements which must be satisfied for a set of regulations to have a positive effect. First the laws must be realistic and second they must be enforceable and be enforced. The state laws of New York under Code 53 do not find, or require, ready acceptance from the public agency-owned utilities. The federal OSHA regulations on excavation of utilities often are not observed. If the law or regulations do not apply equally to all underground facilities they will necessarily be less effective. If the law requires that an excavator call each of the possible underground facility owners instead of permitting a single call to cover all facilities it will be less effective. If the law does not insist on a positive response from each of the utilities it will be less effective.

3.4.1 Staffing Requirements – The natural evolution that will define the preferred staffing mode has not had time to develop. Staffing requirements have been met in numerous ways. There are now two staffing methods extant in Illinois. Chicago Utility Alert Network (CUAN) has a full-time staff in City Hall supplied by the city; the city permit desk cooperates with CUAN and each of the cooperating utilities has a teletype connecting with City Hall. Joint Utility Locating Information for Excavators (JULIE) plans to use a mixture of a full-time staff with part-time assistants.

CUAN operates in the Chicago City Hall, Streets Division. When an excavator applies for a permit, a City Hall clerk processes the excavation request to a teletype that notifies all of the utilities in Chicago. The fact that the utilities have been notified becomes a part of the permit. The Division of Streets has a clerk available from 8:00 a.m. to 5:00 p.m. and after 5:00 the City Hall emergency crew takes over for any emergency excavation reports. These excavation notifications are processed through the teletype. CUAN hopes to have its own crew in the near future, instead of using City Hall clerks on a rotation basis.

JULIE, at the present time, has one full-time employee and hires a person to answer their phones on a part-time basis. As JULIE expands from its territory in Northeastern Illinois, excluding the City of Chicago, it will first encompass the counties surrounding Chicago and then incorporate the part of Cook County which does not include Chicago, and finally by stages the rest of Illinois.

3.4.2 Benefits and Hindrances – The benefits inherent in the regulation of underground activity are not readily accepted by the management of the utilities. There are some obvious benefits that are quite apparent to some utility staff members and to disinterested parties. The staffs of electric and gas utilities now exchange drawings of underground locations as a matter of course. In the not too distant past the thought of a common solution was unacceptable. This type of activity is not confined to the areas where regulations have been imposed, but without the prospect of regulations many voluntary one-call systems probably would not have come into existence.

The hindrances seem obvious. Responding to the regulations costs more in overhead operations. Management has more to be concerned about, and the regulations as written bring additional problems. The probable evolution and modifications of the regulations are also a likely future problem.

A benefit and hindrance combined is the fact that real data concerning underground activity will be developed. The benefits will come from a more effective prediction and control of underground activities. One detriment is that the data might be used against the utility in court.

3.5 Application of Statute Control

Statute regulation of underground activity is in the formulative stage. The large competent utilities have a background in managing damage prevention activities. They are located mostly in or around the large urban centers. The largest cities have of necessity developed a modus vivendi with underground activities. Chicago has its Board of Underground which has been active for a long time; similarly Los Angeles has had an active APWA Chapter for a long time as well as an active Substructure Committee.

The smaller urban areas have not made a concerted attack on the underground damage problem. The very small rural utilities have not attacked the problem but they have not had much of a problem. In areas with low population densities news of future or extant excavation travels fast so that the local utility can be aware of potential dig-ins.

The ICC has required all of the utilities in the state under their control to join a one-call system. The ICC has specifically allowed the Chicago utilities to remain out of JULIE system and to continue in the CUAN. There are obvious reasons in that the municipal sewer and water utilities are not controlled by the ICC but are a very important part of CUAN. The necessity of joining two separate one-call systems does not seem to present a problem to the privately owned utilities.

Except for the large urban areas there has not been much experience developed in damage prevention programs about operational methods or for cost of a damage prevention program. Thus any joining of interests by utilities either on a type of utility basis or a geographical basis has not been explored. It seems unlikely that the existing method whereby each utility worries about its own lines only, will be cost-effective in the long run.

Within the regulatory bounds of any of the existing or proposed statutes there is considerable room for voluntary interutility cooperation. Probably a real benefit of future damage control programs will be a mutual exchange among the various utilities. In the past the utilities have often tended their own business and jealously defended any prerogative which they had won or assumed over the years. The statute-imposed necessity to join together, should help the utilities to realize more fully that the underground damage problem is mutual.

4. VOLUNTARY CONTROL PROGRAMS

Of the few types of voluntary control programs, the one-call system is by far the most important. The bulk of this discusssion will be concentrated on the one-call approach.

4.1 Types of Programs

Probably the most basic damage prevention program is to encourage and rely upon cooperation among the different utilities' foremen in the field. When working together they become aware of their mutual problems and strive to resolve them.

Next in order is direct cooperation between two utilities. It is not uncommon for one utility to repair its damaged facilities without billing the utility that caused the damage. There is an implicit agreement that they have a common problem. The justification for this procedure is that they reduce the paper shuffling expenses associated with billing. The utilities also keep one another advised of excavation plans so that damage problems are reduced.

The third level of damage prevention program activity is that in which the utility actively works alone to reduce excavation damage. The utility will have a claims section that pursues suits to recover money for damages to their underground system. This utility will advertise, to excavators particularly, and request such excavators to contact the utility prior to digging. The utility is then responsible for locating the underground lines and proceeds to do so. The utility claims section can use this procedure for the discipline of contractors. If the contractor damages their facility, but has complied with the utility requests, they can waive collection on the damage. A weakness of the "go it alone'' approach is the lack of direct contact with other facilities on the dig-in problem.

When the utilities establish a central office so that anyone who wishes to excavate can call, they have a basic one-call system.

The one-call system is a necessary communication link, but not completely sufficient for damage prevention. Without the rest of the damage prevention program the one-call system cannot be totally effective.

4.2 One-Call System

The voluntary one-call system has been the clearest response to the call for damage prevention programs. These calls have come from the state regulatory agencies in some cases, and also from the federal agencies, NTSB, OPSO, and OSHA. The OPSO and NTSB have been particularly effective. NTSB has been in support of the all-voluntary one-call system approach, and OPSO has submitted model statutes to the states. The possibility of mandatory damage prevention regulations has been a strong force behind much of the one-call activity.

The most active and effective proponent of one-call system organization is the Utility Location and Coordination Council (ULCC) of the APWA. Section 4.2.1 (except for §4.2.1.7) presents a review of the one-call organization concepts based on a paper by an active participant (Ref. 6) in their development over a period of several years.

4.2.1 Utility Coordinating Committees — Why and when did utility coordinating committees and the one-call system come into existence? Does this concept constitute the best approach to reducing damages caused by excavators? Through these techniques, can we reduce the number of deaths, injuries, major property damage, and loss of service to the consumer?

4.2.1.1 Safety and Service: Safety and service are key words within the utility industry as the operators strive to meet the growing needs of the consumer. In the early stages of growth, the process of conveying products developed a natural pattern and lines for liquid, steam and gases were placed below the surface while communications and electric lines were placed aboveground. As technology changed, communications and electric services began to share the subsurface area with the other utilities.

Now that aesthetics have become a major consideration, services of all types are being placed out of sight and the allocation of underground space has become highly competitive and overcrowded. This condition is causing a very dramatic upward trend in damages to plants owned by each of the operators as additional facilities are placed underground, existing facilities rearranged or changed, repairs are made, or when excavations are made for any reason.

4.2.1.2 Major Cause of Damage: Damage to the utilities is a very serious problem and most of the damages have been caused by excavators who did not know, or did not take the time to find out, whether or not subsurface structures existed before an excavation was begun.

Damage by outside forces, which were analyzed in an earlier section of this report indicate a number of possible damage prevention problems, including: (1) failure to determine the location of subsurface structures before excavation work begins, (2) failure on behalf of the excavator to exercise necessary precautions when working near marked facilities, (3) disregard of the facilities by the excavator, and (4) inaccurate or inadequate marking or staking of underground facilities by the operator.

4.2.1.3 Damage Prevention: To avoid damaging a buried facility, the excavator must be aware of its location. This requires a process through which anyone planning to excavate CAN and WILL determine where subsurface structures are located prior to beginning an excavation. Once a utility knows where an excavation is planned, he should work in advance of the excavator and mark or stake the route of existing subsurface structures. When the excavator knows where subsurface structures are located, a responsible attitude must be demonstrated and care exercised to avoid damage. Much attention has been given this problem and progressive groups in various parts of the country have established an avenue through which a notification process can operate.

4.2.1.4 <u>One-Number Concept</u>: As previously mentioned, separate telephone numbers for each of the utility companies to be called on an individual basis has not been effective. Through the committee approach the one-call concept has become very popular and effective. In this process, the utility operators share the expense of a single telephone system through which all of the participants in the program can be reached. When a call is received, detailed information is recorded as presented by the excavator. This includes such items as the excavator's name, telephone number, the location of the planned work, type of work proposed, whether or not explosives will be used, the date and time when the work is to begin, and any other pertinent data. The information is then promptly transmitted to each of the <u>participating operators</u> who have facilities within the proposed work area.

Each utility operator receiving the information responds by marking and/or staking the route of its facility before excavating work begins. Usually, the excavator is requested to notify the one-call system center 48 hours ahead of planned work to allow sufficient time for coordination and response. Positive response is usually required. That is, if a utility operator is notified of planned work and no underground facilities owned by that operator exist within the area of proposed work, the excavator is made aware that no facilities exist. Emergencies are processed on a demand basis.

Nonparticipating operators within the geographical area of a one-call system reduce the effectiveness of the process. They further expose their underground plant to damage if an excavator thinks that he has reached all of the utility operators but in fact has only reached those who are participating members. This process, being a voluntary approach with shared expenses by each of its participants, is determined by separate management decisions whether or not they want to participate. One exception to this is the state of Michigan. Michigan, Public Act 53, makes it mandatory for any utility operating within the boundary of a one-call system to become a member of the system within six months or to become a participant and share in the expense if they do not want to be a member.

Rochester, New York, under the leadership of Rochester Gas and Electric Company in 1965, is credited as being one of the first areas to use the one-number concept. Its system encompassed the City of Rochester. Michigan, under the leadership of Consumers Power Company, was the next major area to develop a system. Their "Miss Dig" program has become nationally known for its progressive approach and for their willingness to provide assistance and expertise to other systems in the developmental stages. The third major system developed in Maryland under the leadership of The Chesapeake and Potomac Telephone Company of Maryland. They, too, have become known on a national scale for their "Miss Utility" program and its success. The Miss Utility area includes Maryland, four counties in northern Virginia and plans to include the District of Columbia. The committee was organized in January 1971 and Miss Utility became operational in April 1972. The legal agreement accounted for the delay between the formation of the committee and the system becoming operational. There are currently more than 80 systems in 35 states in which damage reduction programs of this type are operational. The area of coverage varies from the size of a city, to a county, a state, and in some cases more than one state.

4.2.1.5 Benefits of the Committee Approach: The committee approach brings together representatives of the various utility groups, governmental officials, homebuilders, contractor organizations, contractors and excavators of all types, planners and developers; people who should be involved with the damage problem and who can jointly take action to solve it. Through planned group meetings, long and short range objectives can be identified, problem areas discussed and a clear understanding achieved. This approach not only prevents damages but also wards off many roadblocks that would otherwise delay planned work. Areas where this approach is being used have reported dramatic damage reduction trends. Furthermore, a very close working relationship develops between groups that would not otherwise exist.

4.2.1.6 Utility Location and Coordination of Service Protection Committees: During the late 60's and early 70's, as damages per mile of plant increased, it became evident to some of the utility operators that the existing operating procedures were not effective and that changes must be made to correct the underground damage problem. They realized that they could no longer work separately as individual companies; that there should be a close working relationship between them, other utility operators, planners, developers, contractors, and governmental agencies. It was further obvious that having a separate telephone number for each of the utilities to be called when excavations were planned was not satisfactory. Excavators, because of the number of calls required were not calling anyone and excavators new to an area often did not know whom to call. These circumstances led to the origin and growth of utility location and coordination committees.

