NBSIR 80-1988

A Study of Work Practices Employed to Protect Workers in Trenches

Jimmie Hinze and Nicholas J. Carino

Structures and Materials Division
Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

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U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*
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ACKNOWLEDGMENTS

The field study was conducted by the first author and he wishes to acknowledge the assistance of all parties who assisted in this research effort. The National Utility Contractors Association was particularly helpful in voluntarily conducting one survey and in helping to set up meetings between NBS representatives and utility contracting firms. Assistance was also received from the Associated General Contractors and the National Association of Plumbing, Heating and Cooling Contractors. Many contractors gave many hours of their time to this study. Since anonymity was assured to all participants, they will remain unnamed, but their time and efforts will be remembered. Special thanks are due also to Lawrence A. Salomone of the National Bureau of Standards for reviewing the report and for his useful comments.

METRIC (SI) CONVERSION UNITS

In view of the presently-accepted practice in this country in this technological area, common U.S. units of measurement have been used throughout this paper. In recognition of the position of the U.S.A. as a signatory to the General Conference on Weights and Measures, which gave official status to the metric SI system of units in 1960, we assist readers interested in making use of the coherent system of SI units by giving conversion factors applicable to U.S. units used in this paper.

Length

1 in = 0.0254 meter* (m)
1 ft = 0.3048 meter* (m)
1 mile = 1.609 kilometer

* Exactly

EXECUTIVE SUMMARY

Experience has shown that the Occupational Safety and Health Administration (OSHA) regulations for excavation, trenching and shoring promulgated in 1974 have been difficult to enforce because of technical weakness and ambiguities. Consequently in June 1976 OSHA engaged the National Bureau of Standards, (NBS), to (a) study the compatibility of the technical provisions in these regulations with actual construction practice and with the state of knowledge in geotechnical and structural engineering, (b) review the field experience accumulated since their promulgation, and (c) recommend potential modifications that could improve their effectiveness. As part of this effort, a field study was conducted of present practice in excavation, trenching, and shoring and of the impact of the OSHA regulations as perceived by contractors.

This research was performed to: (1) study field practices in excavation bracing, particularly empirical practices that seem to be adequate and generally accepted in the industry; (2) identify factors affecting safety performance in trenching operations; and (3) solicit comments on how the OSHA standards might be improved. Data were gathered through personal interviews, small group meetings, field observations and mailed-out questionnaires. The information was both general and technical in nature and was provided primarily by utility contractors. The general information concerned company operations, management and safety practices, and other facts about the contracting firms. The technical information dealt with criteria used by field personnel in evaluating safety conditions and with protection practices used in trenching and excavation operations. The technical data provided such information as soil conditions, water conditions, design of bracing systems, determinations of the angle of repose, use of subsurface explorations, causes of trench cave-ins, extent of use of certain types of bracing systems, types of wood used, typical trench configurations, and specific problems with the OSHA standards. Data were collected from various geographical regions in the United States.

Results from the study show that contractors use various types of bracing or support systems in trenches to cope with the variability of soil and groundwater. While some contractors rely on engineering expertise, others dig their own test holes or conduct some other type of subsurface investigation in proposed areas of work to identify subsurface conditions. In some instances, the owners of the proposed work areas provide boring logs which may be used by contractors. The study also showed that most trenchwork is between 5 and 15 feet deep with the trench width usually being about 3 feet.

Engineering judgment plays a large role in actual field decisions concerning necessary bracing systems for trenches when the trench walls are not sloped. In general, most utility contractors do not consider the OSHA standards helpful for determining the adequacy of trench shoring systems. It was noted that when engineering expertise does not exist in a company, the contractor generally resorts to the use of empirical practices which have been time-tested for given soil types.

The type of protection provided for trench workers varies considerably among utility contractors. The use of trench shields or trench boxes is quite popular in the Eastern States and in parts of the Midwest, while hydraulic shores are often used in similar soil conditions in the Southern and Western States. When wood bracing systems are used, the type of wood could be hardwood or softwood, depending on the region of the country. Other differences noted between various contractors' practices are not directly based on geographical locale, but more on the size of the contracting company. For example, large firms are usually employed for deep trenchwork and they will often use sheetpiling as their support system.

The number of recorded injuries was obtained from the respondents and converted to an injury frequency index in order to characterize the safety performance of the companies. However, uncertainties in the injury reporting practices of the various companies and in the representativeness of the samples prevented the drawing of firm conclusions about the relation between safety performance and those factors believed to have important influences.

Finally, this study obtained comments from contractors concerning the current OSHA standards on trenching safety. The most often quoted statements were that the standards are impractical, antiquated, too restrictive and not responsive to varying soil conditions. There seems to be a strong opinion among contractors that OSHA should play an advisory role in addition to its policing function with respect to trenching safety.

ABSTRACT

Results of a field study of trenching practices, safety related problems in trenching, and the effect of the Occupational Health and Safety Administration (OSHA) regulations for excavation, trenching and shoring are presented. The data were gathered from over 100 interviews with contractors and foremen in various regions of the country and from the answers to questionnaires sent by contractors' associations to their membership. The data indicate: 1) the technical aspects of trenching work, 2) the industry's opinion of the current OSHA regulations, and 3) factors affecting safety performance in trenching work.

Key Words: Construction safety; construction standards; excavation; safety regulations; shoring; trenching.

1.0 INTRODUCTION

1.1 GENERAL

The OSHA regulations for excavation, trenching, and shoring were promulgated in 1974.[1]* Field experience accumulated since their promulgation indicated that the regulations were difficult to enforce because of technical weakness and ambiguities. Consequently in June 1976 OSHA engaged the National Bureau of Standards, NBS, to (a) study the compatibility of the technical provisions in these regulations with actual construction practice and with the state of knowledge in geotechnical and structural engineering, (b) review the experience accumulated since their promulgation and (c) recommend potential modifications that could improve their effectiveness.

This report presents the results of field studies of present practices in excavation, trenching and shoring and of the impact of the OSHA regulations as perceived by contractors. Much of the information presented in this report is not within the realm of OSHA's responsibility for regulations. However, the data is presented to provide information to contractors in a consulting and advisory role.

1.2 PURPOSE AND SCOPE

The purpose of the investigation was: (1) to examine those factors believed to have major influences on safety performance; (2) to study field practices in excavation bracing, particularly empirical practices, that seem to be adequate and generally accepted in the industry; and (3) to determine the industry's opinion of the current OSHA regulations.

Part of the information gathered in this investigation was obtained through discussions with contractors (mostly utility) involved in trenching and excavation operations, through written comments received from such contractors, and through visual inspections of job sites. The information was either general or technical in nature. The general information concerned company operations, management and safety practices, and other characteristics of the contracting firms. The technical information included specific criteria used by field personnel in evaluating safety conditions and protection practices employed in trenching and excavation operations. Similar information was also obtained from letter surveys conducted by the National Utility Contractors Association and by the National Association of Plumbing, Heating, and Cooling Contractors.

The results of the field interviews are presented in Chapter 2 and 3; the results of the letter surveys are given in Chapters 4 and 5; and the Appendix contains details of the questionnaires and specific comments made by contractors on various topics.

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* Numbers in bracket refer to references listed at end of report.

Also presented, as Appendix G, is a report prepared by a Trenching Hazard Task Force of the Building and Construction Trades Department, AFL-CIO, which was appointed in conjunction with this project in order to identify the safety problems as viewed by workers who actually enter the trench. The task force was composed of individuals representing over 200 years of total experience in trenching work. The report gives further information on the industry's view of acceptable practice in trenching work.

1.3 DEFINITIONS: EXCAVATION VS. TRENCH

It is important to understand the basic differences between the terms "trench" and "excavation". By definition a trench is a special type of excavation. Although there is no consensus on the exact difference between a trench and an excavation, some general distinctions are accepted. A trench is considered to be a long, narrow excavation which is left open for a relatively short period of time, usually less than a day. The excavated material from a trench is generally stored within a few feet of the trench and placed into the excavation after the desired work is completed. Trenches tend to be excavated for the installation of utilities such as sewer, water, electric, gas, and telephone lines. In contrast, when contractors use the term "excavation," they refer to an excavation that remains open for long periods of time and where most of the excavated material is usually not backfilled into the excavation. Excavations are common for such structures as buildings and bridge abutments where the structure itself replaces the material that was excavated. In summary, a trench differs from an excavation in that a trench is long and narrow, uses the excavated material as backfill, and tends to be open only for a short period of time.

Different concerns are involved in the side support provisions for excavations and trenches. Many excavations occur in the cities, and the bracing systems are often designed by licensed professional engineers to provide assurance that the banks will be maintained and that subsidence of adjacent properties, particularly those supporting buildings, will be minimized. Few such bracing systems have been known to fail. On the other hand, the temporary nature of trenches and the changing nature of soil conditions, make trenching operations different. Trench shoring systems are rarely designed by licensed professional engineers, and prior engineering design is often impractical since soil conditions may vary greatly over short distances requiring that decisions be made in the field.

There is a clear distinction between those contractors involved in opening excavations and those involved in opening trenches. Only in rare instances would a single contractor be involved in both types of operations, and such a contractor would generally run a larger, more diversified operation. This distinction was evident when several trenching and excavation sites in the Washington, D.C. area were visited and informal discussions held with several area contractors at the start of the study.

Conclusions drawn from discussions with excavation and trenching (utility) contractors revealed that this study should address primarily safety in trenches rather than safety in excavations. Excavations are usually engineered, are machine-intensive and rarely have cave-ins. On the other hand, trenches are rarely engineered, are more labor-intensive, and frequently do cave in. Thus injuries from caving banks are more likely to occur in trenching operations than in excavations.

Although some excavation contractors were involved in the field study, more utility or trenching companies were involved in the final investigation. Excerpts from a few of the conversations held with excavation contractors are included in the Appendix (Part C).

2.0 FIELD INTERVIEWS

2.1 METHODOLOGY

A set of questions was developed which could be used as a guide when talking to the various contractors. The questions dealt with general information about the contractor, management philosophies, work practices that could affect worker safety, safety programs, type of work performed, nature of soil conditions generally encountered, and the current OSHA regulations on trenching operations. The final questionnaire included about 100 questions.

Assistance in contacting utility contractors in different parts of the country was obtained from the National Utility Contractors Association (NUCA), which provided the names of local utility contractor associations throughout the country.

An evaluation was made to determine the most desirable locations for this study. Soil type and shoring practices in specific locations were primary considerations. In a few instances, a strong willingness on the part of the utility contractors to participate in the study was also a factor. Nine sites or municipal areas were eventually selected. These included Washington, D.C.; Boston, Mass.; Atlanta, Georgia; Pittsburgh, Penn.; Kansas City, Mo.; Omaha, Neb.; San Francisco, Cal.; Houston, Texas; and New Orleans, La.

The utility contractors' association in each selected area was contacted and informed about the study. In all cases, these associations volunteered to assist NBS in the study, and the utility contractors in each location gave freely of their time to discuss their trenching operations. It is noted that in some instances time did not permit all willing contractors to be interviewed.

Personal interviews were arranged and scheduled by each participating utility contractors' association. The persons interviewed were familiar with management practices and field operations of their companies. Some companies sent several representatives. Participants included vice

presidents, general managers, general superintendents and safety officers; however, in most instances, the president or owner of the company was interviewed.
Interviews were scheduled to take about one hour; but most participants became quite interested in the topics being discussed, and, consequently, additional time was taken to elaborate on various subjects covered during the interview. Although structured questions were posed, a flexible approach was taken and comments on additional topics were also recorded.

To augment the information gained in the interviews and to obtain a clearer perspective of trenching practices, field visits were made to different sites to observe the various types of current trenching operations.

2.1.1 Data Coding

After the interviews had been completed, codes were set up for each question in the questionnaire. The codes represented general categories (in some cases, specific categories) into which the responses could be grouped. In order to minimize the introduction of bias, coding was performed by technicians and injury frequency was calculated after the other coding had been completed.

Injury frequency was determined by asking the person being interviewed the number of recordable injuries incurred and average number of workers employed over a given time period. The injury frequency index was expressed as the number of recordable injuries per one million man-hours of exposure. By using this index, the safety performance of all companies could be compared in relative terms.

Injury frequencies were compared with different responses to various questions. However, no firm conclusions should be drawn from the comparisons because: 1) it is not possible to ascertain whether identical accident reporting practices exist among all respondents, 2) it was not possible to characterize the nature or severity of the reported injuries, and 3) it is uncertain whether the sample used can be considered statistically representative. Thus, conclusions regarding those factors believed to have major influences on safety performance in trenching work were not formulated. Nevertheless, the average injury frequency indices associated with various response are presented as indications of general trends.

The correlations between the various factors and to injury frequencies were founded upon statistical analyses of the data. However, references in the text to statistical tests is held to a minimum to aid the reader. A high degree of positive correlation implies that as one variable is increased, so does the injury frequency.

Kendall's correlation test[2] was employed in the analysis of the data. This is a nonparametric test, which means that a normal or bell-shaped distribution of the data is not required. The distribution of the injury frequencies was not normal, therefore such a test was essential. This need is confirmed by the fact that the lowest injury frequency was

9, the highest injury frequency was 371 and yet the mean was about 86 with a median of 67.

Data need not be normally distributed, because a nonparametric test considers the relative ranking of variables and not their absolute values. For example, the values of a particular variable for different cases, say 2, 6, 12, 20 and 40, would be treated as relatively ranked values of 1, 2, 3, 4 and 5. Thus, the mean of the values is not considered to be the absolute value of 16 but the ranking value of 3. Note that the value, 16, would be the average but not the median point of the first values, while 3 would be the mean and median value of the ranked data. In Kendall's correlation, the relative ranking of values are used in determining statistical significance. That is, for a particular case, the relative ranking of a variable is compared with the relative rankings of the same variable with other cases. Comparisons are made between the relative positions of these rankings. If a variable is positively correlated with another, it means that as the relative ranks of one variable increase, the relative ranks of the other variable also increase.

2.2 CHARACTERISTICS OF THE INDUSTRY

To give a clearer perspective of the type of contractors involved in trenchwork, a brief description of the industry is provided. This information will be helpful in interpreting and understanding comments and conclusions to be made later in this report. Because many of the contractors in the survey referred to themselves as utility contractors, that title will be used in this report.

A utility contractor is essentially one who installs storm sewer lines, sanitary sewer lines, water lines, telephone lines, electrical lines, or gas lines. In general, the sewer and water line contractors are considered to be "true" utility contractors. They often specialize and orient their operation to only one aspect of utility work. However during a slack period, some contractors shift into other areas; for instance, a water-line contractor may bid on shallow sewer lines.

Most projects are associated with public works, while a small percentage are private sector jobs involving principally development projects, such as subdivisions. As a consequence, almost all the work contracts of utility contractors are obtained through competitive bidding.

Most contractors tend to be small in terms of their annual dollar volume (Table 1).* A majority of the contractors do less than $4 million of work annually, and perhaps only about 15 percent of the contractors have an annual volume greater than $10 million. These larger companies would

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* The information in Table 1 and in all subsequent tables in the chapter was obtained from this field study.

generally be those in which the utility work constituted a branch or division within the company; so, the actual trench volume would still remain fairly small.

Table 1: Annual Dollar Volume of Utility Contractors

Annual Dollar Volume	No. of Companies	Percent of Total
Less than $1 million	11	12.2
1-2	22	24.5
2-3	11	12.2
3-4	6	6.7
4-5	7	7.8
5-7	10	11.1
8-12	12	13.3
12-30	8	8.9
Over $30 million	3	3.3
	90	100.0*

* The total value of the sum of all valid responses will always be reported as being 100% in this report. To guarantee this sum it may be necessary, through numerical rounding, to deviate slightly from standard rounding conventions. Examples: 22 of 90 total responses is 24.44% of the total, but this was rounded to 24.5% to obtain the necessary total of 100.0%.

Table 2: Percent of Company Volume of Work That Is Trenching

Percent that is Trenchwork	No. of Companies	Percent of Total
0-25	14	16.5
26-50	11	12.9
51-75	10	11.8
76-90	15	17.6
Over 90	35	41.2
	85	100.0

Table 3: Amount of Company Work Done Within 50 Miles of the Home Office*

Percent of Company Volume	No. of Companies	Percent of Total
0-25	5	5.5
25-50	8	8.9
50-75	7	7.8
75-90	15	16.7
over 90	55	61.1
	90	100.0

* 1 mile = 1.61 kilometer

Table 4: Average Number of Field Employees in the Company

No. of Workers	No. of Companies	Percent of Total
10 or less	1	1.1
10-25	21	23.6
25-50	25	28.1
50-75	7	7.9
75-100	11	12.4
100-200	14	15.7
over 200	10	11.2
	89	100.0

Utility contractors do virtually all the work associated with their contracts, and this demonstrates that many contractors have diversified capabilities, such as blasting and paving, which support the trenching operations. As most contractors do primarily trenchwork (Table 2), they bid on jobs in the general vicinity (within 50 miles) of the home office (Table 3). This practice is probably caused by the following factors: (1) the contractor may own his equipment and transporting it any greater distance would be too costly to be competitive; (2) the contractor would have a better understanding of soil conditions near "home" and would be reluctant to work areas having unknown soil conditions; (3) the contractor generally keeps a constant crew and this may not be possible if he were to move too far from the home office; and (4) the contractor would lose control of his job if it were too far to monitor on a regular basis.