4.2.1.7 Critique: Sections 4.2.1.1 through 4.2.1.6 were based on the comments of an enthusiastic supporter of the all-voluntary one-call system approach. Morale is one aspect of an all-voluntary approach that should be considered. If morale is maintained at a high level, the voluntary approach can be quite effective. As has been mentioned previously, the one-call system needs a steady communications effort to maintain awareness of the one-call systems existence and the benefits which are received by making use of the system.

The most important part of a damage reduction program is not a function of the one-call system center. Each individual utility must notify the excavator either that the utility does not have a facility at the excavation location or the utility must locate the underground lines. A positive response is necessary. The excavators cannot be expected to function effectively with a one-call system if they get a response "only sometimes".

4.2.2 One-Call System Operation — The one-call systems, JULIE and CUAN, are Illinois Systems. JULIE will cover the entire state except for Chicago by summer 1978 and CUAN services the City of Chicago. Except for one major and important difference, the two systems are quite similar. CUAN operates from the Streets Division Permit Section at City Hall and JULIE is centered in a private office. Everyone who does excavation in Chicago must obtain a permit from the Streets Division. When the permit is applied for, the one-call system is alerted.

Necessarily, the actual day to day operations of the various one-call systems must be quite similar. The following description of a one-call system operation is excerpted from information supplied by the Omaha Metropolitan Utilities District (MUD) (Ref. 7). "When a call is received, specific information is obtained which is placed on a teletype message and transmitted to the other particpants as shown in Table 4.1.

TABLE 4.1 TYPICAL ONE-CALL SYSTEM REPORT DATA

Line Number	Data	Explanation
1	Location number	Numbered consecutively for each day.
2	Not used	
3	Time, initials of recipient, date	Record of call.
4	Address of work	
5	Nature of work	Install water service, etc. to aid locators in determining what information to take to field.
6	Time contractor will be on job	
7	Contractor's name	
8	Contractor's address	
9	Contractor's phone	Usually that of caller.
10	Name of caller	
11	Recipients of teletyped message	All calls are not within service areas of all participants, consequently some messages only go to those companies affected.
12	Time, initials of individual sending message on teletype.	

Each participant responds to the inquiring party if they have underground facilities in the area of the proposed work".

The "if" in the last sentence is very important. Some one-call systems operate from the premise that a positive response from all of the associated utilities is mandatory. It is this investigator's opinion that a positive response is necessary for effective one-call system operation. When an excavator calls he should get a response, to either develop or maintain confidence in the system. The excavator should receive a positive response in the form of help in the locating of underground pipelines, or notification that the particular utility does not have an underground facility near the proposed excavation area. It would seem reasonable that in the not too distant future that a one-call system center could inform the excavator that there are no underground facilities of the "x, y and z" utilities but that there is an underground line belonging to the "w" utility. Some utilities have organized their one-call system so that there is in fact a positive response; however, they do not advertise the positive response because of liability fears. This fear of becoming exposed to greater liability risk is a serious problem for one-call system organizations.

A very important part of a one-call system is the on-going public relation efforts. It is probably safe to say that all of the public relation activities of a one-call system are a continuation of the utilities individual accomplishments prior to the one-call system.

The one-call number is made familiar to all excavators in the area. Several promotional schemes have been developed to disseminate information. Calendars and various handouts, such as key chains, memo books, matches, and similar items have been distributed by the utilities' field locators and also by speakers before various groups. A slide/recording presentation has been developed showing to contractors and various other groups the behind-the-scenes activities of the center.

The Northern Illinois Gas Company annually conducts a fire-fighting school for their operating personnel. They also have a complete set of training films for all phases of operating and safety instruction. Some of these will be available for use by JULIE. Other utilities also have public relations investments which will be used by their one-call systems.

4.2.3 One-Call Legal Problems – Since one-call systems are relatively new their base in law is not well defined. The various types of liability (i.e., general liability of call center) to which they might be exposed, or which they might transmit to the utilities that make up the system, is not well defined. In the formative stage of JULIE, the insurance companies did not have enough experience to adequately determine insurance costs and policies for the JULIE board of directors. Note that the board is composed of utility company employees. The insurance problem was serious enough that the formation was delayed because one utility refused to become a member.

Each of the utility companies responds individually to a Location Request (LR). Because of the inherent liability due to a possible dig-in, whether or not a LR and a resultant buried pipeline location is shown, each utility insists on its own personnel responding to a LR. Obviously a LR that was answered by just one locating team acting for a number of utilities would be more cost-effective.

4.3 Costs of One-Call System Operation

One-call systems, when asked, supply a wide range of costs for system operation. The following excerpt was taken from the same report briefed in Section 4.2.

"During January 1977, 16 one-call systems in 14 different states participated in a survey. The length of time each had been operational varied from 1 year to 6 years or more. Their areas of coverage ranged from a city, to a metropolitan area, to a county, to multicounties (up to 33), to a state and to more than one state. Annual operational costs of their control centers varied from $1000 to $200,000 with a volume of calls ranging from 4800 to 67,200 per year. The number of participants varied from three to 40 per system. Based on the total operational cost of the center and the volume of calls processed, each incoming call costs $2.00 or less for 25 percent of the reporting centers, from $2.00 to $5.00 for 38 percent, from $5.00 to $10.00 for 25 percent and more than $10.00 for 12 percent of the reporting centers. Of those participating in the survey 12.5 percent share expenses according to calls received by the participant; 50 percent share on a percentage basis according to the miles of out of sight plant in service, excluding house services, and 37.5 percent have a flat fee per participant".

A typical base cost involves the rent of a teletype machine (at $130/month) for the one-call center and the rental of one or more teletype machines for each of the system utilities. A telephone outlet must be obtained and office space and equipment must be rented. The office must have regular daily hours, and provisions for emergency calls must be made.

Table 4.2 is a breakdown of the operational cost of UFPO from 1970 through 1975.

TABLE 4.2 OPERATING COSTS OF THE UNDERGROUND FACILITIES PROTECTIVE ORGANIZATION

Year	1970	1971	1972	1973	1974	1975
Annual operating cost	19,058	17,648	18,368	22,188	23,843	26,504
Advertising cost/year	1,617	2,567	3,712	3,603	1,974	3,595
(% ad. costs)	8	13	17	14	7	12
	20,675	20,215	22,080	25,791	25,767	30,099
Calls received	3,326	3,334	4,498	7,190	7,168	7,429
Calls dispatched	9,936	10,139	14,632	23,311	23,802	26,186
Average $/incoming call	6.22	6.06	4.91	3.59	3.59	4.05

Table 4.3 shows the extent of the variation in one-call operating costs. The reasons for the wide cost variation are due to a lack of uniformity in reporting. This is to be expected with the relatively meager one-call system background.

TABLE 4.3 ONE-CALL SYSTEM COSTS ON A PER CALL BASE
(January 1977 Survey)

Annual Number of LR	Total Cost	Cost per LR
1. 67,200	$200,000	$2.98
2. 24,000	78,850	3.29
3. 24,000	96,000	4.00
4. 19,200	123,300	6.42
5. 16,800	70,000	4.17
6. 18,000	80,000	4.44
7. 12,000	96,000	8.00
8. 12,000	100,000	8.33
9. 9,600	65,000	6.77
10. 8,400	59,000	7.00
11. 6,600	150,000	22.73
12. 4,800	100,000	20.83

Table 4.2 shows the base from which the cost per call was determined. The data shown in Table 4.3 were undoubtedly developed in a manner similar to the UFPO for systems Number 1 through 6, and probably Numbers 7, 8, and 9 can be included with 1 through 6. The cost per LR for system Number 10 was determined by a unique method, possibly the average cost of a teletype or telephone message. Probably the cost per LR for Numbers 11 and 12 includes the costs associated with a crew that locates the underground line.

Most of the competently managed utilities do, at the present time, practice damage reduction. They have a number to call before one excavates and they advertise the fact. If that utility joins a one-call system the one-call system <u>must</u> generate more LR than the utility experienced prior to joining the system.

A large utility experienced the following damage history during a 12-month period:

- estimated number of excavations near underground facilities - 200,000
- number of calls received prior to excavation (i.e., location requests which might consist of one person) - 180,000
- number of hits reported - 3300
- cost of damage repairs - $660,000

These data can be used as a base fromwhich to estimate the cost of a one-call system. The following assumptions are made:

- There is an active positive response to each of the 180,000 LR received by the one-call center and transferred to the utility. In *90,000* cases (response to LR) the response is a phone call by an operator in which she tells the excavator that the utility does not have a facility in the excavation area.

  In *90,000* cases a crew is dispatched to the scene of the excavation.

  The cost to the utility of each call to the one-call system is $0.40 (actually $0.40 is a low estimate).

  The labor cost of a crew dispatched to the scene of excavation is $20.00, i.e., 1 man-hour at $20.00/hour.

  The labor cost of an employee to call excavators (positive response) is $12.00 per hour. The unit cost is $1.00 per call plus $0.20 for a phone call of $1.20 per call.

  Assume that the damages are cut in half because of the one-call system and the one-call system saves $330,000 and the claims department continues to collect half of the damages. Thus there is $115,000 to support the one-call system.

  Assume 90 percent of the excavators call for an LR prior to excavation.

An estimate of the cost of a one-call system to this large utility is:

- 180,000 LR at $0.40/call = $72,000
- Phone call response, 90,000 x 1.20 = $108,000

Note without crew dispatch the one-call system cost the utility $180,000. If 90,000 crew dispatches are charged to one-call system expenses then there is an additional $20/call x 90,000 calls or $1,800,000. If however the one-call system is an extension of previous damage reduction programs then only a percentage of the 90,000 LR can be charged to the one-call system. If 10 percent of the 90,000 LR dispatches are charged, then the one-call system is $20/call x 9000 calls or $180,000. Thus the cost of the one-call system to the utility is $180,000 + $180,000 or $360,000. These costs are for the direct information transfer costs of the system. The operational costs to be expected are shown in Tables 4.2 and 4.3.

The cost of damage repairs to the utility were $660,000 per year. The utility now collects over 50 percent of the damage costs. The optimum limits are either complete prevention of accidental dig-ins or complete collection for damage repairs. In the illustration used above the utility cannot break even economically by joining a one-call system. When liability damage costs are considered the picture can change. Obviously an analysis based on facts rather than assumptions would be preferable.

It is of interest to note the cost comparison shown in Table 4.4. Both UFPO and JULIE are one-call systems in areas where damage reduction programs are developing relatively good records. They obviously use very different approaches. The expense category Number 1 shows that both systems pay close to the same amount per call for the basic telephone-teletype services. The promotional effort (Number 4) of Table 4.4 is accomplished in different ways by the two systems. In the UFPO the per call promotional cost is $0.75, and within JULIE it is $0.04. However each of the individual JULIE utilities carries on extensive public relations campaigns. Note further that the UFPO budgets a cost of $0.44 per call for outside representatives. JULIE utilities all have outside representative contacts but JULIE has none.

TABLE 4.4 COMPARISON OF COSTS FOR TWO ONE-CALL SYSTEMS
(UFPO-7429 calls/year 1976 & JULIE-276,864 calls/year 1976)

Expense Category	UFPO Annual Cost	Cost/Call UFPO	Cost/Call JULIE	JULIE Annual Cost
1. Telephone and Teletype and TAS	$4,020	$0.541	$0,318	$87,970
2. Admin. + Expenses[1] (Mgr. + Trans.)	$7,200			$34,270
3. Operators and Rent	$9,980			$41,290
4. Dig Notice Forms[2] Promotion, Advertising and Stationery	$5,595	$0.753	$0.040	$10,987
5. Office and Stationery Supplies	$ 600			$ 726
6. Miscellaneous	$ 300			$ 1,000
7. Outside Expenses	$3,300	$0,444	$0.0	———

1. Manager + Transportation, JULIE Administration + Expenses, UFPO
2. Forms of one-call public relations, advertising and postage, $5,075 UFPO; JULIE, dig notice forms, promotion, and printing

4.3.1 Alternative System Costs - Many of the individual utilities have carried on damage reduction programs over the years. In some cases, as in Chicago's Board of Underground, the utilities work together very effectively. They did not necessarily develop guidelines for operational procedures. The working together was much more informal. Usually, it consisted of the people in the field developing rapport to the extent permitted or encouraged by their employer.