The work force is small because the annual volume is generally small. The majority of the contractors tend to have less than five trenching crews working for them (Table 4). The average size of a crew is from five to eight people, but may vary considerably because of different soil conditions. A typical crew may have a foreman for supervision, a backhoe operator to dig the trench, a bulldozer operator to backfill the trench, two workers in the trench making the connections, and two workers supplying materials to those in the trench. Less men are needed if the foreman operates the backhoe or if the materials are light in weight and can be handled by one worker. Considerably more men would be required if shoring were required in the trench, or if the materials were large and unwieldy.

The home office staff of a typical utility contractor is also quite small, rarely more than 10 people (Table 5). These individuals often have extensive field responsibilities in addition to their "in-house" duties. They are involved in such tasks as accounting and payroll, bidding, making field inspections, monitoring jobs from the office and general trouble-shooting tasks.

Table 5: Number of Home Office Employees

No. of Employees	No. of Companies	Percent of Total
1 or less	2	5.5
2	4	11.1
3	6	16.7
4	6	16.7
5	5	13.9
6-9	7	19.4
10-15	5	13.9
60	1	2.8
	36	100.0

In the states with right-to-work laws, the utility contractors are not unionized. In the other states, however, the contractors may work either union or open shop. In either case, contractors tend to keep the same crew members. Most contractors' work forces are such that over 75 percent of the workers have been with the company for longer than one year. This would not be true in a very busy season when a contractor might add additional crews to his work force.

Because members of the work force are long-term employees, and since very little subcontracting (or interfacing activities with other trades) is done, trenchwork becomes routine. Consequently, by working together the workmen become well-acquainted with their roles and the roles of their co-workers.

In general, the trenching operation is also routine. The backhoe opens a length of trench, shoring is installed (optional), the pipe joint is made and more trench is opened, and so on. As the piping operation continues, a bulldozer backfills the trench above the pipe. Although this phase of the operation is routine, it is the time when the profit is made. Nothing is fixed because the operation is so mobile. A job site warehouse is not practical; consequently, when machinery breaks down or particular problems develop, the field personnel frequently are not able to solve the problem. For this reason, management usually maintains close surveillance on these jobs either by job visits or through radio communications. The fact that the operation is constantly moving separates trenching operations from other work in the construction industry.

Job control for utility contractors seems to be different than for general contractors. There is little long-range planning in trenchwork, other than determining, to some degree, the type of soil to be encountered on the job. Before the bid is actually submitted, establishing the type of soil is necessary. After the job is awarded, the contractor makes arrangements for two or three pieces of equipment, the piping materials (largely worked out by the pipe supplier), and the six-man crew. Job control is frequently on a daily basis (Table 6). Job control is very important and for this reason company owners or presidents remain actively involved in field operations. A minor incident, such as a broken hydraulic line, can be costly if the entire trenching operation is stopped, so management must be responsive to sudden unexpected job needs.

Table 6: How Often the Company President Visits the Jobs

Frequency of Visits	No. of Companies	Percent of Total
Daily	32	38.1
3 times a week	10	11.9
2 times a week	7	8.3
1 time a week	14	16.7
2 times a month	7	8.3
1 time a month	5	6.0
less than monthly	9	10.7
	84	100.0

Although a utility contractor may do $3 million of work annually, this amount should not be compared to similar amounts in general construction. This type of work is very machine-, materials-, and labor-oriented. The machinery (bulldozers and backhoes) is often large and expensive. In addition, the pipe can be very expensive. The labor that installs the pipe may be a fairly inexpensive item in a relative sense, but this is where the contractor makes a profit. Very little subcontracting is done. A single crew of perhaps six or seven men could do $1 million of work in one year.

The foregoing description of utility contracting firms should be considered when: (a) evaluating the comments made by the different contractors, (b) trying to understand the findings and (c) making final conclusions.

2.3 TECHNICAL ASPECTS OF TRENCHING

As part of the field investigation, considerable information was obtained concerning the technical aspects of trenching operations. These data were not obtained for specific analysis, but rather as general information in the overall research effort. They are presented to document the available information with a minimal amount of discussion.

2.3.1 Trench Dimensions

Information was obtained on the geometry of typical trenches and is presented in Tables 7, 8 and 9. Utility contractors generally open trenches which are deeper than 5 feet, thus requiring either shoring or adequate sloping to assure worker protection from collapse. Trench widths are usually narrow (less than 6 feet) but extremely wide trenches were also noted. Trenches tend to remain fairly short (less than 50 feet), and the backfilling operation usually occurs shortly after the pipe laying phase. Only for long water lines, operations requiring shoring, or where large diameter pipes were being installed, were longer open trenches noted.

Table 7: Typical Trench Depth

Depth of Trench	No. of Companies	Percent of Total
less than 5 feet*	3	3.4
5-10 feet	34	38.6
10-15 feet	21	23.9
15-25 feet	21	23.9
over 25 feet	9	10.2
	88	100.0

* 1 foot = 0.305 meter

Table 8: Typical Trench Width

Width of Trench	No. of Companies	Percent of Total
less than 3 feet	42	48.8
3-6 feet	17	19.8
6-9 feet	10	11.6
9-12 feet	3	3.5
over 12 feet	14	16.3
	86	100.0

Table 9: Length of Open Trench Behind the Backhoe

Length of Open Trench	No. of Companies	Percent of Total
less than 20 feet	9	16.4
20-30 feet	12	21.8
30-50 feet	13	23.6
50-75 feet	8	14.6
75-100 feet	6	10.9
100-200 feet	2	3.6
over 200 feet	5	9.1
	55	100.0

2.3.2 Construction Practices

The contractors were asked questions to elicit information on field practices. So that the reader may know the scope of the available information, the questions are listed below but tabulations of the responses are presented in Appendix A:

1) What is the most commonly found soil in the area?

2) How do you determine the angle of repose?

3) Is the OSHA table (P-1) helpful in this (determining the angle of repose)?

4) What type of (solid) sheeting is used?

5) If you have skeleton (skip) shoring in a trench, what type do you use most often?

6) Do you buy the (trench) boxes or do you build your own?

7) Is the shoring (timber) removed when the trench is backfilled?

8) What kind of wood do you use?

9) How often is it (wood shoring) reused?

10) How do you decide when lumber cannot be used?

11) Of the cave-ins you have seen, what do you think is generally the cause?

12) What is the worst soil or water condition that you run into in your work?

13) Do you do your own soils investigations?

14) Do you have an engineer in your company?

15) Does the company ever hire soils consultants?

16) Does the company ever hire a consultant to design the (shoring) bracing?

17) What dewatering method do you usually use?

No attempt will be made to formulate detailed conclusions from the responses to the above questions, only a brief summary is presented. Past experience and "rules of thumb" are being used more than the OSHA regulations for estimating the angle of repose. Contractors make efforts to investigate soil conditions, but one-third of cave-ins are blamed on improper soil evaluations. A majority of contractors have engineers in the company and very seldom are outside consultants employed for bracing design.

3.0 FACTORS INFLUENCING SAFETY PERFORMANCE

Injury frequencies associated with the contractor responses were compared to see if certain practices affected safety performance. The reader is cautioned against drawing firm conclusions from these comparisons because of the limitations mentioned in 2.1.1.

3.1 COMPANY SIZE

The relationship between company size and injury frequency is shown below:

Question 18: What is the annual dollar volume of the company?

Response	Number of Companies	Avg. Injury Frequency
Less than $4 million	50	71
Greater than $4 million	40	105

Because it is difficult to rationally attribute the frequency of injuries to the volume of work being performed, a closer analysis will be made to define other variables which may affect frequency of injuries and which are related in some manner to the annual dollar volume of work.

3.1.1 The Nature of Large Companies

Larger companies have more workers. To increase its volume of business a company needs a corresponding increase in the number of workers required to perform the additional work. Large companies have more crews. The type of work performed by each company, however, could result in different numbers of crews for comparable volumes of work. Labor-intensive trenching work (shoring) would require more workers than an equipment-intensive trenching operation (sloping), although the actual contract amounts could be quite similar.

In short, the crew sizes may vary somewhat, but in the survey the actual number of crews was related to the volume of work done by the company.

Large companies have more levels of management. Interview respondents were asked specifically about the number of levels of management between the workers and the company president. The range of responses was from 0 (in which the president assumed foreman responsibilities over the crew) to 5 levels of management. The number of levels of management increased as the volume of business increased.

Large companies do work in other areas besides trenchwork. Of the contractors included in the study, 71% stated that over 50% of their work was trenching. Some contractors were involved in such nontrenching operations as paving, building construction and excavation. Of the contractors surveyed, 34% stated that all of their work was trenching.

Large companies do a smaller portion of their work locally (near the home office). A criterion for establishing what constituted "local" work was work within a 50-mile radius of the home office, a distance that still permits close surveillance of jobs from the home office. Of the contractors surveyed, 58% stated that their work was done locally. Only 9% stated that less than 50% of their work was done locally.

3.1.2 Other Characteristics Affecting Safety

The foregoing discussion has dealt with factors closely related to the annual dollar volume of companies. These factors have been of a quantitative nature in that most could be easily established by some objective measure. The following discussion relates other variables to the size of the company, but these variables will be qualitative in nature.

Although only 8% of the companies surveyed had any major "people problems", the large companies reported more of these problems in their firms. "People problems" would include such things as lack of qualified workmen, or having people not willing to work.

Each person interviewed was asked who was responsible for checking field operations and how often the person responsible for such checks visited a typical job. In the large companies, the individual responsible for checking on field operations is rarely the president or owner. The relationship between injury frequency and the person responsible for checking field operations is presented below:

Question 19: Who in the home office is responsible for checking field operations?

Response	N*	Avg. Injury Frequency
President or owner	44	74
All others; vice president estimator, superintendent, safety officer, etc.	47	97

Level of significance of the difference between the two categories: $p < .001$**

* N = Number of respondents.

** The significance of the differences between groups is based on the Wilcoxon-Mann-Whitney test.[2] The value of p indicates the level of significance of the statistical finding; i.e., it shows the possibility error in the conclusion based on the data examined. If $p < .001$, there is less than one chance in a thousand that the conclusion is incorrect.

3.2 MANAGEMENT PRACTICE

3.2.1 Impact of Management Style

A set of questions were asked to develop information on the types of relationships maintained between top management and field workers. These questions posed hypothetical situations and the contractors were asked how they would handle them.

The views expressed concerning management styles are not to be construed as being particular causes of accidents or remedies for improving safety performance. Instead, they should be regarded as a reflection of a more general attitude maintained by top management concerning the field workers. The results concerning management practices and attitudes will first be presented individually and then discussed in a more generic sense.

Contractors were asked about their company policies on hiring and firing of employees, specifically, the degree of control that the foremen held over such matters. The responses could show the extent of top management involvement in such circumstances. The questions, responses, and injury frequencies were as follows:

Question 20: "Do the foremen hire their own men?"

Response	N	Average Injury Frequency
NO, top management is involved to a degree, or they can only suggest names of people to be hired.	49	71
YES (full hiring authority)		
Level of significance of the difference between the two two categories: $p < .01$	41	105

Question 21: "Do the foremen fire their own men?"

Response	N	Average Injury Frequency
NO, top management may intercede in the process, or they may only initiate the firing of workers	32	69
YES, or top management may fire the workers too (full firing authority).	56	99

Level of significance of the difference between the two categories: $p < .01$

Another indication of top management involvement at the worker level was obtained by asking each contractor how job conflicts were handled. Specifically, they were asked what they would do if a worker were to come to them with a complaint about a foreman. The responses were as follows:

Question 22 (rephrased): What would you do if a worker came to you with a complaint about his foreman?

Response	N	Average Injury Frequency
Shift the worker to another crew, get the two men together, listen to both sides, or study the situation carefully.	57	79
Back the foreman's position	22	99

Level of significance of the difference between the two categories: $p < .02$

The responses were grouped into two categories. The first category represented top management involvement, even personal concern, in the job conflict. These managers offered various means by which they would handle the problem: shift the worker to another crew, particularly if the conflict was one of personalities; get the two men (foreman and worker) together and force them to establish a common solution; listen to both sides to determine an acceptable solution; or study the situation to see how best to remedy the problem. In all of the foregoing instances, top management would take the complaint seriously, become personally involved in the job conflict, and actively seek a workable solution. The second category representd top managers who would refuse to become involved in such conflicts. They would back the position of the foreman and insist that the worker would have to work the problem out with the foreman. In this case, the worker would have no recourse if the complaint were legitimate and serious.

Another question concerning job conflicts was that of a new foreman who was having difficulty in his job assignment. The managers were asked how they would deal with such a situation, and the responses were as follows:

Question 23: "Suppose you have a man who has worked for you for awhile. You elevate him to foreman on some complicated work, but he doesn't seem to be able to handle it. What would you do?"

Response	No	Average Injury Frequency
Work with him until he catches on, shift him to another crew, or work him into the position slowly.	42	69
Make the new position a trial promotion, put him back as a worker, or dismiss him.	43	99

3.2.2 Cost Information

Typically, utility contractors have projects or job sites under the sole field supervision of the foreman. The foreman will generally have from 4 to 12 workers in the work crew, depending on the type of trenchwork being done. The foreman is responsible for the entire field operation and will report to someone in upper management such as the general superintendent, vice president, or even the company president (or owner). Although most firms will function in this manner, various degrees of authority are given to the foreman. One area of interest is the management policy concerning the sharing of cost information with the foremen. Policies range from giving the foreman no cost information to providing him with all available cost information. Since these policies could have differing influences on the foremen, particularly in terms of management-imposed job pressures, the responses to the following question were compared with the incurred injury frequencies:

Question 24: "What kind of cost information do you give to the foremen?"

Response	N	Average Injury Frequency
None is given to them or only general information is provided.	62	80
Give them detailed cost estimates, give them reduced estimates, informed only of overruns, given complete access to cost records, or they are told that their costs will affect their bonus.	28	102

Level of significance of the difference between the two categories: $p < .04$

3.2.3 Safety Practices

Contractors were asked questions about their company's efforts to maintain safety practices in the field and about the factors affecting job safety. These questions concern safety meetings, safety representatives, insurance assistance or safety, OSHA, and other specific programs or philosophies which exist in each company. The questions are presented below and the responses are found in Appendix B:

25. Are tool box meetings held on the jobs?

26. How often do you have them (tool box meetings)?

27. Day of week that tool box meetings are held?

28. Who attends these (tool box) meetings?

29. Who presides at these meetings?

30. How meaningful do you think they (tool box meetings) are?

31. Do the foremen receive any formal safety training?

32. Who is in charge of the company safety program?

33. How often is he (safety officer) in the field?

34. Is he (safety officer) involved in job planning?

35. What does the safety officer do?

36. To what extent is the company president involved in job safety?

37. Who, outside the company, gives the most valuable assistance on job safety?

38. What assistance do you get from the insurance company on job safety?

39. How often do they (insurance inspectors) visit jobs?

40. How valuable are insurance inspections?

41. What is the experience modification rating of the company?

42. How many OSHA inspections have occurred in the company?

43. (Of those firms inspected) How many citations were received?

44. How has OSHA affected your work?

45. Would you comment on your thoughts or experiences with OSHA inspectors?

46. Has your accident history changed since OSHA became effective?

47. Do you get some kind of cost history that tells you how much each injury claim amounts to?

48. Are safety records considered when establishing raises?

49. Is there a company safety incentive program?

50. How does the field know that the company fully supports job safety?

51. Would you say that some injuries are just part of the job?

Based on the responses to the above questions, the following observations are noted:

1. A large majority of the companies regularly hold "tool box" meetings, but feelings are split concerning their worth.

2. Top management is generally actively involved in company safety programs.

3. Insurance companies provide valuable assistance on matters of safety.

4. OSHA has had a negative impact on company operations and a majority of companies felt negatively towards OSHA inspectors.

5. Few companies have safety incentive programs.

3.3 TYPE OF TRENCH PROTECTION

The type of protection for workers in trenches (sloping, trench boxes, skeleton shoring or solid sheeting) influences to some degree the number of injuries incurred. Each contractor was asked to estimate how frequently (in percent) each different method was employed by his firm. The results showed that the frequency with which the different methods were employed had varying effects on the frequency of injuries experienced by the company.

The most frequently used method of providing protection from trench cave-ins was sloping the banks. Forty-four percent of the companies used the sloping method on at least 50% of their trenches (12% used sloping in over 90% of their trenches). Only 10% of the respondents used sloping less than 10% of the time.

Question 52: What percent of your trenches are not braced but sloped?

Response	No. of Companies	Avg. Injury Frequency
0 - 59%	49	98
60- 100%	37	66

Level of significance of the difference between the two categories: $p < 0.16$

Shallow trenches (generally less than 5 feet deep) do not require shoring and could be regarded as being sloped even if the trench walls were vertical. Thus, some companies involved in primarily installing water lines would do almost all "sloping" as no further protection would be required in shallow trenches; while other companies may actually be sloping trenches which are 10 to 12 feet deep. Failure to distinguish between these two types of firms in the data presented difficulties in interpreting the results.

A popular method of trench protection among some contractors was the use of trench boxes or trench shields. Sixteen percent of the contractors stated that they used trench boxes more than 50% of the time. Seventy-two percent said that they used trench boxes no more than 25% of the time (33% never used trench boxes).

Question 53: How often do you use a trench box?

Response	No. of Companies	Avg. Injury Frequency
0 - 24%	56	93
25 - 100%	25	70

Level of significance of the difference between the two categories: $p < 0.05$

Another frequently used method of shoring was skeleton or skip shoring. This type of shoring refers primarily to the use of hydraulic aluminum shores (only a very small amount of this type of shoring involved wood bracing). Nineteen percent of the contractors stated that they used this method more than 50% of the time, and 64% of the contractors said they used skeleton shoring no more than 25% of the time (21% never used this method).

Question 54 (rephrased): How often is skeleton or skip shoring used?

Response	No. of Companies	Avg. Injury Frequency
0 - 24%	42	85
25 - 100%	29	94

Level of significance of the difference between the two categories: $p < 0.08$

The least used protection method was solid sheeting or tight shoring. Ninety five percent of the contractors used solid sheeting or tight shoring less than 25% of the time (38% never used this method).

Question 55: What percent of them (braced trenches) get solid sheeting?

Response	No. of Companies	Avg. Injury Frequency
0 - 24%	67	80
25 - 100%	9	142

Level of significance of the difference between the two categories: $p < 0.02$

It should be emphasized that the relations between injury frequencies and shoring methods do not indicate that certain methods are not to be used. It shows that when some methods are used, injuries can be expected to increase. Clearly, the method employed is dictated more by the soil conditions encountered than by personal preference for a shoring method. The results did not make comparisons of the injury frequencies associated with one shoring method to those associated with another shoring method.

As a partial explanation of these findings, consider the protection methods (trench boxes, skeleton shoring, solid sheeting) merely on the basis of materials handling. Skeleton shoring and solid sheeting require a great deal of materials handling other than the pipe being laid. It is perhaps the handling of the shoring materials that increases the number of job injuries. Several contractors commented that in handling wood shoring, workers frequently got splinters in their hands and often dropped lumber on their toes. In installing skeleton shoring, primarily done with hydraulic shores, the injury most commonly encountered was that workers pinched their fingers in the collapsible shores when installing or removing them. Another explanation can also be offered: since installing skeleton shoring or tight sheeting requires more materials handling, a larger crew is required to perform the work. Other studies [3,4] have shown that smaller crews tend to be "safer."

In summary, projects using the skeleton shoring method or the tight sheeting method would be expected to have more injuries because of an increase in materials handling.

4.0 NATIONAL UTILITY CONTRACTORS OF AMERICA (NUCA) SURVEY

In January 1977, the National Utility Contractors Association (NUCA) sent out about 2,000 questionnaires entitled, "Questionnaire for Contractors Who Do Work Which Involves Trenching." Responses were received from 223 contractors from more than 40 states, including some national and international contractors. Respondents were primarily utility contractors, although several general contractors also responded. More than half of the forms were completed by company presidents and owners. Most of the remaining responses were completed by individuals who were in uppermanagement positions. About 70% of the responses came from locations east of the Mississippi River, particularly from the Northeastern States where the NUCA membership is strongest. Although nonmembers were also sent a questionnaire (contractors on the NUCA mailing list), participation from such contractors did not appear to be very high.

This chapter presents the results of the responses to the NUCA questionnaire (a sample of which may be found in Appendix E). Much of the information gathered from the NUCA study was similar to that from the NBS study reported in previous chapters. The questions were designed to gather information on the following subjects: characteristics of the business, technical aspects of trenching, impact of OSHA, and company safety programs.

4.1 CHARACTERISTICS OF COMPANIES RESPONDING TO THE NUCA SURVEY

Responses to the NUCA questionnaires indicated that generally the companies which do trenching are relatively small, with a typical company doing an annual business of about $2 million (Table 10). A typical company would employ about 30 field workers with the employment varying, due to the seasonal nature of the work, from a low of about 16 employees to a high of about 50. The field workers in such a company would accrue about 51,000 manhours in a single year.

Although the utility contractors tend to be relatively small, the range in size is quite large. The smaller firms responding to the questionnaire had a minimum annual dollar volume of $150,000 while the larger firms did well over a billion dollars of work each year. More than half of the respondents, however, had a volume of business that was less than $3 million with 5% being over $30 million.

Table 10: Annual Dollar Volume of Utility Contractors

Annual Dollar Volume	No. of Companies	Percent of Total
Less than $1 million	41	19.1
1-2	55	25.6
2-3	29	13.5
3-4	22	10.2
4-5	20	9.3
5-7	18	8.4
7-12	14	6.5
12-30	5	2.3
Over $30 million	11	5.1
	215	100.0

Although firms doing trenching work are referred to as utility contractors in this report, it is recognized that other types of contractors (such as general contractors) also do trenching work. In general, however, utility contractors tend to specialize in trenching work. Seventy-four percent of the respondents stated that the majority of their annual volume of work involved trenching, and 37% stated that over 90% of their work was in trenching (Table 11).

Table 11: Percent of Company Volume of Work That is Trenching

Percent that is Trenchwork	No. of Companies	Percent of Total
0-25%	33	14.8
26-50%	24	10.8
51-75%	44	19.7
76-90%	39	17.5
over 90%	83	37.2
	223	100.0

Not only do these contractors specialize in trench work, but their work is concentrated in a fairly small geographic region, i.e., many of the contractors did a majority of their work within a 25-mile radius of their home office (Table 12). Reasons why a utility contractor would prefer staying in a fairly localized area were presented in Section 2.2.

Table 12: Amount of Company Work Done Within 25 Miles of the Home Office

Percent of Company Volume	No. of Companies	Percent of Total
0-25%	58	26.2
25-50%	62	28.1
50-75%	34	15.4
75-100%	67	30.3
	221	100.0

Utility contractors are involved in such trenching operations as the installation of water lines, sanitary sewers, storm sewers, gas lines, electric lines, and telephone cables. Contractors may specialize in particular trenching operations, but few limit their work to that extent. Only 12% of the contractors indicated that they perform only one type of installation. Although various combinations of work were noted, typical combinations for a single contractor were: storm and sanitary sewers; storm sewers, sanitary sewers and water lines; sanitary sewers and water lines. Other frequently occurring combinations with water line installations were installation of gas, telephone, and electric lines. Most utility work, however, involves sewer installations and water line installations.

Most of the work performed by utility contractors is awarded through public works contracts and is obtained through competitive bidding.

For example, 70% of the contractors received at least 90% of their work through competitive bidding. Only 7% of the contractors received less than 50% of their contracts through competitive bids; such contractors apparently negotiate most of their work with private development firms on projects such as subdivisions. There was a strong positive correlation between the amount of trenchwork performed by the contractors and the amount of work that was obtained by competitive bidding ($p < .001$); this is an indication that the contractors who negotiated much of their work were involved in other tasks such as those pursued by general contractors. Of course, utility work done in subdivision developments (private work) might be obtained through competitive bids or by negotiations.

Companies reported average employment of 4 employees to more than 20,000 employees (Table 13). The very large contractors had many employees, but they were also more diversified in the type of work they did. The large contractors had trenching as a smaller percentage of their annual volume of business than did the small contractors, apparently the large companies were general contractors.

Table 13: Average Number of Field Employees in the Company

No. of Workers	No. of Companies	Percent of Total
10 or less	32	19.1
10-25	46	27.4
25-50	40	23.8
50-75	14	8.3
75-100	11	6.6
100-200	14	8.3
over 200	11	6.5
	168	100.0

There is a fairly equal distribution of union and open shop (merit shop) contractors. Three percent of the contractors operated "double-breasted" (both union and open shop). The larger companies generally ran union operations although exceptions were noted.

In spite of the highly seasonal nature of the work involving trenching, particularly in the Northern States, contractors maintain a fairly consistent composition in their work forces. For example, 68% of the contractors stated that over 60% of their field workers had been employed in the company for over a year and 32% stated that 32% of the workers had been with the company for more than five years. Although the work is seasonal in some areas, with complete work stoppage occurring during the winter months, the utility contractors apparently rehire the same workers when work resumes in the spring.

Not only are utility contractors generally small in terms of the number of field employees, but also in the number of home office employees.

About half of the contractors had a maximum of 3 employees in the home office and 90% had no more than 15 home office employees (Table 14). The home office employees, particuarly in the smaller firms, still have direct responsibilities for the field operations, and consequently, often spend a large portion of their time in the field.

Table 14: Number of Home Office Employees in the Company

No. of Employees	No. of Companies	Percent of Total
1 or less	29	13.3
2	32	14.7
3	44	20.2
4	27	12.3
5	20	9.2
6-10	30	13.8
11-15	16	7.3
16-99	10	4.6
100 and over	10	4.6
	25	
	218	100.0

The small size of the utility contractors lends a degree of informality to the overall operation; and because much of the work is within a 25-mile radius of the home office, there is improved job control. This work radius permits the managers to personally and closely watch the jobs and be more responsive to field problems that arise. The degree of contact between workers and management was indicated by the frequency of visits by the company president to each job site (Table 15). Seventy-three percent of the contractors stated that the company president visited the jobs at least once a week.

Table 15: How Often the Company President Visits the Jobs

Frequency of Visits	No. of Companies	Percent of Total
Daily	80	36.4
3 times a week	38	17.3
2 times a week	43	19.5
2 times a month	22	10.0
Monthly	12	5.4
Less than Monthly	25	11.4
	220	100.0

The size of the firms is also reflected in the degree of sophistication of their engineering capability. The larger firms may have a staff of engineers, but the small firms seldom do. Only 22% of the contractors indicated they had in-house engineers (registration not ascertained), while 45% stated they had never hired an engineer, even for consultation. The remaining firms stated specific instances in which the services of an engineer were obtained.

In summary, most utility contractors are small, although there is considerable variation in size; the operations of a single company tend to be maintained in a fairly small area and in an informal manner; and most are very specialized constructors, doing principally trench work.

4.2 TECHNICAL ASPECTS OF TRENCHING

This section summarizes the responses to those questions in the NUCA study dealing with site conditions encountered during trenchwork, dimensions of trenches and frequency of use of different trench protection methods.

Trenching contractors must be concerned with protecting their workers from trench-wall collapse, and many factors dictate which protection method will be most economical and effective. Perhaps the most critical factor is the unpredictable nature of the soil encountered. Although specific information was obtained from more than 40 states, there is little consistency as to which types of soil occur in any one area. The most commonly encountered soils are soft to medium clays, clayey sands or sandy clays, and stiff clays. Approximately 10% of the contractors stated that all types of soils could be found in their working area. Several contractors indicated that rock, sand and gravel, and very hard clays were most frequently encountered.

In addition to the soil type, contractors were asked to describe the moisture content of the soil as "wet" or "dry."* Twenty-four percent of the contractors indicated that the soil was mostly wet, 30% stated that the soil was mostly dry, and 46% indicated that both conditions existed either in different regions or during different seasons. Only a few areas could be specifically identified as being principally wet or principally dry. Massachusetts tends to be principally wet with a predominance of stiff clays and clayey sands or sandy clays. Pennsylvania tends to have dry conditions with stiff clays, very hard clays, and rock. Washington and Orgeon have primarily sand and gravel and clayey sands or sandy clays which tend to be wet. Even in these locales where fairly consistent soil types were encountered exceptions were noted.

Contractors were also asked about the depth to the water table on most of their jobs. Responses showed that 34% of the contractors encountered the water table typically from 5 to 10 feet below the surface, 34% encountered it from 10 to 15 feet below the ground surface and 25% encountered it at depths greater than 15 feet (Table 16).

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* Although differences can readily be expected, particularly due to seasonal changes, some indication of moisture content was deemed informative.

Table 16: Typical Depth to Water Table

Depth of Water Table	No. of Companies	Percent of Total
0-5 feet	13	7.1
5-10	62	33.7
10-15	62	33.7
15-20	27	14.6
over 20 feet	20	10.9
	184	100.0

The type of protection provided for the workers in trenches is also dependent on the trench configuration. Contractors were asked to describe what they considered to be a typical trench (Table 17). Only 16% of the contractors stated that they generally dug trenches less than 5 feet deep, for which protection is not legally required. About three-fourths of contractors reported typical trench depths between 5 and 15 feet and only 7% of the contractors tended to work in trenches over 15 feet deep. By combining the information in Tables 16 and 17, it can be seen that subsurface water is encountered in many of the trenches: 93% of the contractors dig trenches less than 15 feet deep, and water is encountered at less than 15 feet by 75% of the contractors.

Table 17: Typical Trench Depth

Depth of Trench	No. of Companies	Percent of Total
1-5 feet	31	16.2
5-10	78	40.6
10-15	70	36.5
15-20	11	5.7
over 20 ft.	2	1.0
	192	100.0

Contractors were also asked about the typical width of trenches at the bottom of the excavation. Trenches were relatively narrow -- 42% of the contractors indicating that trenches generally were less than 3 feet wide and another 51% indicating that the widths were generally from 3 to 6 feet wide (Table 18).

Table 18: Typical Trench Width

Width of Trench	No. of Companies	Percent of Total
1-3 ft.	89	42.4
3-6	106	50.5
6-9	8	3.8
9-12	5	2.4
over 12 feet	2	0.9
	210	100.0

In response to the question on length of trench left open behind the backhoe, 27% stated that the length was less than 25 feet, 33% stated that it was from 25 to 50 feet, and 20% indicated that it was from 50 to 100 feet (Table 19). Thus, 20% of the contractors have more than 100 feet of open trench behind the backhoe.

Table 19: Length of Open Trench Behind the Backhoe

Length of Open Trench	No. of Companies	Percent of Total
less than 25 feet	58	27.2
25-50	70	32.9
50-75	25	11.7
75-100	18	8.5
100-150	16	7.5
150-200	10	4.7
over 200 feet	16	7.5
	213	100.0

Respondents were asked the type of protection they used in most trenches based on dollar volume. To give a clearer impression of the number of times each system is used, the data are presented as shown in Table 20.

Table 20: Frequency of Use of Sloping and Different Shoring Systems

Type	Percent of Use by Dollar Volume of Small Companies (under $13 million)	Percent of Use by Dollar Volume of Large Companies* (over $30 million)
Sloping	51	50
Trench Box	28	3
Skip Shoring (Timber)	5	23
Tight Sheeting (Timber)	3	5
Hydraulic Shoring	8	0
Screw Jacks	2	6
Steel Sheet Piling	3	13
	100	100
	No. of Companies = 203	No. of Companies = 11

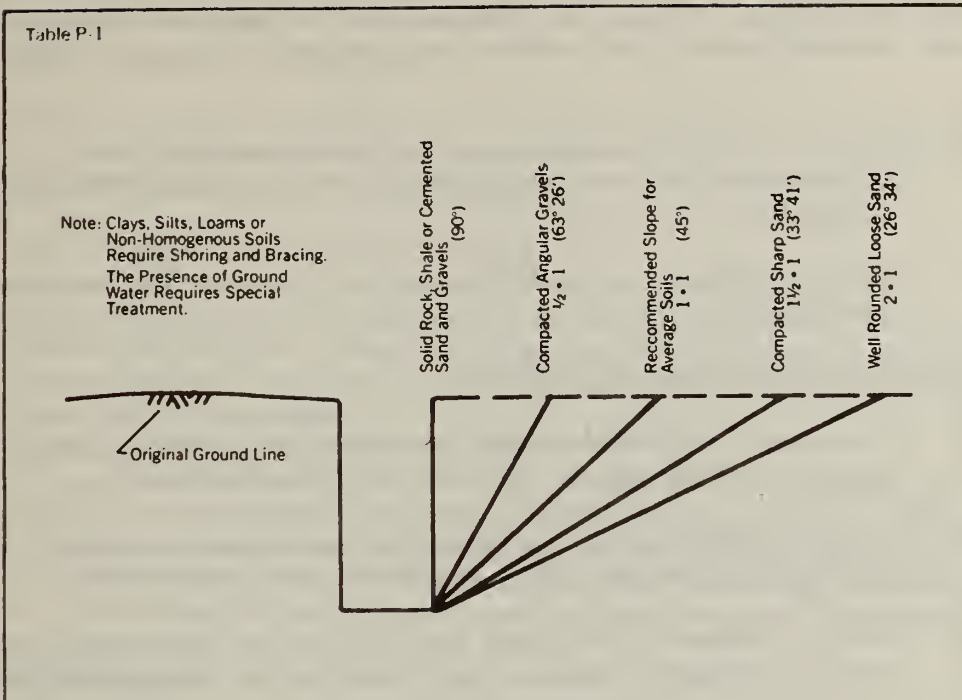
* Companies having annual dollar volumes of from $13-$30 million were not considered small or large contractors and since only 5 respondents were in this volume range, they were excluded from this tabulation. It should be pointed out that the firms with annual dollar volumes of more than $30 million had trenching constituting 0-25% of their total volume, consequently, these are only approximate percentages.