In many areas of the nation the utilities followed a cost reduction program that had little effect on damage reduction. Some utilities reciprocate with one another in repairing damage without billing (Ref. 8). The saving when this method is used results from zero cost on the billing procedure. Other utilities in the same area do not accept it as a sound business practice.

This practice does have one unmentioned benefit, i.e., another avenue of liaison between utilities is developed. They need more contacts. The method of reciprocal repair without cross billing is an implicit recognition by the utilities that damage reduction is a mutual program.

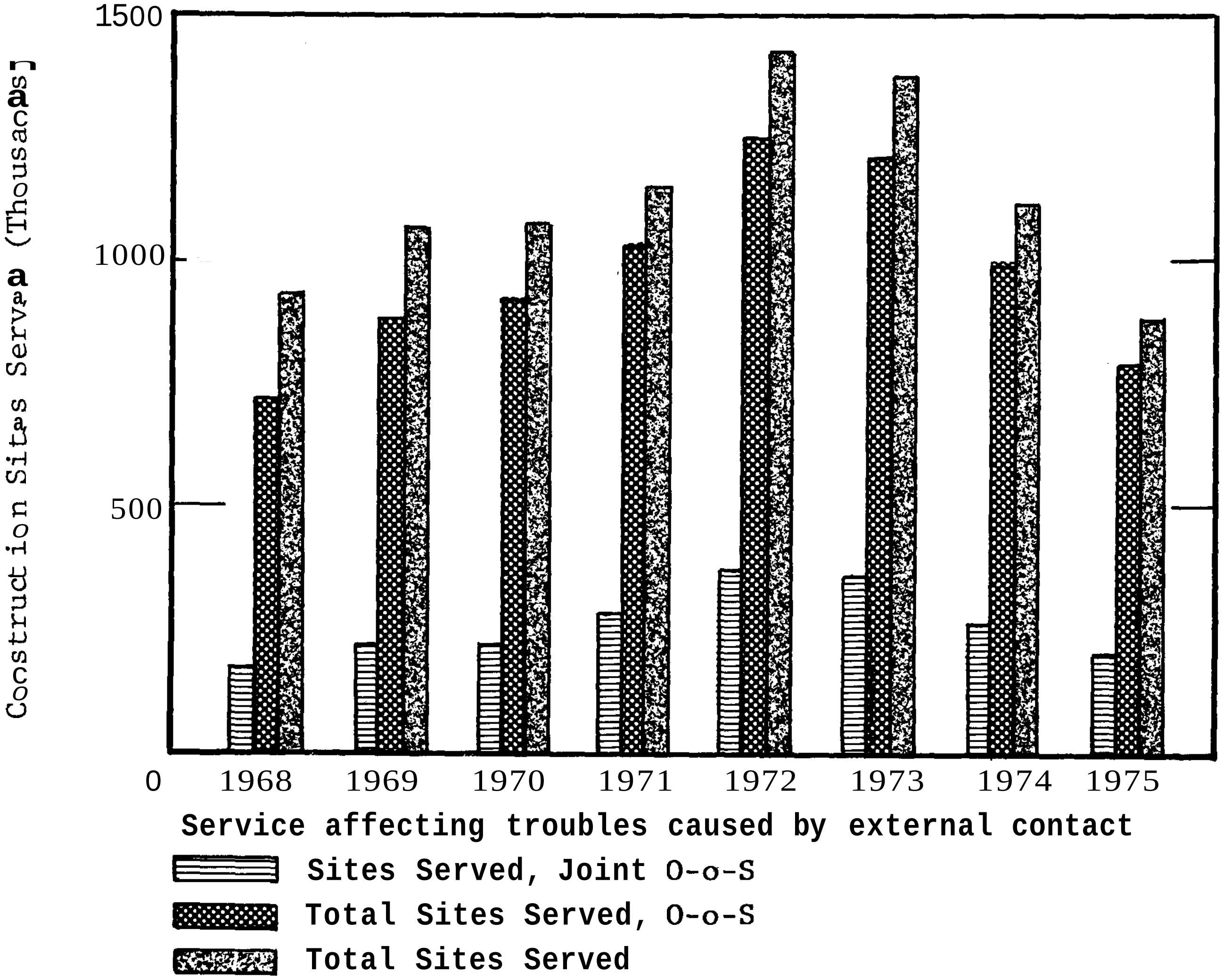
If management changes, as it must, then the new management may in some cases, decide to withdraw from any voluntary mutual efforts. The Michigan statute enabling the formation of the one-call system requires any utilities in the area, where the one-call system is formed, to share in the expense of the one-call system operation. A case in point is the Tampa, Florida one-call system. One of the member utilities withdrew when it decided that mandatory membership would not be required.

4.4 Efficacy of Programs

The effectiveness and the cost of one-call programs is still quite debatable. They have not developed records to any significant extent in the sense of data collection. The areas where they have been started have been for the most part, areas where underground damage was at a higher than average figure. The one-call systems that were started a few years ago started developing records when the natural events of the economy mandated a reduced accident rate. It can be argued, and is, that inflation costs, damage law suits and other causes had a greater effect. However when anyone is questioned as to the reason for his utility's increase in damage incidents, construction activities are always cited.

The different utilities are very obviously proud of their records in developing damage prevention programs. However, utility records of underground damages are relatively sparse.

The Bell Telephone systems have detailed records of damage statistics over the course of the years. Figure 4.1 indicates the extent of the nationwide system data. The telephone system has a background from which to evaluate the effectiveness of a damage



	1968	1969	1970	1971	1972	1973	1974	1975
P	5.8	6.2	5.8	5.3	5.2	5.0	4.1	2.8
NP	14.7	11.4	14.8	16.1	17.0	17.7	16.0	13.6

(P Contacts per 100 sheath miles pressurized system)
(NP Contacts per 100 sheath miles nonpressurized system)

Figure 4.1 New Out of Site Installations and Service-Affecting Trouble Statistics for AT&T

program. They have had and maintain an in-house damage reduction program. The various Bell systems have been active in developing one-call systems. The Bell representatives that were contacted did not try to promote the one-call system on the basis that the system could save the utility money by reducing damage repair costs. Bell representatives with whom damage prevention programs have been discussed favored the one-call system on other grounds. They did not believe that one-call systems would pay for themselves through savings resulting from a lower rate of outside party damages. Of course the potential for reduction of losses is not ignored.

4.4.1 Chicago Utility Alert Network Effects — The CUAN has been active since April 1975. Damage data collection and evaluation is not an important task insofar as most utilities are concerned, excepting AT&T. Often the time, and more rarely the data, of the incoming call is not recorded. One utility, the biggest offender (see Table 4.5), caused well over half of the hits that were reported in Chicago during 1976. This utility also caused over twice as many hits as the private contractors caused. Note that data were obtained from damage reports.

Table 4.5 presents a breakdown of the damage statistics for Chicago utilities during 1976. One utility did not do damage to other utilities; it was low in the amount of damage that it sustained also. Table 4.6 presents data on how the CUAN notification system was used.

Ten of the dig-ins by private contractors had data on the cost of damages and Table 4.7 presents the cost of dig-ins for Chicago utilities. If two of the hits are removed from excavators 1 and 2 then the cost per hit drops to $580.00 and $324.00 per hit respectively. Since there were few hits the effect of high cost on one or two skews the cost per hit.

TABLE 4.5 UNDERGROUND DAMAGE DATA (CUAN, 1976)

Utility Owner	Excavator								Notification		More than (t) hrs before damage occurred					Remarks
	1	2	3	4	5	6	PC	Σ	Yes	No	48	16	1	0	(-)	
1	-	12	1	1	-	-	19	33	8	24	3	1	1	1	1	
2	18	-	-	-	-	-	--	18	16	1	1	9	2	2	1	Notified After Damage
3	*48*	-	-	-	-	-	--	48	38	4	1	5	21	8	3	Notified After Damage
4	2	-	-	-	-	-	1	3	1	2	-	-	--	-	-	
5	6	2	1	1	-	1	3	14	7	5	1	2	1	-	-	
6	-	2		--	-	-	1	3	2	1	-	-	--	-	-	
Σ	74	16	2	2	-	1	24	119								

(1) Gas Utility
(2) Water Distribution and Sewer Utility
(3) Bureau of Electricity
(4) Electric Utility
(5) Telephone Utility
(6) Miscellaneous Underground
PC Private Contractors

TABLE 4.6 USE OF CUAN NOTIFICATION SYSTEM

Damage Caused by(1)	Yes	No	CUAN Notified TTY(2)	Telephone	Permit Desk	Permit Number
1	65	9	62	13	-	63
2	6	10	6	--	-	13
3	--	2	--	--	-	--
4	--	2	--	--	-	--
5	--	1	--	--	-	--
PC	6	19	1	1	4	10

(1) See Table 4.5 footnotes
(2) TTY - Teletype

TABLE 4.7 DOLLAR COST OF DIG-IN REPAIRS

Excavator	Number of Dig-ins Total Number	Number of Damage Repair Cost Estimates	Σ$ $	Cost/Hit $/Hit
1	74	7	10,920	1,560
2	16	5	1,100	275
PC	25	10	12,640	1,264

As the data are reviewed there is a hint of the CUAN policies being "used". There are a number of notification times that had to be coincidental with the arrival of the excavators on the excavation site. There even are a couple of notifications that occurred after the damage hit was made. Section 4.5.2 describes the equipment operator's problem of looking for the utility location after he is on the job.

Chicago traditionally has had a strong City Hall. The use of the building permit keeps the private contractors in line. City Hall estimates that 80 percent of excavations are controlled to some degree through the CUAN.

The CUAN applies only to the City of Chicago, an old built-up city. It will be interesting to study underground damage when the south side of the city is being rebuilt. At this time a significant portion of the near south side has been razed or abandoned. It is anticipated that the combination of the one-call system with the Board of Underground management will be efffective methods of maintaining Chicago's excellent damage reduction record. Review of both Chicago and Illinois data indicates that Chicago suffers much less damage than does the Cook County area surrounding the city. The building activity is much more intense in the counties around Cook than it is within. Because the utilities have been active in damage reduction and because 70 percent of the Illinois population lives in northeast Illinois, the total damage record for Illinois is good both from the ICC report and the OPSO data.

In another example, the OPSO data indicate the outside damages in Michigan are bad and getting worse. Michigan one-call data show that the situation is improving. Standard forms of data collection are needed to resolve this anomaly.

4.5 Contractor/Operator Views and Evaluations

The word operator can have numerous meanings in the rather specific disciplines related to underground damage. The various statute models are careful to define operator. In this particular section operator refers to the one who operates excavation equipment. The word contractor refers to the individual or company that is paid to do the excavating.

4.5.1 Contractor Assessment — There were two types of contractor assessments; the informal comments developed from telephonic conversations and the comments obtained from contractor association representatives. Each type of assessment is of value.

From conversations with contractors who excavate for utilities it quickly becomes apparent that the contractors are quite pleased with their dig-in records. They are quick to point out that in 98 to 99 out of a hundred excavations they do not damage the underground facilities. Insofar as the 1 or 2 percent of the time that damage does occur, the contractors are of the opinion that the utilities do not locate well enough. The contractor and the contractor's associations are of the opinion that voluntary damage reduction systems are adequate.

A number of criticisms and recommendations were obtained from contractors that are pertinent to voluntary control programs as well as to the model statutes to which the comments were addressed.

4.5.1.1 Criticisms:

- A utility should consider doing the excavation itself for excavations that go through its area.
- Damages are done by fly-by-night excavators (the same complaint is often heard from the utilities).

4.5.1.2 Recommendations:

- o Consideration should be given to existing underground utilities during the design stage of a project.
- o Recommend the adoption of a standard marking stake.
- • A national uniform procedure must be developed by a joint effort by the utility and construction industry.
- • Design engineers and architects must make reasonable efforts to research any possibility of the new work encountering existing utilities and show the location of those existing utilities on the construction plans.
- o Local government units should not be exempt, since their own public works personnel are equally guilty of damage to underground plants.
- o Permits should be relayed to all utility companies.
- o Penalties should only apply to those who know an underground utility has been damaged and willfully fail to report it. This should include the employee.
- o If a penalty is enforced, it should apply to the utility as well as the excavator for failure to file their information.
- o Recommend voluntary cooperation between the utility and contractors.

4.5.2 Operator Assessment — The mature equipment operators have a differing view of the damage problem, than the view held by utility representatives and the view of their employers the excavating contractors. The operators are convinced that in a significant number of excavations, the utilities do not know where underground lines are by a matter of feet. They are quite proud of the fact, that as backhoe operators, on a particularly good day they can "feel" the type ground being excavated. They are candid that some operators have little feeling for the ground, and on a bad day no one has that ability. In separate conversations an operator agreed with a utility executive that the use of backhoe hydraulic fail-safe equipment could lead to overconfidence. The overconfidence could lead to an increase in the accidental damage rate.

The equipment operators think that they all too often are required to operate in a manner that invites accidents. They have, and are quick to tell, illustrative anecdotes. The contractors are working against a money limit. If the excavation takes longer than estimated the contractor can lose money. If the power equipment sets idle, time and money are being wasted. The utility operator wants a man in the ditch hand digging around the pipelines. The contractor wants the operator to take as much dirt out as possible before manually digging. Of course some contractors push harder than others. The union can protect its men from being fired, but a contractor can discipline an operator by sending him to a less pleasant job or one that is farther away and thus more time-consuming for the operator.

A recurrent comment made by utility representatives is that there are some contractors who tear up underground pipelines deliberately. Their argument is that the excavators find that the increase in speed pays for damage repair costs. The operators agreed that this practice has been followed.

Information was provided by the operators that had not been hinted at by the excavators or utilities. Often the operator is sent out to excavate when no contact has been made with any utilities, one-call or otherwise. An experienced operator knows when he is excavating in an area where underground facilities might exist. The operator then hunts for and finds a "rusty" phone number to call. Sometimes that phone number is incorrect but after a relay or two of phone numbers he contacts the pertinent utility. The utility then promises to send someone right out -- after the operator threatens to dig. This of course is a reason for the 48 hours advance notice requirement in various statutes and programs.

The operators are pessimistic about improving the accidental damage rate. The possibility of more thorough inspection, before and during excavation was discussed. Their opinion is that in many cases inspection is window dressing. In agreement with the utility position, they believe that inspection should be improved.

Finally they concur in the nearly universal desire for more accurate and reliable locating equipment. The urgent need for accurate depth location is keenly felt.

4.6 Insurance

The approximation of damage costs that was estimated in Section 2.4 was discussed with an insurance company representative who stated that the figure was probably correct nationwide but that insurance companies did not pay out that much on damage repair claims. The reason of course is that policies are written with standard deductibles of around $200. Thus the insurance company in a large number of cases is not made aware of an accident. The insurance companies do not maintain extensive records on this matter.

The possibility of using the insurance rates as a disciplinary weapon with excavators has been mentioned. The Chicago insurance representatives had never heard of any insurance company using the rate structures in such a way though a west coast utility mentioned that this type of discipline had been attempted without significant success. A very important point that was made by the insurance company was that underground damage insurance for repairs was not a significant part of their business.

4.6.1 Policy Structure – Some of the methods of contractor protection with insurance are presented.

Incorporating Insurance Overhead into Contract Cost

On some projects, the general contractor will purchase Workmen's Compensation and General Liability insurance applicable to everyone working at the site. This requires the bid from the subcontractor to be an "ex-insurance" contract price or, in other words, excluding insurance costs.

In either project however, there will be requirements that the contractor provide "Builder's Risk Insurance'' or other high limits of liability. These additional insurance overhead factors are then incorporated in the contract price either on a per job basis or continuously.

Comprehensive General Liability

I. Operations/Premises Liability

Covers legal liability for damages because of bodily injury or property damage:

a) on buildings or premises owned and leased by the insured,

b) business operations in progress, rating basis: \$x/\$100 of payroll

II. Independent Contractor's Protective Liability/Owner's Protective Liability

Covers the insured for operations performed for him by an independent contractor. Or provides the insured protection for injury or damage claims caused by a contractor or subcontractor. Rating basis: \$x/\$100 of sublet contract cost.

III. Completed Operations and Product Liability

Optional coverage for:

a) completed or abandoned operations, away from premises owned or rented to the named insured

b) goods or products manufactured, sold, handled, or distributed by the named insured. Rating basis: \$x/\$1000 of gross receipts.

IV. Contractual Liability

This is someone else's legal liability which'the insured contractually agrees to assume. Rating basis: \$x/\$100 of contract cost.

Some contracts particularly between owners, architects, and engineers and contractors or subcontractors contain harmless clauses. Here the architect interjects into the contract a phrase stating that he is not liable for negligent acts by the contractor.

Special exclusions in the Comprehensive General Liability policy:

"Exclusion X"

Excludes property damage arising out of blasting or explosion.

"Exclusion C"

Excludes structural property damage (collapse) due to grading of land, excavating, burrowing, filling, backfilling, tunneling, pile driving, coffer-dam work, or caisson work, or demolition work.

"Exclusion U"

Excludes property damage to underground facilities (wires, conduits, pipes, mains, sewers, tanks, or tunnels) caused by the use of mechanical equipment for the purpose of grading land, paving, excavating, drilling, burrowing or backfilling.

Elimination of these exclusions on an annual or job-to-job basis is available for an additional premium charge. This additional premium is normally a surcharge of $x/$100 of payroll or a negotiated flat charge. The additional premium rate is <u>dependent on the physical hazards of the job</u>. In order to keep this cost down, the insurance representative should be informed about the site to be worked on, the steps the contractor will take to prevent cutting into a telephone cable, gas main, or other underground facility, the adequacy of blueprints to be followed, etc. In some cases, removal of the X, C, or U exclusion is fairly expensive, and the added cost should be determined before bidding on any contract. It also may be possible to be covered under an Umbrella Excess Liability policy subject to a self-insured retention.

<u>Umbrella Excess Liability</u>

Two forms:

A. As excess over existing primary insurance. A following form excess liability policy extends the limits of liability but maintains the same exclusions as in the primary policy.

B. As excess over self-insured hazards. This self-insured retention or deductible is usually $10,000 or $25,000 per occurrence.

Professional Liability for Architects and Engineers

This protects the insured from legal liability caused by an error, omission, or negligent act in the insured's professional capacity. Few insurance companies write these policies. Market stability and defense expertise must be carefully weighed when comparing premiums. There are many exclusions associated with these policies, but these can be covered by contractual liability, personal injury liability, and equity interest for additional premiums.

Experience Rating

Experience rating is a means of granting credits or debits to the manual base rate dependent upon the ratio of premiums to losses over a given number of years. Manual rates are established by a certain average level of losses. A comparison is then made of actual losses reported over a three-year period compared to the expected average loss. Weighing factors are applied to minimize the effect of a simple catastrophe. Using this method, the frequency of claims will count more in experience rating than will severity, but this effect decreases as premium volume increases. Therefore, it is in the best interest of the contractor to minimize the number of claims. However, for very large contractors (with high premium volume) the frequency of claims becomes less important.

Composite Rating

This method of rating is merely a bookkeeping necessity. The insurance carrier arrives at a premium rate by individually rating each division of insurance coverage using payrolls, receipts, etc., as means of exposure. The premium rate is then divided by either total receipts or payroll to get the composite rate: $x of insurance per $100 of payroll or $x of insurance per $1000 of receipts.

Guaranteed Cost Insurance

Guaranteed Cost Insurance plans mathematically evaluate the insured's premium and loss record over the past several years to arrive at a fixed renewal rate per $100 of payroll, per $100 contract cost ... depending on the kind of insurance involved. The rate is the result of experience rating formulae and negotiation. This rate will then remain fixed for the policy term. The final premium will depend on the units of exposure charged against that rate during the year $x/$100 payroll, contract costs...). The insurance cost will therefore rise and fall directly with payrolls, contract cost, receipts, and vehicles reported during the policy term, but loss experience will have no immediate effect upon the fixed rates.

Retrospective Rating

Retrorating determines the same standard or "going in" rate but then, after the policy term is over, the final premium is determined from loss experience and payrolls, contract costs...

Contractor's Equipment Floaters

This includes almost anything movable or mobile except vehicles designed for use on public highways. (Includes: cranes, power shovel, caterpillar tractor, lift truck, or small tools.) Large units carrying high values are specifically scheduled on such policies and a blanket amount takes care of smaller items. Coverage is largely tailored to suit the exposure. A suitable deductible can be specified. Premium rates are largely negotiated but based on prior loss history.

"Wrap Up" Insurance Programs

Used on very large construction projects. Here the owner, architect, engineer, general contractor, all prime and subcontractors are protected under a single insurance package applicable to everyone. This approach may benefit the owner by reducing overall insurance costs through massed purchasing power and elimination of coverage duplications inherent in separately purchased insurance policies. This type of program can provide better protection against loss, improved claim handling, and more job safety protection for appreciably less premium dollars. From the owner's standpoint, safety, claim, and audit procedures can be greatly simplified and gaps in coverage plugged because the task of reviewing insurance policies and certificates submitted through many sources is minimized or eliminated.

5. POTENTIAL RESEARCH AREAS

5.1 Pipeline Location

The precise location of buried pipelines or other underground utility systems has been mentioned as a problem area by pipeline operators and construction contractors contacted by us in this program. Depending upon the source, either the lack of accuracy of pipeline locating instruments was mentioned first or the lack of accuracy in pipeline mapping was mentioned first. In any event, these two problems are basically related and need attention.

5.1.1 Existing Techniques and Equipment – Instruments designed specifically for identifying the location of underground pipelines have been commercially available for some time. The earliest available instruments were basically magnetic detectors consisting of a vertically or horizontally operated compass capable of responding to the presence of ferromagnetic objects. Such instruments were quite crude and are rarely used today.

An improved version of the earlier compass-type pipeline locator is the so-called "treasure hunter" type of instruments. These instruments are capable of locating invisible ferrous or nonferrous metallic objects from various distances and are operated on the basis of one of two approaches: (1) locating ferromagnetic objects by detecting the flux changes of a mounted permanent magnet or an induced electromagnetic field, and (2) locating metallic objects by detecting the perturbation of a magnetic field. At present, a variety of instruments of this type are commercially available for locating invisible metallic objects of all kinds. They range from highly sophisticated magnetometers used in geological surveys to locate mineral deposits to simple toys sold in hobby shops for hunting lost "treasures". Several instruments of this type are commercially marketed as buried pipe or cable locators. They are generally very compact and have sufficient sensitivity for detecting metallic objects within a distance of a few feet. The path of a buried pipeline can be established with this type of instrument by traversing a likely area with a sensing probe and observing the magnitude of a meter output or the intensity of an audio signal. When two or more pipelines are installed close to each other the exact location of a particular pipeline may be difficult to determine with this type of instrument. The close presence of large metallic objects, such as automobiles, is also known to interfere with the use of such pipeline locators. These instruments cannot, of course, locate plastic, cement, or clay pipelines. Some highly sophisticated and sensitive magnetometers have been tried as pipeline locators for gas distribution systems but have had little success due to interference from adjacent objects such as automobiles.

To minimize the interference to pipeline location, a group of improved instruments have been made available and are in wide use today. These improved instruments locate underground pipelines or cables by detecting an electrical tracing signal introduced in the pipe wall or the cable sheath, or more precisely by detecting with suitable sensing coils the electromagnetic field generated around the pipeline or cable by this flowing tracer signal. The instruments differ primarily in the characteristics of the tracing signal and other minor features. They usually consist of two separate components - a signal transmitter and a receiver. The electrical tracer signal is introduced to the pipeline by either direct connection or indirect induction method. Table 5.1 presents a list of several pipeline locators of this type commercially available in this country.

The direct-connection means of introducing the tracing signal into a buried pipeline or cable has the advantage of providing greater signal strength and greater distance of tracing signal propagation, thus enabling the operator to locate the buried pipeline or cable more precisely. It requires that a signal cable be connected from the transmitter to an exposed spot on the pipe or cable to be located. The strength of the tracing signal to be introduced depends upon whether a complete circuit is formed between the energized pipe and the ground rod of the transmitter.