It is seen that sloping is the most widely used trench protection technique; and it is interesting to note that trench boxes are the second choice of the small companies, while for the large companies it is skip-shoring. It should be noted that a majority of the respondents indicated that they never used skip shoring, tight timber shoring, hydraulic shoring, screw jacks, or steel sheet piling.

4.3 IMPACT OF OSHA

Contractors were asked to indicate the usefulness of OSHA Tables P-1 and P-2 (see Table 21). Only 3 percent indicated that they were very helpful, while 20 percent indicated they were a guide for the company, and 20 percent said they were too general to be helpful. Several of those contractors using the tables as a guide remarked that they used them as such only to avoid OSHA fines. Fifty percent of the contractors indicated that the tables were "not realistic for our work situations." Some contractors made specific comments on such items as problems with existing buried utilities not being addressed, inconsistent interpretation of the standards, the standards not relating to specific conditions, standards not being a substitute for common sense, or that they never saw the standards.

Table 21: OSHA Tables P-1 and P-2



APPROXIMATE ANGLE OF REPOSE FOR SLOPING OF SIDES OF EXCAVATIONS

Table P-2

TRENCH SHORING – MINIMUM REQUIREMENTS

Depth of trench	Kind or condition of earth	Uprights: Minimum dimension	Uprights: Maximum spacing	Stringers: Minimum dimension	Stringers: Maximum spacing	Cross braces[1] (Width of trench): Up to 3 feet	3 to 6 feet	6 to 9 feet	9 to 12 feet	12 to 15 feet	Maximum spacing: Vertical	Maximum spacing: Horizontal
Feet		Inches	Feet	Inches	Feet	Inches	Inches	Inches	Inches	Inches	Feet	Feet
5 to 10	Hard, compact	3 x 4 or 2 x 6	6	....	....	2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	6
	Likely to crack	3 x 4 or 2 x 6	3	4 x 6	4	2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	6
	Soft, sandy, or filled	3 x 4 or 2 x 6	Close sheeting	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
	Hydrostatic pressure	3 x 4 or 2 x 6	Close sheeting	6 x 8	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
10 to 15	Hard	3 x 4 or 2 x 6	4	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	6
	Likely to crack	3 x 4 or 2 x 6	2	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8		6
	Soft, sandy, or filled	3 x 4 or 2 x 6	Close sheeting	4 x 6	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	6
	Hydrostatic pressure	3 x 6	Close sheeting	8 x 10	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	6
15 to 20	All kinds or conditions	3 x 6	Close sheeting	4 x 12	4	4 x 12	6 x 8	8 x 8	8 x 10	10 x 10	4	6
Over 20	All kinds or conditions	3 x 6	Close sheeting	6 x 8	4	4 x 12	8 x 8	8 x 10	10 x 10	10 x 12	4	6

[1] Trench jacks may be used in lieu of, or in combination with, cross braces.
Shoring is not required in solid rock, hard shale, or hard slag.
Where desirable, steel sheet piling and bracing of equal strength may be substituted for wood.

The contractors were asked to recommend what changes should be made in the OSHA standards. Of the 223 contractors, 36 made no comments. Comments received were quite varied, but the most frequently mentioned were:

8% - Need for the development of an understandable soil classification system for easy contractor and OSHA interpretation.

11% - Need to change or permit leeway in the sloping requirements (Table P-1).

12% - Rewrite Tables P-1 and P-2.

21% - Compliance officers should exercise more common sense, be more job-oriented, and not be close-minded.

18% - Local conditions in the specific area should be the determining factor (OSHA standards are too general).

30% - Varied comments including such topics as engineered excavations, hydraulic shores, and deletion of the standards.

Contractors were asked to provide information on their general impression of the OSHA compliance officers. Only 6 percent of the contractors indicated that "they really do identify safety hazards." Thirty-six percent indicated that "they mean well but they don't understand construction work," 22 percent felt that "they interpret the OSHA regulations to the letter of the law," and 5 percent felt that "they are just out on the jobs to fine the contractor." Thirty percent of the contractors made specific comments about the compliance officers, describing them as: having no common sense, having too little experience, trying to justify their existence through contractor fines, being overly "nit-picky," being unable to recommend better solutions to relieve the conditions, and being totally unconcerned about safety but only wanting to find faults by the letter of law. A few contractors had had no experience with OSHA and were unable to comment.

Several questions were asked about the experiences the contractors had with OSHA inspections. Of the contractors who responded, 88 percent indicated they had been visited by OSHA on at least one of their jobs. The data showed that over half the contractors received more than 4 inspections. Further analysis of the OSHA inspections showed that 18 percent of the contractors had inspections which occurred after job accidents, such as those which included job fatalities or multiple-party injuries.

Contractors were asked how many OSHA visits resulted in citations. Responses were as follows:

30% - received no citations

26% - received 1 citation

16% - received 2 citations

22% - received 3 to 9 citations

6% - received more than 10 citations.

On the average, contractors received 3.1 citations (median = 1.3) as the result of OSHA inspections. Since an average of 6.9 inspections (median = 3.1) occurred in each company, less than half the OSHA inspections actually resulted in citations.

OSHA fines associated with citations ranged from $7 to a maximum of $18,000. Half the contractors received maximum fines of about $100, while the average maximum fine was about $1,300. Five of the fines were at least $10,000. Several contractors noted that when they contested their fines, the fines actually paid were reduced in many instances.

4.4 SAFETY PROGRAMS

Contractors were asked about their specific efforts to instill safety awareness on their jobs. Seventy-eight percent of the contractors stated they had job safety meetings or "tool box" ("tailgate") meetings on their jobs. Of these contractors, 45 percent held these meetings weekly, 9 percent held them on a biweekly basis, 22 percent held them on a monthly basis, and 24 percent held them less frequently. Thus, 22 percent of the contractors did not conduct the tool box meetings, and 35 percent held them less frequently than biweekly (every 10 working days) as often recommended.

The survey results indicate that tool box meetings are conducted in a fairly nonstructured manner. Only 20% of the companies scheduled the meetings for a particular day of the week. In addition, there was no well-established pattern as to who presides over these meetings, as shown by the following list of persons who conduct such meetings:

21% - foreman

20% - company president (or owner)

31% - job supervisor

7% - appointed safety representative

21% - various individuals preside at different times.

When asked about company meetings (other than tool box meetings) dealing with safety, 76 percent of the companies indicated that they held such meetings. When asked about safety incentive programs, however, only 17 percent indicated that such programs were maintained. The actual nature of the safety incentive awards and the persons who were eligible for these awards varied with the different companies.

The contractors were asked about aspects of their safety programs dealing with new workers, unsafe workers, and injury responsibility. With regard to new employees, the contractors were asked about the safety orientation that such workers received. The results indicated that 11% of the contractors provided no orientation, 72% provided an informal safety orientation and 17% had a formal orientation.

In response to a question about disciplining unsafe workers, 6 percent of the contractors indicated that workers had been fired for being unsafe. In addition, the contractors were asked whom they held responsible in the event of an injury. They responded as follows:

> 12% - placed the responsibility on the injured worker
>
> 32% - placed the responsibility on the foreman
>
> 23% - placed the responsibility on the superintendent
>
> 33% - indicated that the specific conditions surrounding each incident would have to be known to properly place the responsibility on one individual.

Contractors were asked about the assistance they received from their insurance carriers. Forty-five percent of the respondents indicated that their carriers were "very helpful through their job inspections;" 18 percent indicated that they made inspections "but they are not very helpful;" 14 percent said that the insurance carrier only sent brochures and safety information; and 11 percent indicated that they became concerned only after accidents occurred. The remaining contractors (12 percent) indicated other kinds of assistance, which varied from receiving direct aid in conducting safety meetings and seminars to receiving no assistance at all.

In addition to their safety programs, the contractors were asked about past safety performance, which was measured in several ways. First, the contractors were asked about their Workmen's Compensation Experience Modification Rates, (i.e., the multiplier used to adjust the manual rate on Workmen's Compensation Premium rates). These provide some indication of the frequency and severity of past injuries. These ratings ranged from a low of 0.48 (very good performance) to a high of 1.95, with an average of about 0.90.

Second, the contractors were asked how many OSHA recordable and lost-time injuries were incurred during the past year. These injuries were compared with the manhours worked during the corresponding period of time to provide a means of comparing the different contractors. The incidence of lost-time injuries was relatively low: 35% of the contractors had no lost time injuries, 22% had one lost-time injury, and

12% had two lost-time injuries. Consequently, injury frequencies developed by using the lost-time data would be very sensitive to small changes or minor errors in the number of lost-time injuries. The recordable injuries, on the other hand occurred more frequently, as 67% of the contractors had at least two recordable injuries. For this reason, more reliable information was obtained by using the recordable injury data which represented more frequently occurring events, i.e., accidents. The injury data were used to develop an injury frequency index for each company which represented the number of recordable injuries that occurred in one million manhours of exposure. Recordable injuries were a more viable statistical measure of safety performance than the Experience Modification Rates since about a fourth of the respondents did not provide Experience Modification Rate information.

4.5 FACTORS INFLUENCING SAFETY PERFORMANCE

After the NUCA data were coded, the injury frequency was determined for each contractor that provided the necessary data (only 203 of them did). The average injury frequency index for all respondents was 90 (median = 77).

The responses to the questionnaire that have been presented in previous sections were evaluated to determine the relations between the different variables and injury frequencies. Standard statistical routines were used to individually correlate (Kendall's Correlation) all of the variables with the injury frequency. This report presents findings which have a statistical significance of at least 5 percent (denoted by $p < 0.05$), although in most cases the findings were much stronger (generally $p < 0.001$). A 5 percent level of significance means the chance that the data represent a random occurrence is 5 percent, i.e., on the average 5 false conclusions could be made in a hundred instances where such a distribution of data exists. Appendix E contains a summary of the statistical analyses. The reader is again cautioned against drawing firm conclusions from these correlations for the reasons given in section 2.1.1.

Section 4.1 summarized the responses to those questions dealing with the management characteristics of the companies involved in trenching operations. When these variables were correlated with injury frequency, it was found that the following factors were associated with an increase in injury frequency index ($p < 0.05$):

1. Increase in the annual dollar volume of the company.

2. Increase in the number of field workers, home office workers and man-hours worked in the company.

3. Decrease in the amount of work done within 25 miles of the home office.

4. Decrease in the number of workers who visit the home office.

5. Decrease in the number of times the company president visits job sites.

6. Decrease in the number of workers who have worked for the company more than one year.

7. Decrease in the number of workers who have worked for the company more than five years.

Information was obtained which dealt with how much of each firm's work volume involved trenching, from which the effect of company diversification on safety performance could be determined. It was found that injury frequency increased as contractors did less trenchwork in relation to their total volume ($p < 0.03$). Thus, it appears that diversified contractors are more prone to job accidents than contractors specializing in trenchwork. A possible explanation could be that while a diversified contractor may be experienced and knowledgeable in various phases of work, the job control exercised in each area of work is diminished.

Contractors were asked questions about the typical dimensions of their trenches and the type of trench protection they used. The only variable that showed some relationship ($p < 0.04$) to accident frequency was the length of trench left open behind the backhoe. It is not clear why this relationship exists.

Several questions were asked about the experiences the contractors had with OSHA inspections. Results show that those contractors who had more OSHA inspections following a job accident had the higher injury frequencies. Since inspections of this nature occur after fatalities or after a multiple-party injury, this result indicated that the more severe accidents are associated with the higher accident frequencies. Another finding showed that the firms with the higher injury frequencies had the higher OSHA fines levied against them. It might be expected that the higher fines would be levied against those contractors who had the more severe accidents, and certainly those contractors who had OSHA inspections following job accidents probably had severe accidents.

5.0 NATIONAL ASSOCIATION OF PLUMBING, HEATING AND COOLING CONTRACTORS (NAPHCC) SURVEY

In January 1977, the National Association of Plumbing, Heating, and Cooling Contractors (NAPHCC) sent out questionnaires to 550 of its members. These questionnaires contained 21 questions primarily concerning trenching operations, safety programs and the OSHA trenching regulations. Ninety-four of the questionnaires were completed and returned to the NAPHCC office; more than 30 states were represented by the responses. The National Bureau of Standards was provided with a summary of the data (Appendix F), but the raw data were not made available. About 50% of the responding contractors had less than 30 employees while about 20% had more than 500 employees. Correspondingly, the annual dollar volume of business was less than $1.5 million for tions, contractors are fined for not obeying the regulations. The end result is animosity between contractors and OSHA rather than the desired result, safety. The trenching standards must be revised so that they enable safe trenching operations without undue economic penalties. Further, it is suggested that any standards which are written be periodically revised and improved to accommodate the experiences of those using the standards and to keep up with technology.

REFERENCES

[1] Department of Labor, Occupational Safety and Health Administration, Construction Safety and Health Regulations, Part II, Subpart P, Washington, D.C., June 1, 1974.

[2] Hollander, M. and Wolfe, D., "Nonparametric Statistical Methods," John Wiley and Sons, New York, 1973.

[3] Hinze, J., "Effect of Middle Management on Safety in Construction," Technical Report No. 209, Stanford University, 1976.

[4] Levitt, R., "Effect of Top Management on Safety in Construction," Technical Report No. 196, Stanford University, 1975.

about 50% of the contractors and 20% had more than $5.0 million. Six contractors reported an annual volume of more than $10 million. The respondents included nearly equal numbers of union and merit shops and 23 firms had double-breasted operations.

Most of the responding contractors were involved in utility work including storm sewers, sanitary sewers, water lines, and gas lines. However, for 80% of the firms, utility or trench work comprised less than 20% of the annual dollar volume. In addition, 45% of the contractors stated that they usually subcontracted the trenchwork.

In describing their particular trenching operation, about 90% of the contractors indicated the trenches were generally less than 10 feet deep and less than 3 feet wide. Over half the contractors slope (instead of brace) more than 90% of their trenches. The soil types encountered were quite varied: "soft-medium clays were most common, followed by "all types" and "sand and gravel". Half the contractors stated that ground conditions were "dry" and the other half found "wet and dry" conditions. Dry conditions tend to prevail since 69% of the contractors indicated the water table was deeper than 10 feet and thus below the bottom of most trenches. Most contractors never employed the services of a soils engineer. Of those who had, such engineers were usually employed "only before major bids" or "only when legal problems arose after the job started."

With regard to safety, 81% of the contractors indicated they had safety programs. Newly hired employees are generally (85%) given an informal safety orientation. Assistance from the insurance carriers is rarely (7%) in the form of job inspections, but rather (82%) in the form of brochures and safety information sent to the company.

Concerning OSHA, 88% of the contractors had at least one OSHA inspection, and 79% had them at least once every two months. Thirty one percent reported receiving at least one fine that was associated with a trenching violation such as insufficient sloping or inadequate shoring. When asked about the OSHA compliance officers, 10% stated "they really do identify safety hazards;" 50% said "they mean well but they do not understand construction work;" and 33% indicated" they interpret OSHA regulations to the letter of the law."

When asked about Tables P-1 and P-2 of the OSHA regulations, 9% of the contractors felt they were "very helpful;" 48% said they were "a guide for our company;" and 31% indicated they were "not realistic for our work situations." These contractors were also asked to suggest specific changes to the OSHA trenching standards. Several contractors suggested that more "common sense" should be exercised in the enforcement of the OSHA standards and that employees should be held responsible to a degree, particularly when they deliberately ignore specific safety instructions. Several comments concerned the individuality of specific work sites: the standards should address their own work conditions more directly, or at least have provisions to allow for clear interpretation of the standards.

6.0 SUMMARY AND CONCLUSIONS

The purpose of this study was threefold: (1) to characterize the trenching industry, (2) to identify factors affecting injury frequencies, and (3) to determine the usefulness of the current OSHA standards on trenching operations. Information was gathered through personal interviews and letter questionnaires.

Trenching work is performed by companies of varying size, but most is done by small firms specializing in this type of work. Most trenchwork is associated with the installation of utilities, and trenches range from shallow as for water lines to deep as for sanitary sewers. The small utility contractors generally do their work within a 50 mile radius of the home office. Large, diversified general contractors do significant amounts of trenchwork, but only as a small part of their total annual business. An important characteristic of the small trenching firms is the high degree of management-field worker interaction.

Because of uncertainties in the data (as discussed in 2.1.1), firm conclusions were not formulated with respect to the effects of various factors on safety performance. The data, however, have been analyzed and presented to reveal general trends.

In regard to the trenching industry's opinion of the current OSHA standards on trenching operations, a large majority of contractors felt that extensive revisions are needed. Appendix C lists specific recommendations for improving various aspects of the standards. The following revisions were often recommended:

1) develop an improved soil classification system;

2) revise the shoring requirements so that work could proceed within the trenches with less obstruction;

3) acceptance of engineered trench boxes and plywood sheeting with hydraulic shores as alternate shoring systems;

4) revise the section dealing with escape provisions in the event of a cave-in so that practicality is considered.

In general, the provisions should be revised and written with enough flexibility to accommodate local conditions. Also, it was strongly recommended that OSHA compliance officers have a technical background.

7.0 RECOMMENDATIONS

Based on the results of this study, it is recommended that the OSHA regulations be revised in order to improve their effectiveness.