TABLE 5.1 EIGHT COMMERCIALLY AVAILABLE PIPELINE LOCATORS

Trade Name	Manufacturer	Mode of Operation: Conduction	Mode of Operation: Induction	Tracer Signal Frequency, kHz	Approximate Cost, $
1. Pipe Horn	Utility Tool Co., Birmingham, Ala.	X	X	*	300
2. M-Scope	Fisher Research Laboratory, Palo Alto, Calif.	X	X	*	350
3. Detectron	Tinker & Rasor San Gabriel, Calif.	X	X	*	300
4. Pipe Locator	Heath Survey Consultants, Inc., Wellesley Hills, Mass.	X	X	1.1 or 10 Pulsed or Continuous	1200
5. Delcon Cable Fault Locator	Hewlett Packard, Mountain View, Calif.	X		0.99 Pulsed at 7 Hz	850
6. Line Locator	Wilkinson Products, Co., Pasadena, Calif.	X	X	*	300
7. Cable Locator	Western Electric Co., New York, N.Y.	X		20	*
8. Pipe and Cable Locator	Dynatal Corp., Sunnyvalle, Calif.	X	X	300	800

* Not available

Therefore, the direct-connection method of signal introduction is not feasible on electrically insulated pipelines.

The propagation of the tracing signal is also hampered by electrical discontinuities, such as bell-and-spigot joints of cast-iron pipes. And, connecting the signal cable to the buried pipeline requires a convenient access, such as the meter connection of gas services, providing the gas service is not electrically isolated from the gas mains. Such convenient locations for cable connection are generally not available in gas transmission-gathering systems; excavation must be made to connect the tracing signal transmitter to the pipe. The necessity of breaking the pipeline coating to gain electrical connection further complicates the process. Therefore, these instruments are more suitable for locating metallic gas distribution pipelines. Once the tracing signal of sufficient strength is introduced into the pipeline, the location can be accurate to within a few inches and to a depth of several feet. The interference from surrounding structures is minimized due to the significantly weaker strength of any induced field.

The induction means of introducing a tracing signal into a buried pipeline or cable requires only that the transmitter and its induction coil be placed near the pipeline or cable to be located; electrical connection is not necessary. Thus, it is much simpler to use in the field. However, it has some shortcomings: the strength of the tracing signal introduced into the pipeline by induction is considerably weaker than that obtained by direct connection; thus, the effective distance of operation is limited. Furthermore, the tracing signal can be induced in any metallic objects located near the induction coil; thus, interference from an adjacent structure may occur, and the accuracy in locating buried pipelines or cables may be reduced. Another shortcoming of the induction approach is that, if the approximate location of a pipeline or cable is not known, the transmitter and its induction coil have to be moved around the area in order to detect the buried pipeline. One way to facilitate the operation is to connect the transmitter and the receiver with a carrying rod and move both units simultaneously.

The types of pipeline locators discussed so far are all based on magnetic or electromagnetic operating principles. Thus they are good only for locating metallic pipelines and are not suitable for locating plastic pipelines. To make plastic pipes traceable with the available pipeline line locators, several approaches have been used by gas industry. One approach is to install a tracing cable or tape in conjunction with the plastic pipe so that the tracing signal can be introduced or induced in the cable conductor, thus allowing the plastic pipe to be located. Unfortunately, such tracing cables or tapes are subject to corrosion by the soil and can be readily severed by earthmoving tools. The tracing tape in particular can be easily cut if it is installed in the backfill of a pipeline trench on top of a pipe. On the other hand, the manufacturers of such tapes claim that the presence of such bright-colored tape also can serve to warn the equipment operators of the presence of adjacent plastic pipe so that caution could be applied.

Another approach of tracing plastic pipeline is to use a special plastic pipe that has an inner metallic liner. The metallic liner allows the plastic pipe to be traced just as metallic pipe and provides much stronger joint at a compression fitting than possible with pure plastic pipes. Satisfactory results have been reported by the users of such metal lined plastic pipes. Currently, most of such lined plastic pipes are used in gas services.

The tracing signal used to locate underground utilities with the electromagnetic locators must not interfere with telephone communications when they are used near telephone cables. In one instrument manufactured by Western Electric Company for the Bell systems, the tracing signal has a frequency of 20 kHz-somewhat above the audio range. Other popular pipe locators, however, operate at much lower frequencies and can interfere with telephone communications, if they are used near telephone cables.

5.1.1.1 Depth Location Problems: An operation related to locating precisely buried pipeline or cable is the determination of the depth of the pipeline or cable. The commercially available electromagnetic pipeline or cable locators all have some weaknesses in this regard. The electromagnetic instruments provide a rough indication of pipe or cable depth by means of a simple triangulation in which the receiving coil is held at a 45 degree angle and is moved away from the pipe or cable path until a null (or a peak, depending upon the instrument) in tracing signal strength is detected, shown in Figure 5.1. The depth of the activated pipe or cable is then the distance between the receiving coil and centerline of the pipe as located. The accuracy of the pipe depth by this triangulation method is obviously not high due to the fact that the flux lines around the energized pipe are rarely in the form of concentric circles and a slight deviation of the receiving coil from the 45 degrees can cause significant errors in the depth readings.

To improve the depth determination capability of electromagnetic pipe locators, IGT research staff members designed a pipe and cable locator that offers both convenience in operation and improved accuracy in depth determination (Ref. 9). It is based on a more refined triangulation relationship of signal detection. However, this unit was never commercialized.

5.1.2 New Equipment – There is a new instrument, which has just been put into commercial production, for locating underground utility systems of all types. It has been called a downward radar capable of detecting the presence in soil of a wide variety of materials, including metals and plastics. It is marketed by Microwave Associates, Inc., of Columbus, Ohio. It operates on the principle of sending a broadband signal impulse into the ground with a suitable signal coupler and of processing the echo from buried objects with digital techniques, By arranging the transmitting and receiving tranducers in a configuration tuned to circular conduits, this new instrument is capable of locating and determining the depth of buried pipelines.

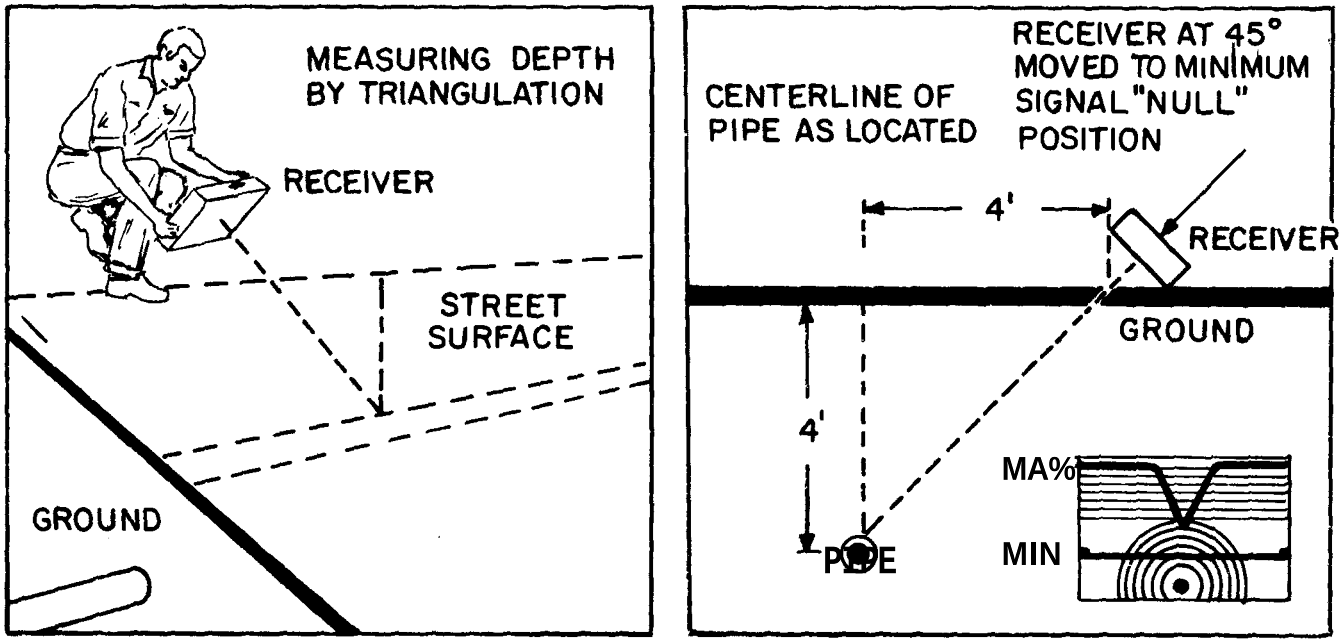


Figure 5.1 Determining Pipe Depth by Simple Triangulation With an Electromagnetic Pipe Locator

The idea of using RF waves or microwaves for detecting buried objects has been around for sometime. A downward radar was developed by Calspan Corp. of Buffalo, New York, for the U.S. Army some years ago for locating plastic mines and explosives. To locate underground pipelines, cables, and conduits of various types, however, presents a more difficult task due to the variations in the material properties. This new instrument apparently has solved the problems by using an impulse of broad frequencies and by the application of digital signal processing techniques that allow signals to be stored, averaged, and compared. The prototype units of this new pipeline locator have been under field testing for the past 2 years. It has been reported that this instrument has a resolution of 6 inches in depth and in horizontal position, and has a total depth capability of 10 feet. The first commercial units are presently in production. The reported price for this instrument is in the range of $5000 to $7000.

It is our impression that this new instrument will have improved capabilities in locating underground utility systems and in determining their depth compared to any instruments heretofore available. However, the level of skill required to operate the instrument to its fullest capability will be considerably higher than that for conventional electromagnetic pipeline locators, thus requiring a trained operator. At this stage of development, its price, too, may be prohibitive. Therefore, it may be sometime before this new instrument will have meaningful impact on the problem of outside party damage to underground utility systems.

5.1.3 Other Potential Techniques – To overcome the inability of plastic pipe to transmit electrical tracing signals, the IGT research staff developed a vibrational technique for locating underground pipeline and cables. This technique consists of introducing a stress-wave signal into the pipe wall or cable sheath and subsequently detecting this tracing signal with a suitable sensor. Since all elastic materials, such as metals and plastics, are good conductors of stress waves, the introduced tracing signal can propagate with minimal attenuation and without any concern to electrical discontinuities. Unlike the electromagnetic techniques, the stress-wave signal will not create induced field in adjacent pipe or cable; therefore, there will be no interference from other structures and the location of a given pipeline can be very accurate. This technique is suitable for locating pipeline or cable of all types and is particularly suited for tracing services because of the access of the meter connection for introducing the tracing signal. However, this technique is still in research stage and has not been fully developed. It does have the potential of offering a less-expensive alternative to the microwave technique discussed earlier.

5.1.4 Location Dispatch – Under the one-call system of damage prevention, it is possible that several utility system operators could dispatch underground system location crews to a site where excavation is planned by a contractor who has notified the one-call center and requested line location. If the site happens to be an area congested with underground utility systems, crews from many system operators could be present and duplication of effort could be very significant. Table 2.40 shows that there could be approximately 9.5 million excavation and construction activities occurring annually near underground utility systems. If each activity requires 2.5 location request dispatches at $20.00 per dispatch, the annual cost to the utility system operators will be $375,000,000. If only one locating crew dispatch per request were required, the cost would be reduced to $150,000,000. This significant annual savings could be used to support other activities of the damage prevention program. Therefore, there should be ideally one group of underground utility locating crews who handle the location requests for all utility systems. By so doing, the crews can be well trained and equipped, and become skillful in all facets of locating underground facilities. It would be worthwhile for OPSO, or some other federal agencies interested in the prevention of damage to underground utility systems to investigate the cost aspects of responding to location requests in one-call systems and to devise an approach that could be most effective and economical for solving the problem. At the present time utilities are not in favor of having locating crews who are not employed by the utility. The liability problem would have to be addressed.