The current OSHA regulations pertaining to safety in excavations have been found to be impractical and uneconomical for contractors to follow, and so they have been largely disregarded. Upon subsequent OSHA inspec-

APPENDIX A

RESPONSES TO QUESTIONS RELATED TO FIELD PRACTICES

Question 1: What is the most commonly found soil in the area?

Response	No. of Companies	Percent of Total
Various types noted	32	36
Clay	29	33
Clay and Shale	5	6
Loess	2	2
Clay and Sand	12	14
Hard Pan	4	4
Rock and Clay	4	4
Rock	1	1
	89	100

Question 2: How do you determine the angle of repose?

Response	No. of Companies	Percent of Total
Rely on experience (judgment)	42	53
Use some prescribed constant slope	18	23
Whatever is in compliance with OSHA	7	9
Follow some set procedure:	12	15
	79	100

Other Responses

- strike the banks with a backhoe bucket and see the angle with which the bank caves in.
- see the angle that the banks cave and slope a little more.
- let it slough until it is stable.

Question 3: Is the OSHA table (P-1) helpful in this (determining the angle of repose)?

Response	No. of Companies	Percent of Total
The table is used a lot	2	3
We use it only as a guide	14	18
It is of no help	60	79
	76	100

Question 4: What type of (solid) sheeting is used?

Response	No. of Companies	Percent of Total
None	25	29
Steel Sheet Piling	9	10
Tight Timber Sheeting	18	21
Steel Sheet Piling and Tight Timber Sheeting	28	33
Solid piles and lagging, plywood supported with screw jacks on hydraulic shores, or fiberglass panels supported by hydraulic shores.	6	7
	86	100

NOTE: Steel sheet piling is used in trenches that are to remain open for longer periods of time or when excessive ground water is encountered. Timber sheeting is used on shallow trenches (from 8 to 14 or 16 feet deep) while steel sheet piling is used in deeper trenches.

Question 5: If you have skelet on (skip) shoring in a trench, what type do you use most often?

Response	No. of Companies	Percent of Total
None is used	15	17
Hydraulic shores*	44	51
Timber shoring	4	5
Screw jacks	6	7
Hydraulic shores, timber shoring and screw jacks	2	2
Hydraulic shores and screw jacks	8	9
Hydraulic shores and timber shoring	6	7
Timber shoring and screw jacks	2	2
	87	100

* Twenty-three contractors (26%) mentioned that they used plywood on occasion in trenches. These plywood panels are generally supported by hydraulic shores. Some panels would have stiffeners added for additional resistance to bending.

Question 6: Do you buy the (trench) boxes or do you build your own?

Response	No. of Companies	Percent of Total
Company buys the trench boxes	21*	36
Company builds its own boxes	20	35
Company borrows or rents the boxes	7**	12
Company buys some and builds some of its own	10	17
	58	100

* Although many contractors bought their own trench boxes, it was not uncommon for the contractor to make modifications on these units. Modifications generally were made to strengthen the boxes and to facilitate easier movement of the boxes in the trench.

** Contractors who borrowed or rented trench boxes were those who did not use the trench boxes extensively in their operations.

Question 7: Is the shoring (timber) removed when the trench is backfilled?

Response	No. of Companies	Percent of Total
Mostly buried	18	42
Generally buried	2	5
Some buried; some left in place	4	9
Generally removed	7	16
Mostly removed	12	28
	43	100

Question 8: What kind of wood do you use?

Response	No. of Companies	Percent of Total
Hardwood*	41	71
Softwood**	15	26
Softwood with some hardwood	2	3
	58	100

* Hardwoods included the use of primarily oak but some other types was also noted (birch, gum, hickory, cottonwood, cypress, pecan).

** Softwoods included the use of primarily fir but pine, spruce and hemlock were also mentioned.

Question 9: How often is it (wood shoring) reused?

Response	No. of Companies	Percent of Total
It is not reused, it remains buried in the trench	13	29
It is rarely reused	4	9
We reclaim only the walers	3	7
We can get only a specified number of uses (many reuses on the same job when shoring is used in leap-frog fashion, used as long as it is green and thus still strong, reused but not for shoring, one reuse to 4 reuses, two jobs)	18	41
Reused quite often	6	14
	44	100

Question 10: How do you decide when lumber cannot be used?

Response	No. of Companies	Percent of Total
Imperfections in the wood	2	4
Decaying and drying	14	31
Damages in usage	7	15
Damages in usage and decay	8	17
Depends on the extent of usage (weakened in use)	3	7
It is not reused	12	26
	46	100

Question 11: Of the cave-ins you have seen, what do you think is generally the cause?

Response	No. of Companies	Percent of Total
Poor supervision, failure to recognize poor soil, too much ditch left open, trench walls exposed to the air too long before bracing is installed	5	7
Failure to shore, inadequate shoring, insufficient slope, excessive overburden	18	24
Bad or unknown soil, excessive ground water, poor evaluation of soil conditions, clay with silt layers (slick heads)	24	32
Ignorance	12	16
Breaks in waterlines and rain	6	8
Existing utility trenches	3	4
Vibrations of equipment and traffic	7	9
	75	100

Question 12: What is the worst soil or water condition that you run into in your work?

Response	No. of Companies	Percent of Total
Running sand	46	53
Faults in clay	13	15
Gravel not cemented	5	6
Sand and clay faults	12	14
Excessive ground water	4	5
Other (mud on top of rock, disturbed soil of previous excavation, deep marine clay, rocks, organic matter and debris in soil)	6	7
	86	100

Question 13: Do you do your own soils investigation?

Response	No. of Companies	Percent of Total
We know the area real well	1	1
We make test borings	8	10
We dig test pits or trenches	15	19
We may hire a testing lab	2	3
We make test borings at some prescribed spacing	26	33
We rely on the owner's borings	9	12
We make a general field investigation	5	6
Our borings look only for rock	8	10
We make no investigations	5	6
	79	100

NOTE: Many contractors stated that in certain areas they felt sufficiently confident about their knowledge of the soil conditions. Therefore, no additional tests were necessary. Several contractors also stated that the owners' logs were used if they were provided and appeared adequate. Contractor tests included both pre-bid and post-bid investigations.

Question 14: Do you have an engineer in your company?

Response	No. of Companies	Percent of Total
Yes	49*	60
No	32	40
	81	100

* Of these, 32 companies had registered engineers.

Question 15: Does the company ever hire soils consulants?

Response	No. of Companies	Percent of Total
Yes	49	54
No	42	46
	91	100

Question 16: Does the company ever hire a consultant to design the (shoring) bracing?

Response	No. of Companies	Percent of Total
Yes	7	12
No	52	88
	59	100

Question 17: What dewatering method do you usually use?

Response	No. of Companies	Percent of Total
Sump pumps	25	29
Sump pumps and well points	32	37
Sump pumps and deep wells	14	16
Sump pumps, well points, and deep wells	16	18
	87	100

NOTE: Contractors indicated that dewatering was rarely subcontracted to other firms.

APPENDIX B

RESPONSES TO QUESTION ON SAFETY PRACTICES AND ATTITUDES

Question 25: Are tool box meetings held on the jobs?

Response	No. of Companies	Percent of Total
Yes	79	89
No	10	11
	89	100

Question 26: How often do you have them (tool box meetings)?

Response	No. of Companies	Percent of Total
Daily	7	9
Weekly	37	47
Two per month	9	11
One per month	12	15
Less than monthly	6	8
Unknown	8	10
	79	100

Question 27: Day of week (that tool box meetings are held)?

Response	No. of Companies	Percent of Total
Monday	18	23
Wednesday	2	3
Thursday	2	3
Friday	6	7
No set day	38	48
Unknown	13	16
	79	100

Question 28: Who attends these (tool box) meetings?

Response	No. of Companies	Percent of Total
The workers of a single crew	60	78
All company personnel	17	22
	77	100

Question 29: Who presides at these meetings?

Response	No. of Companies	Percent of Total
President or owner	14	18
Foreman	38	49
Superintendent	12	16
General superintendent	5	6
Safety officer	4	5
Other (engineer, vice president, estimator)	5	6
	78	100

Question 30: How meaningful do you think they (tool box meetings) are?

Response	No. of Companies	Percent of Total
Very essential	4	5
They do some good	33	44
Not convinced of their value	33	44
They have no value	5	7
	75	100

Question 31: Do the foremen receive any formal safety training?

Response	No. of Companies	Percent of Total
Yes*	59	65
No	32	35
	91	100

* Training for foremen included first aid training, safety classes, safety seminars, and OSHA safety training.

Question 32: Who is in charge of the company safety program?

Response	No. of Companies	Percent of Total
President or owner	40	46
Vice President	12	14
Safety officer	17	20
Other (superintendent, engineer, estimator)	17	20
	86	100

Question 33: How often is he (safety officer) in the field?

Response	No. of Companies	Percent of Total
Daily	48	58
Weekly or more frequently	25	30
Monthly	9	11
Less than monthly	1	1
	83	100

Question 34: Is he (safety officer) involved in job planning?

Response	No. of Companies	Percent of Total
Yes	73	90
No	8	10
	81	100

Question 35: What does he (safety officer) do?

Response	No. of Companies	Percent of Total
Pushes on safety	18	32
akes routine inspections	16	28
Has minimal involvement in safety	15	26
Has very vague duties	8	14
	57	100

Question 36: To what extent is the company president involved in job safety?

Response	No. of Companies	Percent of Total
In charge of safety	10	12
Very much	59	71
Somewhat	8	10
Very little	6	7
	83	100

Question 37: Who, outside the company, gives the most valuable assistance on job safety?

Reponse	No. of Companies	Percent of Total
Insurance carrier	48	58
Contractor association	24	29
State or federal agency	5	6
Equipment suppliers	6	7
	83	100

Question 38: What assistance do you get from the insurance company on job safety?

Response	No. of Companies	Percent of Total
Minimial assistance	20	22
Routine assistance	44	48
Special consultation	11	12
Movies and lectures	6	7
Safety classes	1	1
No assistance	9	10
	91	100

Note: Most (90%) contractors indicated that the insurance carrier made jobsite inspections; however the frequency of such inspections was quite varied.

Question 39: How often do they (insurance inspectors) visit the jobs?

Response	No. of Companies	Percent of Total
Weekly	5	6
Twice a month	5	6
Monthly	16	19
Quarterly	31	36
Yearly or less	20	24
Never	8	9
	85	100

Question 40: How valuable are insurance inspections?

Response	No. of Companies	Percent of Total
Extremely helpful	24	27
Helpful	33	36
Some are helpful	6	7
Very little help	14	15
No help at all	14	15
	91	100

Note: About 85% of the inspections are described in formal reports sent to the contractor's office.

Question 41: What is the Experience Modification Rating* of the Company?

Response	No. of Companies	Percent of Total
less than 60	3	4
60 - 69	4	5
70 - 79	13	18
80 - 89	23	31
90 - 99	12	16
100 - 120	13	18
over 120	6	8
	74	100

* In relation to Workmen's Compensation premium rates.

Question 42: How many OSHA inspections have occurred in the company?

Response	No. of Companies	Percent of Total
0	9	10
1	14	15
2 - 5	31	34
6 - 10	15	17
11 - 20	13	14
over 20	9	10
	91	100

Question 43: (of those firms inspected) How many citations were received?

Response	No. of Companies	Percent of Total
0	17	21
1	13	16
2 - 3	25	30
4 - 5	17	21
6 - 10	4	5
11 - 20	4	5
over 20	2	2
	82	100

Question 44: How has OSHA affected your work?

Response	No. of Companies	Percent of Total
No effect	12	15
Increased costs	29	37
Slowed production	6	8
Hurt costs and production	5	6
It had a bad effect	22	28
It had a minor impact	5	6
	79	100

Question 45: Would you comment on your thoughts or experiences with OSHA inspectors?

Responses	No. of Companies	Percent of Total
Impractical, lack of experience, no common sense, etc.	54	64
Fair and reasonable	22	26
Some are good while others are bad	8	10
	84	100

Question 46: Has your accident history changed since OSHA became effective?

Response	No. of Companies	Percent of Total
Yes - it's improved	4	5
Yes - it's worse	15	18
No change	63	77
	82	100

Question 47: Do you get some kind of cost history that tells you how much each injury claim amounts to?

Response	No. of Companies	Percent of Total
Yes	40	69
No	12	21
Do not know	6	10
	58	100

Question 48: Are safety records considered when establishing raises?

Response	No. of Companies	Percent of Total
Yes	15	18
No	70	82
	85	100

Question 49: Is there a company safety incentive program?

Response	No. of Companies	Percent of Total
Yes	11	12
No	78	88
	89	100

Question 50: How does the field know that the company fully supports job safety?

Response	No. of Companies	Percent of Total
The company is strict on safety	10	11
The company president harps on safety	38	44
We stress it with the foreman	4	5
Through safety meetings and posters	25	29
Through the safety equipment the company supplies	5	6
Through the company's safety personnel	4	5
	86	100

Question 51: Would you say that some injuries are just a part of the job?

Response	No. of Companies	Percent of Total
Yes	51	56
No	27	30
They are caused by carelessness	13	14
	91	100

APPENDIX C

COMMENTS ON EMPIRICAL PRACTICES

Contractors were asked specific questions about their company operations. In addition, they were asked to expound on any empirical practices, or guidelines, particularly shoring practices which they consistently followed. It should be noted that many different soil conditions could be encountered, therefore work practices could vary considerably.

COMMENTS MADE BY UTILITY CONTRACTORS ABOUT THEIR OPERATIONS

We shore with primarily fir members. We usually use 8 by 8's. We use these up to depths of 15 to 18 feet. Beyond that depth we use steel sheeting. We rarely use 6 by 6 members.

We often use 2 by 12 fir planking and use trench jacks horizontally as cross-braces.

If the backhoe teeth marks stay clearly imprinted in the trench walls, it is a stable bank.

We use hydraulic shores up to 13 feet in depth. At greater depths, we use trench boxes.

We use steel sheet piling, instead of wood sheeting, as soon as the trench depth reaches 17 feet or when the width is over 7 feet.

We sometimes use the bucket of the backhoe for trench protection. This is effective protection for short periods, and it is also a safer procedure since the trench jacks may not hold the trench.

We never retrieve the bottom walers in the trench, because it is too unsafe.

If the trench walls are unstable, we use (7/8" to 1") plywood backing for the hydraulic shores.

On any trench deeper than 10 or 12 feet, we use 12 by 12 walers and braces.

A typical spacing for skip shoring in our company is from 3 to 5 feet on center.

In loess we don't slope, we cut a vertical trench up to 8 feet deep. At depths greater than that we start to bench the trench with 3 to 5 foot benches. We cut 12 feet for vertical banks in hard clays. If the clay is wet, however, we slope the entire trench.

In loess we slope or shore the trenches, no matter how hard the soil is. If the trench width approaches 8 to 10 feet, we use 12" steel I-beams for struts. Otherwise we use 10" by 10" or 12" by 12" wood members.

We use a shield behind our trenching machine so that no more than 12 inches of unbraced trench is exposed at a single time.

We use only green lumber on our shored trenches. It bends before breaking, giving advance notice of problems.

We use 2" wood sheeting for trench depths under 12 feet. At 12 foot depths and deeper, we use 3" sheeting.

We use trench boxes only in hard clay.

In mucky soil, we use a 4 foot toe on our sheeting or it would give way. Often a wood floor is essential.

We use 2" material where 14 foot long sheeting members are used. For longer lengths, 3" sheeting is used.

We brace our trenches so that walers are spaced not more than 4 feet apart. The top waler is 4 feet from the top of the trench and the bottom waler is 3 to 5 feet from the bottom of the trench. As soon as one of these dimensions is reached, we add another waler.

In 9 foot trenches we go to 8" by 8" shoring members, in 12-foot trenches we go to 12" by 12" shoring members, and in trenches over 20 feet deep we slope the banks. Our strut spacing in shored trenches is 8 feet on centers.

We use 4 struts on 16 foot walers. This allows us to lower 6-foot pipe sections into the trench.

We don't use 4" by 6" members on any trenches over 8 feet deep.

We use wood to shore trenches that are about 12 to 14 feet deep. Beyond that depth we use steel sheet piling.

We use 8" by 8" members for shoring trenches 8 to 14 feet in depth. At 16 foot depths (or if the width is 12 feet) we go to steel walers and 3 inch sheeting.

In tight timber sheeting we use 3-inch sheeting if the trench depth is 14 to 16 feet (interior strut spacing of 5 feet). For shallower depths we use 2 inch sheeting.

On trenches 18 feet deep we use 12" by 12" members with cross braces 8 feet apart. This would be typical for a trench that is 15 feet wide.

Our foremen (or superintendents) determine from a visual inspection what the angle of repose should be. It tends to be steep for glacial till and low for sand. After the ditch is dug the foreman remains at the surface continuously to watch for cracking and sloughing.

We use trench boxes even when the soil is very stable. Our boxes are 10 feet high and 24 feet long with various widths. We have stacked as many as three of these boxes on top of each other. If the trench is deeper than 30 feet, we slope that portion above the top of the upper box.