5.2 Pipeline Marking

The markers installed by the industries to indicate the location of underground facilities can be divided into two types: (1) permanent markers, and (2) temporary markers. The permanent markers are erected at strategic locations to provide visual indication of the location where underground facilities are installed and are supposed to last many years. The temporary markers are strictly for short-term use to protect lines from excavation and construction activities.

5.2.1 Permanent Markers - At present, the nation's gas transmission pipeline operators are required by the Federal gas pipeline safety standard 49 CFR, Part 192 to install permanent markers at specified locations to warn the public of the presence of underground pipelines. This requirement is also extended to certain buried distribution mains effective January 1, 1978. Permanent markers are also used by liquid pipeline and cable operators.

The permanent pipeline markers come in various forms and sizes, as shown in Figure 5.2. The Federal regulations specify that the permanent markers should have certain inscriptions, such as "Warning", "Danger", or "Caution", and the name and telephone number of the operator. Other than size specification of the lettering, the Federal regulations do not specify the marker size or shape.

It is our opinion that the installation of permanent markers is a necessary step toward the reduction of outside party damages. Although there have been damage incidents in which permanent markers were near the accident sites, they do not, however, indicate that the markers overall are not effective. The number of

Figure 5.2 Common Permanent Markers for Underground Pipelines

excavation or construction jobs is not known in which the presence of permanent markers prompted the contractors or parties to call the pipeline operators and thus resulted in safe operations. However, the effectiveness of the present permanent markers could be enhanced either by attaching a horizontal arm that indicates the path of the underground pipeline at that particular location or painting a double-ended arrow to indicate the pipeline path if a pole marker is used.

Present markers often provide only "point" location of the pipeline instead of "line" location unless two or more markers are within sight of the location crew. By adding the path information to the existing markers, the "line" location of the pipeline could be indicated without the need to increase the number of markers.

Ideally, the permanent markers should also provide depth information so that "informed" caution could be used by excavators in operating the equipment. However, the depth information may provide excavators with false sense of security which may prompt them not to notify the pipeline operators. Furthermore, the implementation of depth information on existing markers may be costly.

The locations for installing permanent pipeline markers are specified in the Federal Safety Standards Section 195.410 for buried liquid pipelines and Section 192.707 for buried gas mains and transmission pipelines. These specified locations are public road crossing, railroad crossing, navigable waterway crossing, and other locations necessary to identify the presence of underground pipelines. However, marker location should also include places where terrain changes have occurred, are occurring, or probably will be occurring along the path of a pipeline. The pipeline operators in their scheduled patrol of the pipeline routes, should take notice of the activities that are occurring along the routes and determine if additional markers should be installed. In other words, the locations of permanent markers should be frequently updated and reviewed so that effective markers are maintained. The maintenance of existing markers and the installation of new markers should be an important part of the pipeline maintenance operations.

The use of permanent markers for identifying the location of gas distribution mains and other underground utility systems in populated areas is not yet a reality but has gained attention recently. Some thought might be given to a combined marking system for all common underground utility systems in a metropolitan area. The system could identify the type of utility, their relative locations, and depth in code form, and have a single marker inscribed with the coded information and installed at appropriate locations, such as at street intersections. The marker could be a vertical sign similar to traffic signs, or could be a part of the existing traffic signs. It could also be a horizontal sign installed on the surface of street pavement at strategic locations, such as at curbs. Existence of such combination markers could make location of underground utility systems much quicker and effective, A study should be made by concerned organizations to determine the feasibility of such cooperative combination underground utility marking systems. Once feasibility is proven, the development of a suitable system could be initiated. The feasibility study should consider vandalism and wear and tear, such as traffic damage to curbside markers.

5.2.2 Temporary Markers – The temporary markers are for temporary identification of the location of underground utility systems during the period of excavation or construction activities. A wide variety of methods and equipment are being used by the utility system operators for this purpose, with staking and spraying paint being most popular.

The main features of a suitable temporary marker for underground utility systems:

- Provides good visibility and identification of underground utility systems,

- Easy to install and to retrieve but not easily moved by accidental contacts,
- Its presence does not interfere with the construction or excavation activities,
- Inexpensive.

Since the terrain and ground surface of excavation and construction sites vary widely, it is difficult if not impossible to find one marking system suitable under all conditions. Spray paint is best suited for applications on paved surface. Ideally the paint for this purpose is biodegradable so that it does not leave permanent marking on the pavement. A color code should be developed and applied to identify various utility systems. A suggested color code is that proposed by the APWA and TJLCC.

The method of applying the spray paint should also be made more or less uniform among utility system operators. It should be designed with various types of excavation and construction activities in mind so that the markers will not be obscured or lose their effectiveness during these activities. For example, the marker should be extended to a suitable distance beyond the immediate area of intended excavation so that the spoil from the excavation will not obscure the marker.

The staking is suited only for applications where the ground is soft enough to drive the stakes into the soil and to anchor them firmly. The length and size of suitable stakes depend on the conditions of the site. For gas distribution systems, short stakes in the length of 16 to 20 inches are suitable as the ground surface is generally free of tall vegetation. For other pipeline systems where tall vegetation is likely to be encountered at construction sites, taller, more durable and visible stakes are desirable. These stakes should be made of materials suitable for the ground conditions. Wooden stakes, for example, are perfectly suitable for use on lawns and soft ground but are difficult to drive into hard, compacted ground. Therefore stakes made of more than one material may be needed to cover all ground conditions.

The stakes should also be color coded to identify various types of utility systems. The color code should be the same as used with the spray-paint marking system. Ideally, the general shape of the stakes should also be uniform among various utilities so as to improve their recognition.

A sufficient number of stakes should be installed so that the path of an underground utility system is not obscured when a few stakes are removed. The path of an underground utility system should be clearly identified by these stakes during all construction or excavation activities. This need is similar to that discussed earlier in the method of paint application.

Present spray-paint and staking methods for temporarily marking underground utility systems are sufficient for the majority of situations. The most important aspect of marking underground utility systems is the accuracy of these markers. Secondary to the accuracy is how these markers are installed and maintained during the construction activities. Use of a wide variety of temporary marking systems is not helpful in preventing damage to underground utility systems. This marking system standardization is being actively promoted by the APWA.

Another aspect of temporary marking concerns the protection of exposed systems. An east coast gas distribution system operator noted that a large number of outside-party damage incidents occurred after the gas pipelines have been exposed. However, the details of such damages are not known. Are these damages caused by careless operation of the equipment? Are willful damage and vandalism the cause of these damages? Did vehicles or other equipment fall into the excavation and damage the exposed pipelines due to inadequate protection? Since this particular system operator has a large amount of cast iron gas mains, possibly the damages he was referring to are those caused mostly by inadvertent impact from construction or excavation equipment.

5.3 Pipeline Mapping

Among the various methods used by the utility system operators to respond to location requests by outside parties, one is to provide the outside parties with drawings, maps, or sketches to show the location of underground utility systems. This often is not effective in preventing outside party damages for several reasons. One reason is the dubious accuracy of such maps due to the lack of stable bench marks. It is common for a pipeline or other utility systems to be located by distance references from an existing curb. If the road has been widened and the map has not been updated, the reference to the curb will be in error. The records on pipeline depth are generally even worse and are usually the specified installation depth of pipeline when it was first placed in the trench.

It was common in the past that line sketches were used by utility system operators to show the desired location of an underground utility system to be constructed. Such sketches were frequently made in the field data book eventually showing up in the operator's engineering department, and sketches of pipeline or other underground utility systems became the permanent location record. Actual location of the constructed pipeline could be significantly different from these sketches. Surveying was rarely applied to accurately map out the constructed pipeline or other utility systems. As a result, the location records as shown in the engineering drawings of some utility system operators could be very unreliable. In one particular case, for example, a field data book dated 1910 was the current reference of an installed underground pipeline of an operator.

Most of the utility system operators now spend a considerable amount of effort to develop more accurate drawings for location of their underground facilities. However, few have developed a method of mapping that permits information on the location of underground utility systems to be transferable from one operator's map to that of another. However, as the result of the implementation of one-call system and other damage prevention programs, the utility system operators have begun the exchange of maps. Such interchanges among utility system operators are essential for the success of any damage prevention programs. The standardization of maps is believed to be a step in the right direction. Any such standardization will not be an overnight change.

As previously mentioned, much could be gained if a central organization were set up to implement the damage prevention efforts for the construction activities of all underground utility system operators in a given area, and to respond to the LR of underground facilities from outside parties. Such a centralized organization should have current and accurate maps of all underground facilities and should have well trained and well equipped crews capable of effectively taking actions necessary to prevent damage to buried facilities and of working together with outside parties. By dealing directly with such crews, the outside parties could develop personal communication which is invaluable in damage prevention.

Accurate maps showing the location of underground utility systems, greatly reduces the effort required in locating such systems when responding to LR from outside parties. Frequently, the effort can be reduced to simple distance measurements and the application of markers. Therefore, updating and improving the accuracy of maps of underground utility systems are important steps that should be taken after the maps of these systems are standardized and a centralized organization has been set up. The effort required to update the maps might be handled by the crews of this centralized organization when they are not out locating underground utility systems. By having such a centralized organization, the coordination of information on new construction of streets, roads, and underground facilities could be significantly improved.

As accurate maps on underground utility systems are prepared it is desirable to digitize the location information and to store the data in a computer. By so doing, not only the retrieval of location information is made very simple and fast, but additions of new data and updating of existing data are also simplified. At present, the cost of digitizing the location information of underground utility systems is quite expensive. However, the cost could be justified if its long-term benefits are taken into consideration. To realize the benefits of this modern technique, it would be necessary to have all underground utility system operators join together so that duplication could be eliminated. After the information on the location of underground utility systems and pipelines has been stored on a computer, it will be readily accessible to all locating crews, system operators, and other concerned governmental and municipal agencies.

IITRI suggests that a study be made to investigate how the efforts discussed here could best be implemented and how much the implementation will cost. That study should also investigate the economical incentives and the cost sharing of such efforts. On the basis of figures developed in this program, the economical incentives for implementing these efforts do exist. The CAMRAS study that is currently under way in Memphis should be evaluated.

Regarding those gas transmission-gathering pipelines and liquid pipelines often situated in rural areas, probably the location of these facilities should be incorporated into county road maps. The location information should be sufficiently detailed to include the name and telephone number of the pipeline operators. This is deemed advisable because a centralized organization probably is not feasible in rural areas and the county road or highway department could well be the best qualified party to coordinate construction records/maps. Existing roads are frequently used as the bench marks for underground pipelines and the highway department is usually well known to people living in any given area. Once such maps are constructed, they should be made available to all construction contractors and utility system operators in that area as well as concerned municipal agencies. It has been said that pipeline operators have been very reluctant to make maps on pipeline locations available to others in fear of sabotage or vandalism. This attitude should be reconsidered in view of the record of past damage to these pipelines and the sometimes limited effectiveness of pipeline markers. Willful damage and vandalism has not caused significant damage to underground pipelines, and certainly the location of these pipelines has been generally known.

5.4 Excavation Techniques and Equipment

5.4.1 Early Warning and Emergency Shut-Off - There are techniques and equipment now being marketed for use with the earthmoving machinery for the specific purpose of preventing accidental damage to underground facilities. One group of such techniques involves the introduction of an electrical tracing signal into the buried pipeline and placing a sensor and an alarm system on the blade or backhoe of the earthmoving equipment so that the equipment operator is warned if the blade or backhoe gets close to the energized pipeline. A variation of this approach consists of using a magnetic or metal detector and an alarm system rather than energizing the pipeline with an electric tracing signal. In either case, the idea is to provide an early-warning system to the earthmoving equipment so that the operator can be made aware of the proximity of underground facilities before damage occurs.

Another approach consists of incorporating solenoid-controlled hydraulic valves, in addition to energizing the pipeline and placing sensors on the excavating blade or backhoe, to the earthmoving equipment to quickly disable the backhoe or blade when it makes contact with an activated pipeline. This approach falls into the "emergency stop" method of damage prevention.

Activating a buried pipeline with an electrical tracing signal to provide early-warning requires that the pipeline be exposed at a convenient spot to connect the tracer signal generator. This need is similar to that when an electromagnetic pipe locator is used to locate underground pipelines. It can be easily accomplished for metallic gas services and for some gas mains (if services are not electrically isolated from the mains) but cannot be easily accomplished on transmission pipelines without major excavation. Once the pipeline is energized with a tracing signal, the path of the pipeline can therefore be established by traversing the area with a pipe locator. It may then be marked with stakes and other suitable means.

When location and marking are done properly it is questionable if an audio or visual warning system on equipment will further reduce the risk of inadvertent damage to a pipeline. When a pipeline is accurately located and marked on the ground surface and damage still occurs, one has to question the skill of the equipment operator or the conditions of the equipment; adding warning systems is not likely to lessen damage occurrences. The early-warning system may even be ineffective if the excavation calls for work closer to the pipeline or cable and the equipment operator switches it off or ignores the warning signal.

The emergency shut-off approach also has some shortcomings. The need for activating the pipeline is, as discussed earlier, one of the drawbacks, Having this system on the earthmoving equipment also might give some operators a false sense of security such that excessive force may be used in operating the equipment, thus increasing the risk of damage. These methods can have limited effectiveness in preventing damage to underground facilities and there is difficulty in implementing them. Other approaches are needed to achieve meaningful reduction in damage incidents.

5.4.2 <u>"Soft" Excavators</u> — The OPSO data on outside party damage to gas and liquid pipelines and other data available to us indicate that many damages occurred even though the location of underground facilities had been established and clearly marked. These damages could be attributed to several causes, including the lack of attention or skill on the part of equipment operators, malfunction of the equipment, circumstantial conditions, and design or operating deficiencies of the equipment. It is true that most of these damages could have been avoided if recommended excavation procedures such as that recommended by APWA, OSHA, and American National Standards Institute (ANSI) were used in which hand tools are specified when the excavation has reached the close vicinity of underground facilities. Unfortunately, such recommended procedures are frequently not observed by excavators. Under current conditions, it is difficult if not impossible to enforce the application of these procedures. Therefore, other possibilities of damage prevention approaches must be explored.

The earthmoving equipment mentioned most frequently in outside party damage records of underground facilities is the backhoe which is commonly used in spot excavations, such as opening a bellhole to gain access to underground utilities. The backhoe is mentioned so often because it is ubiquitously present on construction sites. It can be used to open bellholes even though a clamshell shovel is more suitable. However a contractors profits depend very much on his ability to keep his machinery operating. A backhoe is necessarily a heavy construction machine that is built for heavy duty rather than a "soft touch" operation. If a soft excavator could be developed as an attachment it would be worthwhile.

There are several possible approaches to achieve this soft feature which would prohibit the excavator damaging underground facilities. These approaches include the use of a rotating abrader, suction or vacuum, air jets, conveyor system, vibrating blades, and combinations of these techniques. The principle is to remove a small amount of soil at a time by means of overcoming the shear strength of the soil but at high operating speed so that the total amount of soil removed in a given time period will be considerably higher than that of conventional backhoes. Furthermore, the envisioned excavator will have a small applicator which can be easily manipulated around underground utility systems situated in an excavation. Ideally, the envisioned soft excavator should be designed so that it could be integrated to existing backhoes.

5.5 Communications

The first line of defense against outside party damage to underground utility systems is effective communications among all concerned parties. This includes all underground utility system operators, municipal agencies, involved contractors, and the general public. Whether it is called public information, pre-construction planning, or continuing education, the goal is to make people aware of the potentially hazardous consequences of uninformed digging or excavation and of the proper precautions that should be taken before starting such activity. Since the outside party damage to underground utility systems is basically a "people" problem, the most effective, and unfortunately also the most difficult, method of damage prevention is the people-to-people communication and the information flow at various levels.

First, the management of underground utility system operators have to be convinced of the importance of damage prevention and of the potential benefits to support damage prevention programs. The benefits to be considered should not be limited to those for each individual utility but that of the entire utility industry and society as a whole. The congestion of underground utility systems in many areas and the interactions of these systems preclude any isolationism in the operation of these systems. A damaged water main may not cause injuries of fatalities, but it could cause adjacent gas mains to lose critical soil support and damage, or it could cause water leakage into telephone cables. As a result, gas mains may break and produce hazardous conditions or the telephone service may be interrupted resulting in some tragic consequences. A complacent attitude toward damage prevention on the part of utility management can quickly run down to the operating levels; such attitudes are frequently responsible for many damages. This is an area where governmental agencies could have a strong influence. The activities of the Federal agencies, particularly OPSO and NTSB, and of the state regulatory agencies may not have made the management of many utility system operators into enthusiastic supporters of damage prevention programs but interest and support seem to be increasing.

Another channel of communications vital to the success of damage prevention programs involves the private contractors and efforts to convince them not to dig into the ground without first informing the utility system operators. At present, some utilities individually use various forms of handouts to get their messages across. Calendars with pretty girls, matchbooks, stickers, and posters are examples of such handouts to remind contractors to use the one-call system. They also use "spots" on television and advertisements in newspapers or magazines for communication. Movies have been made and shown in local union meetings and contractor association meetings for the same purpose. These approaches may be effective in reaching the equipment operators and field crews but may not be effective in reaching the management of these contractors. Situations occur where field crews of contractors were instructed by their management to maintain a schedule of excavation despite the fact that underground utility systems were known to exist at the job site. The subsequent pace of work could have resulted in the sacrifice of care and damage to underground facilities. In such situations, it is obvious that the management of the contractors have placed profit ahead of safety and the contractors' field crews do not have much choice except following the instructions and doing their best to avoid damages. These situations, according to our information, are apparently not uncommon.

It is the writer's opinion that damage to underground utility systems during excavation or construction activities by outside parties can be avoided only if care is exercised in every phase of these activities, such as planning, coordination, and execution. Contractor managements are directly responsible for the planning and coordination of excavation and should exert influence in the prevention of damage. Therefore, it is more important to reach the management of contractors with the safety message than to reach the crews of these contractors. Unfortunately the approaches that have been taken, or are being taken by utilities may not be effective due to lack of "teeth". The extent of outside party damages can be reduced only if contractors adhere to the rule of safety first. It may be necessary to resort to legal penalties to assure this rule.

There is another important area of communication in the overall effort to reduce the outside party damage to underground facilities. It is the direct coordination between contractors' field crews and the personnel of the utility systems during excavation and construction activities. This coordination is particularly important and difficult to achieve in cities due to the number of underground systems in existence. Ill feelings could easily grow between contractors and utility system operators if this coordination is not smooth. To achieve smooth coordination under present conditions may be very costly as each utility system operator may have to send a crew or crews to the job to locate underground facilities and to stake them out. Also, it may be necessary to continue this effort during the entire course of the excavation or construction job. Counting the number of utility systems typically found in metropolitan areas, one can easily see how difficult it is to achieve smooth coordination in the field. This coordination could be significantly simplified if a central organization is set up to handle the location and marking of underground utility systems. By having such a centralized organization and body of people, the people-to-people communication can be vastly improved and the cost involved in maintaining such good communication can be significantly reduced.

6. RESPONSIBLE ENTITIES

A number of Federal, State and local government bodies, plus other organizations have an interest in underground damage prevention programs for many good reasons.

6.1 Federal Agencies

The Secretary of Transportation has Federal safety regulatory authority for gas and liquid pipeline transportation. The DOT pipeline safety regulatory programs are administered by the OSPO in the Materials Transportation Bureau (MTB). MTB has responsibility for pipeline safety and hazardous materials functions as a line organizational element under the Secretary of Transportation. In addition to DOT gas pipeline safety activities covered by the Natural Gas Pipeline Safety Act of 1968, MTB has also been assigned the Department safety responsibilities over liquid pipelines.

With regard to pipeline safety matters, OPSO also coordinates with other federal agencies including: National Transportation Safety Board (NTSB), Federal Power Commission, Department of the Interior, Department of Labor, Federal Energy Administration, Environmental Protection Agency, Department of Housing and Urban Development, Department of State, and Council on Environmental Quality.

The responsibility of the NTSB is to investigate transportation accidents and conduct programs for their prevention in the transportation industries. After these investigations the NTSB issues reports on the accidents and makes recommendations on ways to prevent such accidents in the future. OPSO and NTSB are by far the most involved of the Federal agencies in the development of pipeline damage prevention programs. The Department of the Interior (DOI) is involved where pipelines cross Federal lands under DOI management, Some branch of the new Department of Energy will be involved in various future energy research programs possibly including those in pipeline transportation.

The OSHA, a part of the Department of Labor, is charged with responsibility for occupational safety and health programs and for monitoring employee working conditions which often involve underground excavation activities. Many of the parties involved in pipeline excavation advise that OSHA regulations are often not followed in complete detail.

Several activities in 1972 by NTSB and OPSO signalled the beginning of major efforts concerned with the development of underground damage control programs. OPSO submitted a model statute to the various State agencies and other involved groups; NTSB started encouraging support of the all-voluntary one-call systems. As voluntary one-call systems develop, it would be anticipated that when State statutes are considered the utilities will push for the incorporation of provisions that one-call systems with proper recordkeeping, etc., may meet the notification and response requirements of such laws.

6.2 State Agencies

States have a considerable array of resources which can be instituted for pipeline damage prevention programs. A statute can be introduced in the State legislature, and statutes have been proposed in many states. There has been opposition to some proposed State statutes on the basis that they were not well written. However, statutes can be written properly, or amended, when necessary. The State could require all utilities in the State to participate or require that all utilities in an area join any one-call system that is organized. At the present time each of the States has an agency responsible for pipeline safety, and utilities under its jurisdiction must comply with agency regulations. One of the problems inherent in regulation by the State agency is the fact that utility commissions often do not have safety jurisdiction over municipal utilities or State owned facilities.

State departments of transportation also could have a significant impact on utility damage prevention programs. Quoting from the State of Illinois DOT Policy on the Accommodation of Utilities on Rights of Way of the Illiniois State Highway System:

> "Under Illinois law, the Department has authority to consent to the use and occupany of right-of-way only on the state highway system. Such consent or regulation on county, road district or municipal highways, whether federally aided or otherwise funded, is reserved to the respective highway authorities.
>
> The manner in which utilities are accommodated on state highways marked on municipal streets shall comply with this policy within the limits of the roadway occupied by the state marked route. The manner in which utilities are accommodated along and outside the limits of state marked routes within a municipality is the responsibility of the municipality".

Where a State Department of Transportation can grant permission, it can also withhold permission. State Highway Departments often coordinate plans for relocating utilities during highway construction and reconstruction. Thus all of the organizations that have an interest in highway construction also have at least an indirect interest in damage reduction programs and their support.

The National Association of Regulatory Utility Commissioners (Ref. *4)* has worked among the State utility regulatory commissions keeping the problem of dig-in damage to the forefront. It has also presented the voluntary one-call system and the OPSO model statute in its publications.

In urban areas the mayor and city governments can exercise considerable power over the conduct of utilities. The agencies of the city government always have some degree of control over the city streets; the utilities use the city street right-of-way to lay their pipelines. Even without legal requirements, if the city government wishes to make a utility take certain actions it can often find a way to encourage this.

6.3 Voluntary Associations

The fact that an organization is voluntary does not mean that it is neither a responsible entity nor that it does not have a character of its own. One has only to make brief contact with one-call system organizers and it is soon discovered that they are strongly in favor of the all-voluntary, one-call systems. The zeal that helped to establish the one-call concept and convince a sometimes reluctant management should help to keep the voluntary one-call system strong even when the State opts for statute control. The APWA-ULCC has provided strong support for one-call systems. The appendix to this report contains data on the method with which a one-call system associated with APWA-ULCC can be initiated.

Pipeline and other underground contractor organizations have informed their members about the various types of damage prevention programs. Their publications have presented the details about the voluntary one-call system programs. Like the majority of the involved groups responsible for damage prevention on underground pipelines, they would prefer that the voluntary approach be pursued.

7. CONCLUSIONS

Objectives of this study were identified in the report introduction and study details are presented in the first six sections. This section presents the conclusions developed in the study as the objectives were pursued.