APPENDIX D

COMMENTS ON EXCAVATION AND TRENCHING STANDARDS

Information regarding OSHA and the OSHA trenching standards was obtained by telephone calls, personal conversations, letters, and questionnaire responses. Comments were made by contractors, contractor association officers, construction workers, engineers, educators, safety consultants, municipal officials, and equipment suppliers. These comments are presented herein to provide additional insight into trenching safety concerns. Some of these comments present specific or general problems, while others present possible solutions.

COMMENTS ON OSHA TRENCHING TABLES P-1 AND P-2

OSHA should change the soil conditions and depth requirements before shoring or sloping is required.

Experience and common sense cannot be put into a table or diagram.

We feel that in stable soil no bracing should be required in a situation where sloping may be done from a point 5 feet above the bottom of the trench. The bottom 5 feet would not require bracing where sloping may be done above that level.

There should be a complete revision of Tables P-1 and P-2 to reflect varying soil composition, different moisture conditions, and a method of accurately evaluating shoring requirements as they exist on the job.

From depths of 5 to 12 feet, soil conditions should dictate the use of shoring. Stiff clay does not need to be sloped at 45 degrees.

Tables P-1 and P-2 should be revised so they can be more easily read and understood.

The requirements are very much overdesigned.

A contractor can still be cited by trying to follow these guidelines.

They do not consider time in safety. Trench walls should hold up a short time, not a lifetime.

If the trench is over a man's head, some protection should be provided.

These tables are satisfactory for permanent (10 to 50 years) excavations only.

These tables are antiquated and not responsive to varying soil conditions.

COMMENTS ON OSHA SLOPING REQUIREMENTS (TABLE P-1)

There should be liberalization of sloping requirements to allow less slope. Allow the contractor more options in which he can use judgment.

Change the sloping requirements to start at the 5 foot elevation, not the bottom of the trench.

Allow 1/2 to 1 slope in good ground conditions.

The sides of the trench should not be steeper than 1-foot rise to each 1/2 - horizontal run in unstable soil. Otherwise, the decision should be made by a competent person, one who is knowledgeable about the soils in the particular area.

Mixtures of soils must be accounted for in Table P-1.

OSHA should establish a slope guideline within each local area that would be specific to the conditions that exist.

The wording of "approximate angle of repose" is most deceptive and that should be reworded and made realistic.

Many soils will stand with less slope than is now required, especially when ditches are only open for short periods of time.

The sloping requirements are not practical. It requires way too much digging for a safe trench.

Revise Table P-1; it is not realistic to require 45 degree slopes in hard compact soil. The word "average" is too broad.

Most highway cuts are 1 1/2 to 1, yet OSHA shows that a ditch slope at 2 to 1 is required.

"Cemented sand and gravels," what are they?

Sloping requirements in ditches need to be modified. Where pipelaying and backfilling follow immediately behind the digging operation, sloping at 1/2 to 1 is adequate. In wide ditches, effective slopes of the sides should be measured from the center of the ditch instead of the sides of the ditch.

The angles of repose should be lessened and sloping should start 4 feet above the bottom of the trench in soils which will allow this.

The angles of repose used in the OSHA standards are for disturbed material. Our trenches are dug in virgin, undisturbed soils which have higher angles of repose.

It is impossible to dig a trench in a 30-year-old road bed and conform to the OSHA sloping requirements.

The slope cannot be below the top of the proposed pipe as specified in all specifications.

Clay should not have to be braced. We need research on better methods.

Allow for sloping clay.

Slopes on solid rock should not be vertical. Two-in-one slopes on a ditch are impossible in many cases due to right-of-way constraints.

Sloping a ditch to the bottom of the ditch is asinine. A vertical bank should be determined by the width of the trench. A higher wall should be allowed in the wider trenches. In joint clay, however, this is not applicable.

The standard should allow for sandstone and shale which stand up like rock.

In loess soil, a vertical bank is safer than a sloped bank.

Municipalities do not provide enough right of way to slope banks in many cases.

COMMENTS ON OSHA SHORING REQUIREMENTS (TABLE P-2)

Spacing of trench bracing could be more lenient and trench depths could be lowered for minimum use of shoring. Most 4 to 6 foot trenches in our soil (very hard clays) do not need shoring and often trenches up to 10 feet do not need it.

Table P-2 should be revised to conform with empirical practices.

Trenchwork needs to be removed from table-type regulations. Control should be by additional training of personnel.

Revise Table P-2. Upright spacing for trench depths of 5 to 15 feet in hard compact soil is unreasonable.

Supervisors on the job need the authority to make on-the-job decisions as to the bracing requirements.

Shallow ditches in good ground up to a 6- or 7-foot depth do not need to be braced, especially waterline ditches.

Let contractors design their own sheeting and shoring since they are responsible. Make everyone shore below a certain depth, but 5 feet is too shallow; possibly 7 feet would be more realistic.

Field conditions are too variable to be defined by tables.

Minimum dimensions of stringers in depths over 20 feet are less than for depths of 10 to 15 feet.

Table P-2 is good for wide open areas with nothing in the way. Engineers do not design jobs in clean open areas.

Table P-2 is unrealistic due to member size and spacing. The table, if followed, would grossly restrict work. Normal pipe lengths used today could not get into the trench through the forest of bracing.

It is difficult to put a 10-foot length of pipe into a trench that has crossbraces spaced at 6 feet.

It is very difficult to install some lengths of pipe when you adhere fully to brace spacing requirements.

A 6-foot brace spacing is impossible if a clamshell is to be used inside the shoring.

It is impossible to completely comply with the OSHA standards if the trench crosses an existing utility line.

COMMENTS ABOUT TRENCH BOXES

I am not sure if the trench box is legal by OSHA standards. If not, I think it should be.

OSHA should recognize trench boxes as temporary sheeting.

OSHA should evaluate and strongly recommend the use of engineered steel trench boxes, with automatic fine credits given to those contractors who use them.

OSHA should be more flexible and realistic. You can allow the trench shield (trench box) to ride a few feet off the bottom of the trench and still not jeopardize any employees.

The definition of a trench shield is wrong. OSHA should not specify that it protect the trench from the top to the bottom. Shoring should start at the top of the installation, i.e., protection should start at the top of the pipe in the trench.

We need clear and reasonable trench box standards.

More allowances should be made by engineers permitting wider trench widths and then the use of more trench boxes can be possible.

COMMENTS ON THE "LADDER IN TRENCH" REQUIREMENTS

Backfill in the trench should be allowed as a means of exit when the backfilling operation is close behind the trench box.

The ladder problem must be redone.

In trenches where larger diameter (60") pipe is laid, the pipe should be permitted to be used as a safety escape. It is easier to get into the pipe than to wait in line to get out of the trench by way of a ladder.

Ladders in big pipe trenches are unsafe. It is far safer to jump into the pipe if it is a 48" diameter pipe.

Why is a ladder needed in a trench that is sloped? If the trench is shored, why require a ladder?

Ladders in a trench can actually create a hazard.

We were fined once for not having a ladder in the trench. We were moving the ladder forward at the time.

A ladder in a trench impedes escape if a sloped bank caves in.

Ladders in a muddy trench bottom will sink if a worker uses it. It is actually more dangerous with the ladder.

Where do you put the ladder if the backfilling operation is close behind the pipelaying operation. It is in the way. It is not necessary to have a ladder if the backfill is close and the banks are sloped so people can exit by them.

COMMENTS REGARDING VARIOUS TRENCHING PROVISIONS

The four-foot bench requirement on large diameter pipe seems arbitrary.

Trenching machines have conveyors. The bulldozer pushes dirt away from the conveyor, but it will not pass under the conveyor with a roll-over bar.

OSHA and consulting engineers should explain how a trench can be hand-tamped and backfilled without tight sheeting.

An on-site test of trench wall stability is by scaling (striking) the walls with the backhoe bucket. If the walls do not cave-in with this scaling, the walls will never cave in. This method has never failed in 16 years of experience in digging by open cut method over 200,000 feet of trenches up to 31 feet in depth.

There should be a practical standard procedure for installing welded steel pipeline in a shored trench.

Consideration should be given to the type of surface we pile dirt on adjacent to the trench.

The widths of trenches should be unlimited.

If the embankment is hard and compact and will stand alone for 24 hours, they should then do away with the 5-foot minimum required standard for bracing.

Most of our trenchwork is in city streets with 8" - 12" of pavement. We feel that this prevents the shear of the trench walls for medium depth trenches.

I wish our local (OSHA) office would recognize our use of hydraulic shores with 3/4" plywood sheeting.

Contractors should determine the type of soil and establish procedures of operation if specifications do not apply.

In unusual situations, let the contractor submit a proposed plan or method for approval.

OSHA should accept 1" plywood for bracing when used with air, hydraulic or screw jacks.

For a manhole excavation next to an existing utility line, you have to put a man in the hole to put in the shoring.

Close sheeting should not be required if the trench is over 15 feet deep. We prefer to use double trench jacks in these deep trenches.

Back-up alarms on equipment make people nervous. The workmen get used to the sound and it is not any safer. Some workers wear ear plugs and then they cannot hear it anyway.

OSHA should put more emphasis on hydraulic shores.

It is impossible to store material more than 2 feet from the trench if you are forced to leave room for public traffic.

On big jobs, our company has a man on top of the trench who looks for tension cracks constantly all day.

We cannot slope back into an area that has an existing utility.

Back-up alarms do not stand up under dust, moisture, and vibrations.

Roll-over protection is not necessary in flat areas.

Workers on heavy equipment will not use seat belts.

We would like to see an acceptance of compound sloping. This is where the bottom five feet of a trench can be vertical and the rest is sloped.

The standards do not specify the type of wood to be used in shoring.

COMMENTS ON THE NEED TO CONSIDER SPECIFIC CONDITIONS

Shoring requirements need to be suited to each area.

Compaction, type of soil, knowledge of soil, etc., need to be considered when determining the angle of the slope or the necessity of a trench box.

The OSHA requirements should be set more on a local level, otherwise they are too general.

There should be flexibility to incorporate the specific conditions that exist on each job.

Judgement rights should be restored to company experts to determine trench slopes under the continuously changing conditions in which we work.

Since soils and soil conditions vary considerably throughout a job, OSHA should allow the contractor to make his own determinations on slopes, bracing, etc., in conjunction with the OSHA standards.

Standards should not be the same for urban and rural areas.

OSHA standards 1926-653(h) should be redefined by noting various types of soils.

They should take into consideration the actual conditions that exist; use a little common sense.

There should be more consideration given to job conditions and the specific safety methods that are most appropriate, regardless of the general dictates of the OSHA standards.

Each state must have its own specifications on soils.

Permit competent persons, preferably engineers, to make determinations as to trenching requirements. However, penalties for willful violations should be severe.

Existing utilities present problems to contractors, but this is not often realized by OSHA.

OSHA should be geographically oriented.

COMMENTS ON SOIL CLASSIFICATIONS AND SOIL CHARACTERISTICS

A greater effort is needed to classify soils and trenching conditions as they exist in the field; five or six classes cannot cover the various conditions experienced on a national level.

OSHA should have standards written by experienced trenching personnel, experienced in the particular soils being encountered in specific circumstances.

More consideration should be given to soils encountered that are substantially more stable. Example: some areas filled with poured slag that has cemented and is very stable should not require shoring.

There are no provisions for loess materials.

Inspectors will not allow for cohesion in the soil caused by root systems.

Before a fine is imposed, soil conditions should be analyzed. Some hard gravels and hard clays are like rock and will stand up.

The standards do not allow for analysis of soils in lieu of Table P-1.

COMMENTS ON POSSIBLE CHANGES IN BIDDING POLICIES

OSHA should insist that Engineers specify that payment to contractors shall be made for any additional width of trench which is made necessary for OSHA compliance. The fixed specified widths of trenches indicated by engineering consultants in their plans and specifications often conflict with the OSHA standards.

Since OSHA is enforced for private firms, municipalities and other authorities should comply. OSHA should force engineers and municipalities to pay for proper trench widths and they should also include pavement as a pay item.

On cross sections for trenches, the states and design engineers should be required to use the same cross sections as those required (by OSHA) of the contractor, especially if backfill is a pay item.

If I bid my projects with all inclusions for necessary expenses for OSHA compliance, everyone should include it in his bid.

Bidding should be handled so that tight sheeting would be regarded as an extra if it is needed. This would eliminate guesswork and the contractors' bids could be more equitably compared.

Specifications should allow the guesswork to be removed regarding the necessity of tight sheeting, etc.

The angle of repose should be included in the specifications.

Owners should specify the shoring price.

Shoring as a bid item would be good.

Shoring as a bid item is good. It keeps the small guy or the bad guy from getting the bid when he did not include shoring.

The owner has to specify the type of shoring so everyone bids the same thing. This puts the responsibility on the owner's back. The owner should also have to check that the contractor is complying.

If shoring is put in as a bid item, the contractor can unbalance his bid.

Contractors do not oppose having shoring as a bid item. They want to get paid for what they do.

GENERAL COMMENTS ABOUT TRENCHING AND THE OSHA TRENCHING STANDARDS

I have not read it (OSHA trenching standards) since I first reviewed it and discovered it had no relationship with reality.

Trenchwork should be separated from excavations.

Attempt to be more specific. Have contractors and soils engineers combine their talents along with the legal profession in rewriting this entire section of the standards.

No one wants to bury a man, no matter what.

The rules are not practical and do not allow for particular job conditions. Consulting engineers should be made responsible to design jobs in a manner that makes it possible for a contractor to build the jobs within existing safety rules and regulations.

We know what is safe and what is not safe. We try in every case to be conservatively safe.

OSHA should use standards as stated in the state of Wisconsin Administration Code. This code has been tested and proven to be a sound code. It is workable in all soil conditions.

The specification standard should be changed to performance standards to include recommended guidelines.

There should be separate regulations for trenching.

A soil in which five foot unshored walls are safe would require more than 2 1/2 times the volume of excavation and backfill if the depth were increased to 5 1/4 feet. The spoil bank occupies more than 3 times the surface area which in conjested traffic locations can create unsafe conditions. There is a need for a provision in the standards for varying combinations of vertical and sloped walls which will provide equivalent safety to the 5' vertical wall without the expense of unnecessary earth handling.

Where soil tests and engineering analysis indicates that specific compound trench slope designs meet the safety standards, the contractor should have reasonable assurance before bidding the job that he will be allowed to utilize such designs and that their acceptance will not entail such delay as to discourage their use.

Table P-2 should be replaced by a new table which refers to the strength of the material and a standard of performance rather than a specification.

GENERAL COMMENTS ABOUT SAFETY, OSHA AND THE OSHA STANDARDS

Contractors need to review and add grass roots to standards in concert.

OSHA needs to be less police oriented and be more educational.

I would like to see the standards applied fairly to all instead of strictly to some and not at all to those who are "buying off" state and Federal inspectors. The incidence of "buying off" (State) OSHA inspectors by a few contractors is most troublesome in our area.

OSHA should refrain from harassing contractors.

OSHA standards should be more realistic and flexible.

OSHA should pay for schooling workers in safety.

I think the whole thing should be restructured. We need people who have practical on-the-job experience.

OSHA standards should reflect common sense.

OSHA standards should be simplified.

OSHA should make the standards more realistic.

Everyone should be forced to comply the same.

We should get rid of OSHA.

Instead of being police, they should be more helpful in correcting violations. They should not just be punitive, but rather they should make visits and correct problems.

Why does OSHA have no jurisdiction over cities and the federal government?

We want to be safe. So OSHA should come on my job. But work with me in being safe, i.e., do not play police.

If insurance companies did their job, OSHA would not be needed.

We can buy the hard hats but we cannot make the workers wear them; we cannot afford to fire our best workers.

We would never work if we complied 100%.

Owners should also be responsive to OSHA regulations.

They should allow pre-construction meetings between OSHA and the contractors.

Unions use OSHA to get at the contractors.

OSHA should give advice and be hand-in-hand safety partners with contractors. Then you would have cooperation and more safe conditions.

OSHA does not have time to come to our company planning meetings.

If I would comply fully with OSHA, I would go out of business.

OSHA takes for granted that you are doing something wrong.

We need on-site consultation.

We are drowning in bureaucracy.

It is not worth a life to take a chance.

Who can I realistically go to, to get advice on OSHA?

In wanting to be safe, I cannot get advice from OSHA.

OSHA should stop the cloak and dagger approach and really advise people. No one wants anyone hurt.

OSHA should put on some safety courses (for each trade) and tell contractors what they want.

We cannot get advice without jeopardizing ourselves.

OSHA's approach to a contractor has to be one of help rather than of fining and condemning.

Consideration should be given to the type of contractor and contractor practices that actually kill a lot of people.

It is apparent to most contractors that the costs of injuries directly affect the costs of insurance. It is not apparent, however, to what extent these costs are affected. It is clear from the little knowledge that many contractors have about insurance costs, as reflected to some degree in Workman's Compensation Experience Modification Rates, that education in this area has been poor.

OSHA inspections do not seem to be random.

COMMENTS ABOUT OSHA COMPLIANCE OFFICERS

OSHA should have inspectors who are technically competent to survey the worksites.

OSHA should allow inspectors some leeway with regard to the interpretation of the laws.

OSHA needs qualified inspectors, not shoe salesmen.

They should have inspectors with construction experience and they should stay with one rule.

Inspectors should be knowledgeable about all conditions and they should make recommendations at the jobsites.

Citations should be issued only when professional engineers with extensive experience in trench safety deem the trench to be unsafe. I submit that only an experienced professional can make a rational judgement on this issue--not the average OSHA inspector. The inspectors should have available to themselves such professional assistance when it is needed.

Possibly, OSHA could use inspectors with construction experience who can judge the safety of a trench based on their experience while using the standards as a general guideline.

OSHA should have some inspectors with some actual experience in trenching and excavations. This would be better than the inspector we recently had who was an illiterate steel worker who had never worked around or had any knowledge of excavations.

OSHA compliance officers place too much emphasis on the exact measurement of trenches.

All inspectors make their own rules.

Sometimes special conditions are treated in too much of a textbook manner. We have all seen 5-ft. trenches that were dangerous and 8-ft. trenches, with less than 1 on 1 sloping, that were safe. Inspectors go by the book, not by realistic judgement.

Inspectors should stop nit-picking.

OSHA inspectors feel they have to justify their jobs by fining contractors.

We would not hire them as safety engineers.

They are not necessarily well-endowed with common sense.

OSHA needs to establish some method of credibility for field personnel to assure that they are experienced in judging shoring requirements.

They should consider if life is actually endangered, not if a law is not strictly adhered too.

Inspectors should visit private work projects.

COMMENTS ABOUT THE OSHA FINING POLICIES

On first visits to the job sites, OSHA should not fine the contractors. They should issue warnings and not fines for the small problems.

I believe their rules should not be so cut and dry. Possibly they should give more responsibility to their compliance officers and let them be the final judge as to whether or not a rule has been bent too much.

Fines should be assessed on an experience rating basis, based on each firm's record of accidents.

The regulations should be set up so that if an accident occurs and the contractor made a bad judgement, he should be fined.

On-the-spot citations should be eliminated. Instead, the inspector should first give the contractor a written order to comply and give the contractor a reasonable time to make the corrections.

The ability to pay seems to determine the amount of the fines. The area director, who did not see the violation, sets the amount of the fine, not the inspector.

OSHA should not fine the contractor right off. They should give the contractor a little time to correct the problem. If it is not promptly corrected, then fine the contractor.

Why don't we have free inspections without the risk of fines.

Even though we may feel justified in contesting a citation, it costs us too much to defend our position.

COMMENTS ON WORKER RESPONSIBILITIES FOR SAFETY

We would like to see more responsibility placed on the employees. If the person is doing something he knows to be unsafe, why is the contractor fined or punished for this?

Responsibility for safety is now totally with management. It should be shifted somewhat to the workers.

If a company truckdriver is caught speeding on the highway, the truckdriver pays the fine. However, if the same worker is caught driving recklessly on a construction jobsite, the contractor is obligated to pay the fine. The law is inequitable in that regard.

APPENDIX E

NATIONAL UTILITY CONTRACTORS ASSOCIATION (NUCA) STUDY

NATIONAL UTILITY CONTRACTORS ASSOCIATION INC.
815 Fifteenth Street, N.W., Washington, D.C. 20005
Phone Area Code 202 737-0037

December, 1976

Dear Contractor:

As a result of wide-spread concern, the Occupational Safety and Health Administration (OSHA), has asked the National Bureau of Standards to reevaluate its trenching standards and to conduct an investigation of the technical aspects of trenching safety.

Since the climate now seems ideal for a vigorous industry response to this re-evaluation, we are seeking a broad range of contractor opinions and recommendations on the current standards. You can help to provide input into this important study by completing the enclosed questionnaire and returning it to the NUCA National office as soon as possible.

It appears that some definite changes will be made in the trenching and shoring standards, and we feel we have both an opportunity and a responsibility to see that this re-evaluation effort contains the thoughts and recommendations of the Nation's Ditchdiggers who are on the firing line.

If you have any questions, please feel free to contact the National office. Results of the survey will be made available to participants upon request.

Cordially,

John H. Pannullo
Executive Director

JNP:pdf

QUESTIONNAIRE FOR CONTRACTORS WHO DO WORK WHICH INVOLVES TRENCHING

1. Your job title in the company: ____________________

2. Type of trench work that the company generally does: (circle appropriate ones)

   storm sewer   sanitary sewer   water   gas   telephone   electric

   other: ____________________

3. In which geographic area (or state) does the company do most of its work?

   ____

4. Approximately what percent of the total dollar volume of work done by the company involves trenchwork? (circle one)

   0-25%   26-50%   51-75%   76-90%   over 90%

5. Which of the following types of soils do you most frequently encounter? (circle one)

   - sand
   - sand & gravel
   - soft to medium clays
   - stiff clays
   - very hard clays
   - rock
   - clayey sands or sandy clays
   - other: ____________________

6. Is the soil wet or dry?   wet   dry   other: ____________________

7. Approximate depth to ground water table: (circle one)

   0-5 ft   5-10 ft.   10-15 ft.   15-20 ft   over 20 ft.

8. Describe a trench which is most typical of the type of work that you do: (circle the answer that is most typical)

   A. Trench depth: 0-5 ft.   5-10 ft.   10-15 ft.   15-20 ft.

   over 20 ft.

   B. Trench width (at bottom of trench):

   0-3 ft.   3-6 ft.   6-9 ft.   9-12 ft.   over 12 ft.

C. Length of trench that is left open at one time (distance from back-filled portion of the trench to the backhoe):

0-25 ft.	25-50 ft.	50-75 ft.	75-100 ft.
100-150 ft.	150-200 ft.	200-400 ft.	over 400 ft.

9. What percent of the trenches are not braced but sloped? (circle one)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

When trenches are shored (braced), how often are the following used?

trench box: ________%
timber bracing: ______
tight timber sheeting: ________%
other: ______________________: ________%

hydraulic shores: ________%
screw jacks: ____________%
sheet piling: ____________%

10. On what occasions has the company hired a soils engineer? (check one)

- we have our own engineers
- we never have
- only before major bids
- when the owner didn't supply sufficient information
- only when legal problems arise after the job starts
- other: ______________________________

11. In the OSHA standards, contractors are provided with guidelines as set forth in Tables P-1 and P-2. How clear and useful are these tables? (check one)

- very helpful
- a guide for our company
- too general to be a helpful guide
- not realistic for our work situations
- other: ______________________________

Please comment: ______________________________

12. What specific changes would you recommend to be made in the OSHA standards regarding "Trenchwork and Excavation?" ______________

____

____

13. What are your thoughts or experiences with OSHA compliance officers? (check one)
- they really do identify safety hazards
- they mean well but they don't understand construction work
- they interpret the OSHA regulations to the letter of the law
- they are just out on the jobs to fine the contractor
- other comments: ____________________

____

14. Have any OSHA inspections occurred on your company jobs: yes no

If yes, how many inspections have been made? __________

how many of these inspections occurred as the result of an accident? __________

how many inspections resulted in citations? __________

what was the maximum fine? __________

15. Does the company have a safety incentive or safety award system?

yes no

If yes, what is the award? __________

who receives the award? __________

16. Are tool box (safety) meetings held on the job sites? yes no

If yes, how often are they held? (circle one) weekly biweekly monthly quarterly annually

When are they held? (circle one) Monday Tuesday Wednesday Thursday Friday No set day of the week

Who presides at these meetings? (circle one)

- assigned worker
- foreman
- president or owner
- job supervisor
- safety man
- other: __________

Does the company ever have any other meetings that involve safety?

yes no

17. What type of safety orientation do the new hires receive? (check one)

- no safety orientation
- informal safety orientation
- formal orientation, describe briefly: ______________________

____

18. Have any of your employees ever been fired specifically for violating trenching safety standards?

yes no

19. Who does the company generally hold responsible for job injuries? (circle one)

- injured worker - foreman - superintendent
- other: ____

20. How much assistance does the company get from the insurance company on safety? (check one)

- they are very helpful through their job inspections
- they inspect the jobs but they are not very helpful
- they send us brochures and safety information
- they only get concerned after accidents
- other: ____

21. How many recordable injuries occurred in the company in 1975? _____

Of these injuries, how many were lost time injuries? __________

22. What is the insurance experience modification rating of the company?

____

(Since this particular information is of extreme interest in this survey, please try to provide this information.)

23. Approximately how many man-hours were worked by company forces in 1975?

______________ man-hours

24. What is the average number of field workers on the company payroll?

minimum number: __________ maximum number: __________

WE WOULD ALSO LIKE TO HAVE SOME GENERAL INFORMATION ABOUT YOUR FIRM

25. Approximate annual dollar volume of the company: $_______ million

26. How many people does the company employ in the office? ___________

27. Of the field employees, approximately what percent has been with the company for longer than one year? (circle one)

0-20% 20-40% 40-60% 60-80% 80-100%

How many have been with the company for longer than 5 years? (circle one)

0-20% 20-40% 40-60% 60-80% 80-100%

28. Type of contractor; Union Merit Shop

29. Approximately what percent of the company's work is obtained through competitive bidding (not negotiated)? __________________% bid

30. How many workers regularly visit the premises at the home office? (circle one)

0-20% 20-40% 40-60% 60-80% 80-100%

31. What percent of the company work is done within 25 miles of the home office? (circle one)

10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

32. What kind of cost information is given to the foremen? (check one)

- they are given exactly what is in the estimate
- they are given only a rough idea of what is in the estimate
- they are told only if they are behind schedule or over budget
- they are not given any cost information
- other: ____

33. How often does the president (or an owner) visit most job sites? (circle one)

- daily
- 3 times a week
- 2 times a week
- 2 times a month
- 1 time a month
- less than monthly

34. Does the company have a pension fund or profit-sharing plan for the field workers?

yes no

35. What kind of communication does the company have with the jobs? (check appropriate ones)
- home office people frequently visit the jobs
- most jobs have CB radios for home office communications
- telephones are available at most jobs
- top management is stationed on the jobs
- other: ____________________

PARTIAL SUMMARY OF NUCA QUESTIONNAIRE RESULTS
CORRELATION BETWEEN VARIABLES

	Increase in Injury Frequency	Increase in the Company Annual Dollar Volume
Increase in the Annual Dollar Volume of the Company	K = .21 N = (199) Sig = .001	K = 1.00 N = (203) Sig = .001
Increase in the Number of Field Workers in the Company	K = .21 N = (156) Sig = .001	K = .73 N = (155) Sig = .001
Increase in the Number of Manhours Worked in the Company	K = .24 N = (181) Sig = .001	K = .66 N = (178) Sig = .001
Increase in the Number of Home Office Employees in the Company	K = .22 N - (201) Sig = .001	K = .67 N = (198) Sig = .001
Decrease in the Amount of Work Done Within 25 Miles of the Home Office	K = .13 N = (202) Sig = .003	K = .24 N = (199) Sig = .001
Decrease in the Number of Workers Who Have Occasion to Visit the Home Office Premises	K = .09 N = (197) Sig = .03	K = .32 N = (194) Sig = .001
Decrease in the Number of Times the Company President Visits the Job Sites	K = .23 N = (200) Sig = .001	K = .42 N = (198) Sig = .001
Decrease in the Number of Workers Who Have Worked for the Company for More Than One Year	K = .08 N = (194) Sig = .05	K = .16 N = (193) Sig = .001
Decrease in the Number of Workers Who Have Worked for the Company for More Than Five Years	K = .16 N = (187) Sig = .001	K = .07 N = (186) Sig = .07
Decrease in the Percentage of Trenchwork Comprising the Company Volume	K = .09 N = (203) Sig = .03	K = .18 N = (199) Sig = .001
Increase in the Length of Trench Typically Left Open	K = .08 N = (194) Sig = .04	K = .03 N = (189) Sig = .29

Increase in the Number of OSHA Inspections Following Accidents	K = .19 N = (193) Sig = .001	K = .31 N = (189) Sig = .001
Increase in the Amount of the Maximum Fine Levied by the OSHA	K = .11 N = (194) Sig = .009	K = .28 N = (191) Sig = .001

KEY: K = Kendall's Correlation Coefficient
N = Sample Size
Sig = Level of Significance

APPENDIX F

NATIONAL ASSOCIATION OF PLUMBING, HEATING AND COOLING CONTRACTORS (NPHCC) STUDY

1. Trench Work Performed

Storm Sewer	87 Units (or Responses)
Sanitary Sewer	90 Units
Water	90 Units
Gas	77 Units

Added

Disposal Systems	3 Units
Steam Lines	2 Units
Interior Storm, Solid Waste & Vent	1 Unit
Underground Fueling Station	14 Units

2. Percentage of Total Dollar Volume

0%	3 Units	60%	2 Units
5%	8 Units	70%	5 Units
10%	41 Units	80%	0 Units
15%	4 Units	90%	0 Units
20%	20 Units	100%	0 Units
25%	0 Units		
30%	2 Units		
35%	0 Units		
40%	9 Units		
45%	0 Units		
50%	0 Units		

3. Soil Conditions

Sand	10 Units
Sand & Gravel	19 Units
Soft-Medium Clays	42 Units
Stiff Clays	10 Units
Very Hard Clays	2 Units
Rock	4 Units
Clayey Sands or Sandy Clays	4 Units

Others:

Coral	3 Units
All	26 Units

4. Soil Conditions

Dry	47 Units
Wet	5 Units
Combination	41 Units
No Response	1 Unit

5. Depth to Water Table

0-5 ft	4 Units
5-10 ft	23 Units
10-15 ft	45 Units
15-20 ft	9 Units
Over 20 ft	4 Units
Variables	7 Units
No Response	2 Units

6. Trenches

a. Depth

0-5 ft	9 Units
5-10 ft	77 Units
10-15 ft	8 Units
15-20 ft	0 Units
Over 20 ft	0 Units

b. Width

0-3 ft	83 Units
3-6 ft	7 Units
6-9 ft	4 Units
9-12 ft	0 Units
Over 12 ft	0 Units

c. Length

0-25 ft	11 Units
25-50 ft	16 Units
50-75 ft	33 Units
75-100 ft	24 Units
Over 100 ft	10 Units

7. Precent Sloped

0%	0 Units	60%	0 Units
10%	13 Units	70%	3 Units
20%	8 Units	80%	0 Units
30%	0 Units	90%	33 Units
40%	9 Units	100%	18 Units
50%	10 Units		

8. Soil Engineer

0 Units - We have our own
52 Units - We never have
19 Units - Only before major bids
7 Units - When the owner didn't supply adequate information
15 Units - Only when legal problems arose after the job started
0 Units - Other
1 Unit - "When specified and called for"

9. OSHA Standards

8 Units - Very helpful
45 Units - A guide for our company
9 Units - Too general to be a helpful guide
29 Units - Not realistic for our work situations
0 Units - Other
1 Unit - "Didn't really cover our situation"
1 Unit - "Field conditions apply"
1 Unit - "Too hard to understand"

10. Specific changes; comments:

"Investigate the realistic conditions and economic impact on the industry"
"Make employee responsible when not following instructions"
"Use of common sense"
"Let the contractor determine the requirements on an individual job basis"
"Review each job individually"
"There is not enough responsibility or liability put on the worker"
"Common sense"
"Stricter enforcement"
"Very good"

"Quite extensive; overall changes including ways of testing soils by own people"
"More round table discussion"
"When OSHA fines you over $100, he should have an engineer verify dangerous"
"More direct to area"
"No fines for non-serious violations"
"OSHA in our business is necessary for protection of employees but more common sense is needed to do a good job. I am proud of our job record but we still got fined unjustly. Takes more time to fight it than to pay and be guilty. I would like to have a perfect record but without inspectors; with common sense; I give up."

11. OSHA Officers

9 Units - They really do identify safety hazards
47 Units - They mean well but they do not understand construction work
31 Units - They interpret OSHA regulations to the letter of the law
5 Units - They are just out on the jobs to fine the contractor
0 Units - Other comments
1 Unit - Evaluate complete situations before acting
1 Unit - No common sense

12. OSHA inspections - have they occurred?

83 Yes
3 No
8 No response

Frequency

1 Unit - 4/month
5 Units - 2/month
25 Units - 1 month
43 Units - 1/2 month
1 Unit - 1/3 month
3 Units - 1/6 month
4 Units - 1/year
12 Units - No response

Fines?

28 Units - Yes
61 Units - No
5 Units - No response

Reasons

"Sloping"
"Ditch not shored"
"Inadequate shoring"
"Laborer had removed trench jack and got down into ditch while safety inspector was watching unsafe act."

13. Do members have safety programs?

76 Units - Yes
18 Units - No

14. What type of safety program?

2 Units - No safety orientation
80 Units - Informal safety orientation
12 Units - Formal orientation, describe briefly...