7.1 Effectiveness of Damage Prevention Programs

There are a number of significant conclusions reached concerning the effectiveness of laws and regulations pertaining to damage prevention programs.

7.1.1 Mutual Utility Problem – All of the utilities need to join together in damage prevention activities to ensure a successful program. The natural gas distribution and telephone utilities have been in the forefront of the utilities that have developed damage reduction programs because of their risk of hazardous leak or large economic service loss. The electric, sewer and water utilities do not have as great an incentive because their risks are not as great. However, excavation at any utility location often jeapordizes the others. Underground damage is a mutual problem of the utilities exacerbated by excavators. Thus the utilities must work together to reduce damage. A statute requiring all utilities with underground facilities to cooperate would favor the necessary mutual efforts to reduce damage.

7.1.2 Effect of Local Repulations – The use of the local building permit authority should be integrated into a damage prevention program. The permit desk has a right to deny a permit if advisable and can stamp the permit with utility protection requirements. The permit authority can also notify the utilities about future excavation plans. Local authorities often have the authority and information necessary to discipline negligent and reckless excavation contractors who "rip and pay". If a statute assigns this responsibility to a local government there probably would be many more areas where the permit desk "discipline" technique could be used.

7.1.3 Positive Response to an Excavator – Shortly after an excavator notifies a one-call center, or an individual utility, that he intends to dig, the excavator should be provided a positive response.

Either the excavator should be informed that excavation can proceed without hindrance because there are no underground facilities; or, he should be told that marking will be done and when. If the one-call center, or the individual utility, does not respond to his call the excavator will be left in doubt. When the excavator calls the one-call system center it would be more efficient if the center could respond for all of the member utilities. The excavator should not be required to check back to learn that each of four or five utilities has called and stated that they do or do not possess underground facilities at the proposed excavation location. At this time an overwhelming number of individual utilities oppose a positive response program because of liability problems. A positive response by the one-call center for all of the utilities is also not popular with the utilities for similar liability reasons.

7.1.4 Prior Notification – Any effective underground damage prevention program is based on prior notification by the excavator and line marking before excavation starts by the utility. Figure 2.17 shows that there has been little change in the percentage of reportable leaks in which incidents there had been prior notification. For transmission and gathering systems the change over the 6-year period was from just under 20 percent to just over 10 percent, for distribution systems approximately 40 percent of the outside party reportable leaks occurred where the utility had been notified prior to excavation. Figures 2.4 and 2.5 show that the total number of repaired leaks caused by outside force damage for both the distribution and the transmission-gathering systems exhibit a year-to-year pattern similar to that shown in Figure 2.17. Figure 2.17 definitely shows the need for a much more effective damage prevention program.

7.2 Statute and Other Damage Control Regulations

7.2.1 Statute Requirements – The OPSO Model Statute, the Michigan Code number 53 Statute, the APWA Model Statute and others show more similarities than differences. Section 3 presents details on both the similarities and the differences. The following subsections highlight some of the conclusions developed during this study. More or less generally accepted conclusions on statute requirements include: all parties responsible for underground facilities should be covered in either a Statewide or a local damage prevention program; provision for a one-call system is a necessary condition; provision for notification and positive response; data collection and collation should be required; and if feasible, the statute could provide for liability limitations.

7.2.2 Notification – There are two types of "planned excavation" notification to be employed which may be required by statute; one for long-range plans and the other for immediate excavation. When a utility or a highway planner is in the initial planning stages the appropriate utilities should be notified early; possibly many months in advance. The affected utilities then can become involved in the planning and possibly in temporary rerouting or other protection of their lines. When an excavator is ready to start a job the utility should be notified within a lead time period of less than 10 days and more than 48 hours.

7.2.3 State Ranking in Damage Rate – The utilities, their contractors, and outside excavators are inclined to defend their records insofar as outside party damage is concerned. They argue that one hit out of 100 jobs is not bad. It is not complacency but rather the lack of a "standard". If one hit per 200 jobs is the nationwide average, then one out of 100 is poor, but the national average is not known. This study analysis of outside force damage data indicates that the States having both a great mileage of underground pipelines and a high dig-up rate should show the greatest reduction in excavation damage if they develop a more effective damage prevention program. Figures 2.21 and 2.22

show the trends in the damage rate for five states with relatively large underground pipeline systems. Tables 2.7 and 2.8 list the 17 states with highest damage incident rates. An annual national ranking list might encourage those in poor position to work on damage control programs as well as to show which State programs are most effective. Such data ranking might enhance the evolution of an effective damage prevention program for the entire nation.

7.2.4 Planning Coordination – As pointed out in subsection 4.5.1, which is an excavation contractor assessment, there is a need for greater attention to damage prevention during the planning stages of any construction work that affects the underground facilities. Utilities should present plans well in advance of excavation so risks of underground conflicts are minimized. Engineers and architects need to do more research to locate underground facilities on construction plans. A requirement for prior planning to minimize damage is another facet of the need for mutual attack on the problem.

7.2.5 Penalties – All of the parties involved in underground facilities excavation, whether utility or excavation contractor, recognize the need for penalties. Depending on the particular party there is a change in emphasis as to who should be penalized and how much.

The penalty section of a statute should be fair and directed to the prevention of outside force damage. Any penalties should be applied equally to all who violate the provisions of damage prevention laws. There should be penalties for excavators who repetitively and recklessly cause damage to underground pipelines. There should be penalties for utilities that regularly do not respond (or respond late) when a location request is made.

7.3 Data Observations

The collection, collation and use of data concerning damage to underground facilities are not adequate to make meaningful judgments about damage prevention programs. The Bell Telephone System has a long history of data collection and development, as have some gas utilities. OPSO has developed a partial picture of the conditions in the natural gas distribution systems and the gas and liquid transmission and gathering systems. Most of the data from one-call system performance is less than 5 years old. A longer history is needed to put evaluation of damage prevention programs in perspective.

7.3.1 Damage Correlations – Building and other construction activities correlate with damage to pipelines and underground utilities. The initiation of activity is forewarned by activity in the construction industry and business community, or in the State legislature for road construction. These damage correlations are another indication that effective damage prevention programs depend upon mutual efforts by the utilities, excavators, and all others involved.

8. RECOMMENDATIONS

Consideration of the various damage prevention programs across the country, analysis of the OPSO accident data, and a review of the statutory requirements lead us to make these several recommendations. There is considerable resistance among the utilities to more governmental regulations; hence, they favor the all-voluntary one-call concept for damage prevention. However governmental imposed safety regulations often result if a need is perceived for proper procedures to be followed which will solve a recognized safety problem. As safety procedures are refined they certainly should reduce human error and resulting accidents. Where there is willful neglect governmental regulatory action may be the ultimate solution.

Some of these recommendations are inherently a part of a set of statutory regulations. Other recommendations concern activities that are essentially separate from statute regulations. The statute related recommendations are presented first.

8.1 Utility Cooperation Essential

Any statute addressing damage prevention needs to increase cooperation among all of the underground utilities. Along with providing for a one-call system a statute should lead to effective involvement and better cooperation among all underground facility owners if it is to meet DOT and State requirements. If any of the municipally owned utilities, underground State facilities or other governmentally controlled facilities do not join in efforts to reduce damage on a cooperative basis with the private underground line utilities, any damage reduction program will be hampered. If a statute does not provide specifically for a one-call system it should require liaison among the utilities, both private and government owned, because it is the contractors for all these underground facility owners who most often do the damage to one another.

8.2 Penalties

A statute that is written to reduce damage must include appropriate penalties. There is a concensus among utility representatives that "rip and pay" contractors are a serious and significant part of the outside party damage problem. There should be penalties for those contractors who repeatedly damage underground facilities, and also for those utilities who do not follow the procedures in damage control programs.

8.3 Statute Provision for One-Call Systems

An effective one-call system is an essential part of the development of a successful underground facilities damage reduction program.

Any statute for the prevention of underground damage should provide for a one-call system and require a positive response. Thus when an excavator calls the one-call number, a response should tell him either that it is safe to dig or that utility location will be marked.

8.4 Provision for the Development of an All-Utility Report Form

The lack of accurate and complete data concerning outside party damage has been emphasized in this report; the problem is acknowledged by utility representatives. Most of the necessary data are now collected by the utilities for their o m purposes. At many utilities the data are stored in, and can be retrieved from, their electronic data processing systems. However the data report forms that the utilities are now using are not directly comparable from one utility to another and much less so when the different types of utilities are considered.

OPSO in conjunction with the utility associations such as the American Gas Association, the Edison Electric Institute, and others, should support the development of a report form that could be filed annually with an appropriate state or national organization such as **APWA-ULCC.** The report form should be developed by a committee with representatives from each of the various utilities, electricity, gas distribution, gas and oil transmission, sewer, telephone, water and the cable television and other communication groups.

The proposed form should develop data on the number and types of outside party damage incidents, the cost of repair, details of the underground location effort, the cost of the excavation, (the cost of excavation can be related to excavation size without requiring extra data collection), and the depth of excavation. This form should be based on the data that the utilities must collect for their own purposes, and it should be compatible for both "manual" and EDP collection.

8.5 Continuing Education Support

Effective one-call systems are important in the nation's underground damage prevention program. Imposition of penalties to be applied against excavators who repeatedly cause accidents is another tool. It is almost universally agreed that the most important elements of an effective damage prevention program are acquiring knowledge of underground pipeline locations and then performing excavation carefully. A continuing information and education program is needed. The utilities have resources for the development of television, motion picture and other educational aids.

The following educational aids are used currently: attractive calendars, matchbooks, and motion pictures. All of these are used to deliver the message "call before you dig". Some utilities show groups of excavators the results of outside force damage. The "attention getter" such as Miss Dig and Miss Utility advertisements have been popular as a means of telling contractors about the one-call systems. The validity of such educational aids should be verified. Further educational programs might well be supported by a governmental agency. The private utilities at this time are not allocating funds in sufficient amounts for educational aids that support damage prevention programs. It seems likely that the technical community of the industry needs help, particularly in motion picture production.

8.6 Improvement of Location Crews

A statute might well be made more effective by providing that a one-call system center maintain a specialized complete locating and marking crew. The one-call system center might at least assist in the training of a cadre of qualified personnel for underground facility location duties.

The use of duplicate crews to locate underground facilities at one location is not cost-effective. Use of a single crew to locate and mark for all underground lines for all of the utilities at the excavation site could be more cost-effective. Also the composition of a locating crew should be studied. A locating crew could consist of personnel from each of the local utilities providing a cadre of specially trained line locators and markers. These locators should be trained to use any instrumentation that might be needed. They might also be trained to accomplish emergency repairs on any of the underground utilities at least as a temporary repair. The cost of training, the composition of such crews, and the liability aspects would need to be evaluated, of course.

The future of sophisticated locating equipment, particularly for depth location, and training of personnel to use it should be evaluated, and improvements made where necessary to make precise line location more effective.

8.7 More Complete Mapping and Data Recording

Any damage prevention program should require competent mapping and facility location data records, Underground facility mapping, both original mapping and continued map updating need improvement. Each of the utilities knows approximately where its own underground facilities are but too often it cannot check its facility location compared to the location of another utility's underground facilities. Since the present trend is toward the coordinated use of computers to store facility location data, it would seem likely that one more effective cost approach would be to use coordinated mapping teams probably as a part of the duties of the location teams. The outcome of the APWA program in Memphis, Tennessee Computer Assisted Mapping and Records Activities System (CAMRAS) should be evaluated as a part of the study on mapping assistance for damage prevention programs.

8.8 Outside Force Damages and Construction Rates

In the last portion of Section 2, a correlation between outside force damage rates and construction activities was shown. Insofar as underground excavation damage is concerned, the specific construction rates of the various utilities are particularly pertinent.

A damage prevention program should not wait to start up after excavation is well underway and the outside force damage rate has increased. Action to reduce damage rates must be initiated prior to the need for coordinated action. The senior management of the utilities are in the position to be aware of pending construction activities, both by the utilities and generally. The State Department of Transportation is aware of the scope of road building throughout each state. These senior management personnel can have a significant impact on damage prevention efforts because of their special positions and should take a leadership role.

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