"Signed statement from employee that he has read and understood company safety program"
"Union should train (claim to be)"
"Meeting once a week"
"Safety course offered by trade association throughout the year"

15. Employees fired related to unsafe acts

2 Units - Yes
82 Units - No
10 Units - No response

16. Who is responsible for injuries?

19 Units - injured worker
27 Units - foreman
15 Units - Superintendent
0 Units - Other
18 Units - Contractor
1 Unit - Owner
14 Units - No response

17. Insurance Company - Assistance

7 Units - They are very helpful through their job inspections
0 Units - They inspect jobs but they are not very helpful
77 Units - They send us brochures and safety information
7 Units - They only get concerned after accidents
0 Units - Other
1 Unit - "They were helpful in most any way when asked"
1 Unit - "We have constant inspection from our carrier company"
1 Unit - "None (they cancel if too many accidents occur)"

18. Average number of field workers?

8 Units - 0-10	3 Units - 70-80
25 Units - 10-20	1 Unit - 80-90
13 Units - 20-30	5 Units - 90-100
4 Units - 30-40	11 Units - 100-500
9 Units - 40-50	6 Units - 500-1000
1 Unit - 50-60	4 Units - 1000-2000
2 Units - 60-70	2 Units - No response

19. Approximate dollar value:

- 8 Units - .25-.5 mil
- 27 Units - .5-1.0 mil
- 17 Units - 1.0-1.5 mil
- 2 Units - 1.5-2.0 mil
- 8 Units - 2.0-2.5 mil
- 9 Units - 2.5-5.0 mil
- 12 Units - 5.0-10.0 mil
- 6 Units - Above listed . . . 12 mil, 25 mil, 33 mil
- 5 Units - No response

20. Type of contractor

- 36 Union
- 33 Merit
- 23 Combination
- 2 No response

21. Trenching done by member

- 42 Units - Primarily subcontracted
- 4 Units - Done by member with rental equipment
- 45 Units - Done by member with own equipment
- 3 Units - No response

APPENDIX G

REPORT OF THE BUILDING AND CONSTRUCTION TRADES DEPARTMENT, AFL-CIO

TRENCHING HAZARD IDENTIFICATION TASK FORCE

Final Report

April 25, 1977

Prepared for the

National Bureau of Standards

Building Safety Section

James O. Bryson, Chief

By

Building and Construction Trades Department

AFL-CIO

FOREWORD

Special acknowledgement is given for the contents of this report to Task Force members Clifford Ahlquist, Carl Gill, Robert L. Mack, Jerry Martin, Charles L. Stover and Robert E. Wood for their sincere efforts and insight into the problems addressed by the Task Force.

Others contributing to the design and implementation of the Task Force were Jack Wilkinson, Regional Manager, Laborers' International; Joe Adam, Safety and Health Director, United Association of Plumbers and Pipe Fitters; Robert Glenn, Business Manager, Laborers' District Council; Mike Collins, Business Manager, Plumbers Local #5; Martin P. Nygard, Plumbers' Local #630, W. Vernie Reed, General Secretary-Treasurer, Laborers' International Union.

The Task Force was chaired by Jack L. Mickle, Civil Engineering Department, Iowa State University. Technical Observer from the National Bureau of Standards was Felix Y. Yokel.

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BIOGRAPHICAL SKETCHES

TASK FORCE MEMBERS

CLIFFORD W. AHLQUIST

Mr. Ahlquist has 29 years of experience as a contractor installing water and sewer lines. He has been employed as a foreman and worked on projects in Minnesota, Pennsylvania and Washington, D.C. Metropolitan Area.

CARL F. GILL, SR.

Mr. Gill has 37 years experience and is a Master Mechanic in the Plumbing, Heating and Air Conditioning Trades. He has also worked as a laborer and crane truck driver. The majority of his work experience has been in the Washington Metropolitan Area.

ROBERT L. MACK

Mr. Mack has 37 years experience as a construction laborer and foreman. He is presently an instructor at the Francis L. Greenfield Institute, Sterling, Virginia. The majority of his work experience has been in the Washington Metropolitan Area.

JERRY MARTIN

Mr. Martin has 30 years of experience and is Director of Occupational Safety and Health Training, Operating Engineers Local #3. He has been employed as a Journeyman, Foreman, Superintendent and Equipment Manager. His experiences include job assignments on transmission pipe lines, sewer lines, storm drains, pump stations, petroleum, oil, lubricant distribution pipe-lines, water main pipelines, gas main pipelines in North Dakota, California, Maryland, Arkansas, Eniwetok Atoll, Franch Morocco, Arabia, Spain, Greenland, Iceland, Alaska, Guam, Azores, Italy, Libya, Liberia and Kuwait. He is a member of numerous Federal, State, Professional and National Safety Boards, Commissions and Societies.

CHARLES L. STOVER

Mr. Stover has 30 years experience and is the Safety Director, Operating Engineers Local #77. He has worked as an Apprentice, Engineer, Steward and Business Representative. His work in the Maryland, District of Columbia and Virginia areas has included projects for sewer excavations, natural gas stations, building construction, power house and disposal plants.

ROBERT E. WOOD

Mr. Wood has 19 years experience and is a Journeyman Plumber and Pipefitter. He has worked primarily as a foreman on jobs in Pennsylvania, Delaware, Maryland, Alabama and Florida.

JACK L. MICKLE, CHAIRMAN

Dr. Mickle has been a registered engineer for 22 years and is a Professor of Civil Engineering at Iowa State University. He has conducted numerous research projects and teaches Soil Engineering.

JIM E. LAPPING, COORDINATOR

Mr. Lapping is Director, Safety and Occupational Health for the Building and Construction Trades Dept., AFL-CIO. He has worked with the affiliated International Unions in developing and conducting Construction Safety and Health Training for Union and Management leadership.

JOB ORGANIZATION

BID DOCUMENT

R.O.W. Job

Adequate right-of-way shall be provided for proper execution of the job.

Overall Design

The overall design shall provide for the safety of the worker.

Soil Conditions

Whatever information concerning soil conditions is available, need to be included in the bidding documents.

Locate Utilities

The location of all utilities needs to be shown in the bid documents.

Medical Facilities

The location of the nearest hospital where a man may receive treatment. First line supervisor needs to have this knowledge and responsibility.

Safety Program

Include as item in bid document.

PRE JOB CONFERENCE

Construction Procedures

Safety program shall be outlined. (Was incorporated in the bid document.)

Permits

Permits shall be required before any work begins.

Supervisory Personnel

First line supervisors shall be trained in OSHA approved or equivalent safety training.

Medical Facilities

See under Bid Document - Medical Facilities

Safety Program

The Supervisor shall provide for weekly safety meetings for all workmen. Good housekeeping on the job site shall be mandatory. Nearest Rescue Squad and how to contact.

JOB SITE WORK PROCEDURES

Equipment Standards

Equipment and tools shall be adquate for the job and properly maintained.

Job Execution

The supervisor shall be knowledgeable in all facets of the work. There shall be proper posting of OSHA Regulations.

Working Alone

No one working along - no workmen shall be permitted in a trench without a topman. This is important, it cannot be overemphasized. (Equipment operators cannot be considered topmen). There shall be sufficient manpower to properly do the job.

Orientation to the Job Site

Safety Program: the following need to be emphasized in the safety program:

1. Blind side equipment
2. One man gives signals
3. Proper rigging (shackle or closed hook)
4. Pressure testing the pipe
5. How much weight should a man lift
6. Safety guard rails around holes
7. Inspection and maintenance of equipment (and recordkeeping)
8. Equipment too close to ditch
9. Job housekeeping
10. Weather conditions
11. Efficient and safe utilization of job site hand tools
12. Use of gases in confined spaces
13. Fumes entering work space
14. Exposure to radioactive minerals
15. Pressure hazards (air locks, etc.)
16. Certified divers where required

SPECIFIC RECOMMENDATIONS

OSHA TABLE P-2

OSHA TABLE P-2 is impractical because:

1. The braces are too closely spaced, the result is:
   a. It is extremely difficult and hazardous to install pipes.
   b. Laborers can't function (8 feet spacing is necessary)
   c. It is difficult for any digging operation except small hydraulic clam shells.

2. People are unfamiliar with the table.

3. The table is very difficult to interpret.

OSHA TABLE P-2 may be improved by:

1. Increasing the size of stringers and braces; probable minimum should be 10" x 10".

2. Increase spacing of braces to 16 feet with a temporary brace to be used in the center when driving sheeting and grading for pipe.

3. Do not use small timbers; they will "pop".

4. Do not recommend 3" x 4" uprights.

5. Use full 2" thickness sheeting to 12 feet and full 3" thickness sheeting for greater depths.

6. The greatest pressure on shoring in normal trenching depths appears to be at the base of the shoring.

7. Provide for temporary bracing just beyond the ends of each section of pipe as it is being installed.

8. See Figures A-9 and A-10.

CONSTRUCTION DESIGN

Adequate right-of-way. A national system (such as Underground Services Alert, U.S.A.) for locating utilities is necessary.

ALTERNATIVE PROCEDURES

Some procedure needs to be established to provide for innovation in procedures and equipment.

PERMITS - APPROVED PLANS

SOIL IDENTIFICATION

How different soils respond to disturbance.

1. Good Soils will break up uniformly when excavated.

2. Soils which required watching have the tendency to come out of the excavation in globs.

3. Wet clays are the most critical and treacherous.

4. Moist, sandy conditions are very treacherous.

CONSTRUCTION PROCEDURES

Sloping - See figures A-1 and A-2.

Trenching Widths - See figures A-5 and A-6.

Minimum Depth

Free Board (Pig Trough) - See figure A-7.

Surcharge (super-imposed loads, soil banks) - See figure A-8 and A-9.

Skeleton Bracing - See figure A-3.

Clear distance from spoil pile to edge of trench - See figure A-8.

Ladders tied off - ladders shall be properly secured and extend a minimum of 3 feet above the surface of the ground. The ladders need to be in place in the trench when workmen are in the trench.

PRE-ASSEMBLED EQUIPMENT

Braces and Jacks

Hydraulic or screw jacks should not be extended beyond a practical working limit.

Ladder (How Judged)

Ladders must meet OSHA requirements.

Design of Shield

Use realistic sketch of a shield for examples. See Figure A-11. The shield may be made of steel or its equvalent.

Protection of Public

National Color Code

A national uniform color code shall be adopted for public utilities.

Unattended Excavation

Excavations should not be left unattended without barricades.

Job Site Visitors

No children or unauthorized personnel should be permitted on the job site.

Personal Dress and Behavior

Engineered Workspace

Emphasize the engineering of a safe workspace in addition to designing personal protective equipment. The first priority would be to engineer out the problem.

Clothing and Equipment

The workman shall wear proper clothing and proper personal protective equipment (conforming).

Personal Behavior

Proper personal behavior (no horseplay).

Standards

There is a Need For:

1. Uniform national standards

2. A proper standard reporting form

3. Organization of standards

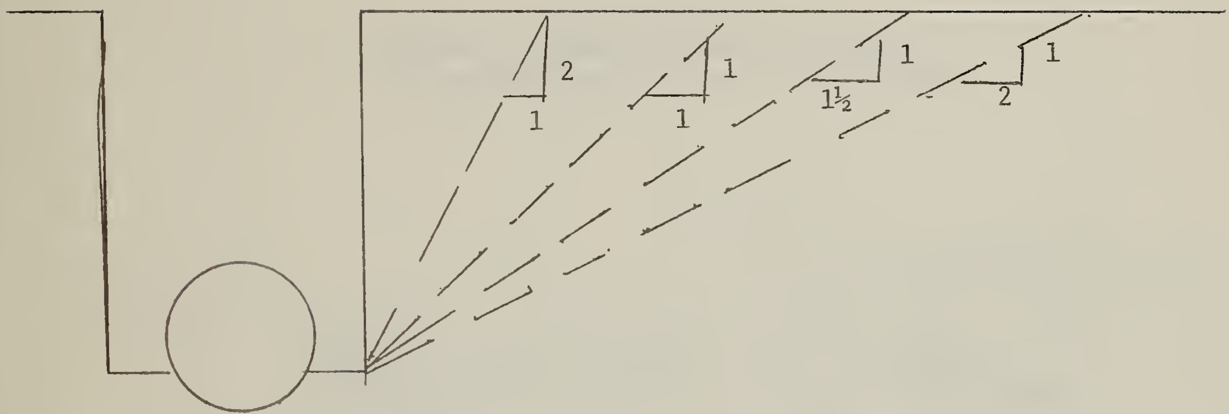
4. Distribution

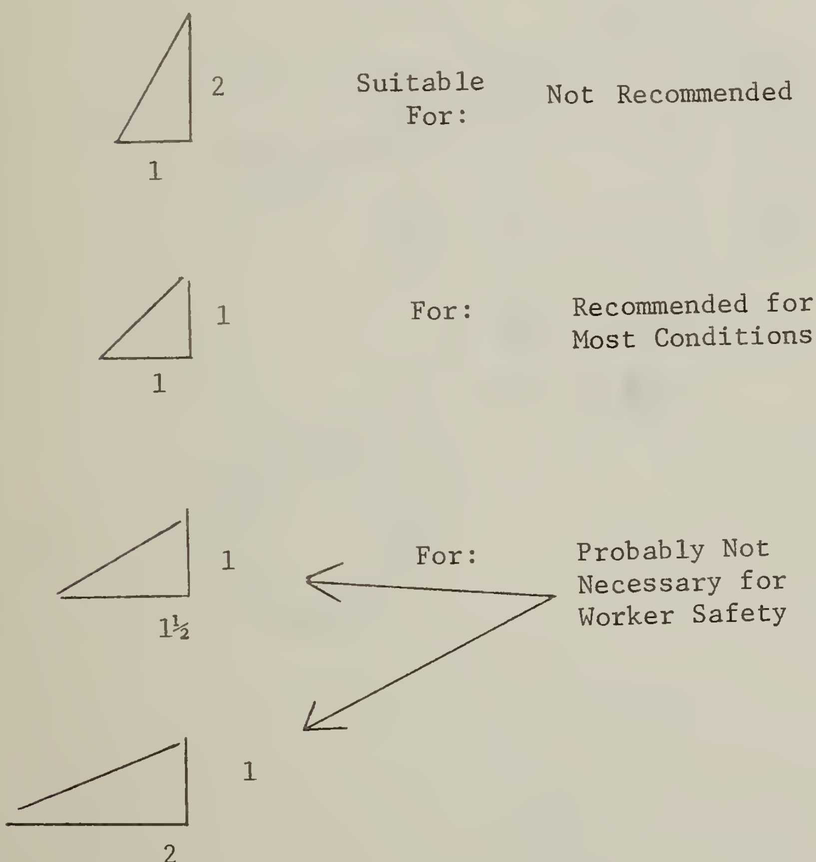
Training, Examinations and Licensing

There is a Need For:

1. Mandatory training (approved courses), for first line supervisors.
2. There shall be mandatory First Aid-CPR Training for supervisors.
3. Employee education and training needs to be implemented.
4. OSHA Safety: inspectors need training.
5. There needs to be standard criteria to evaluate inspectors competence.

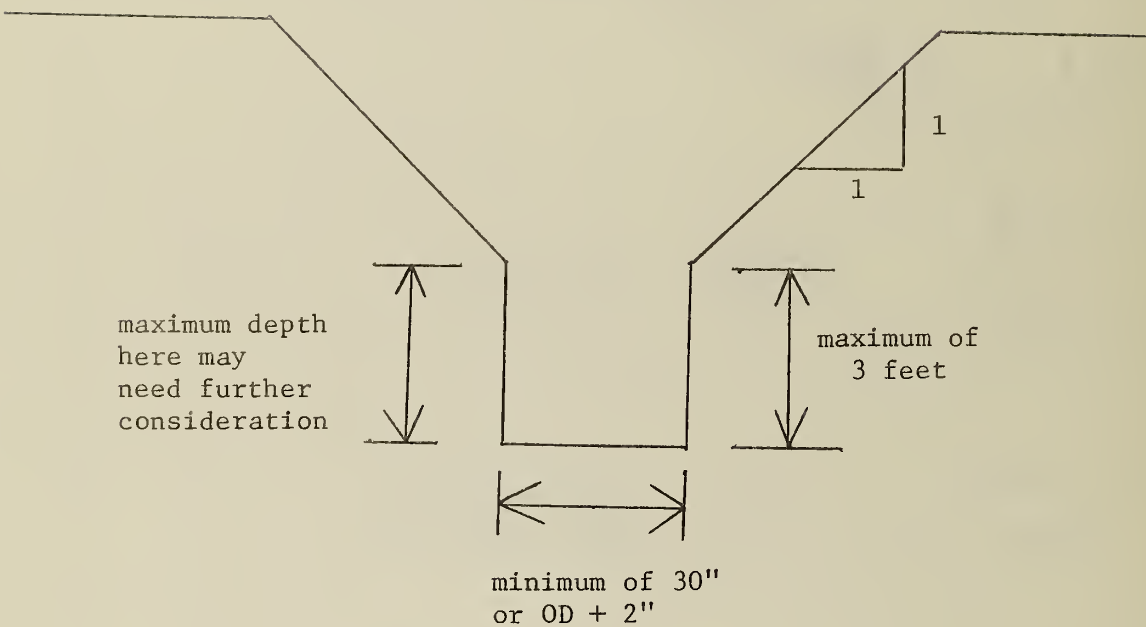
SLOPING


2
1
1
1
1
1½
1
2


2
1
Suitable For:
Not Recommended
1
1
For:
Recommended for Most Conditions
1
1½
For:
Probably Not Necessary for Worker Safety
1
2

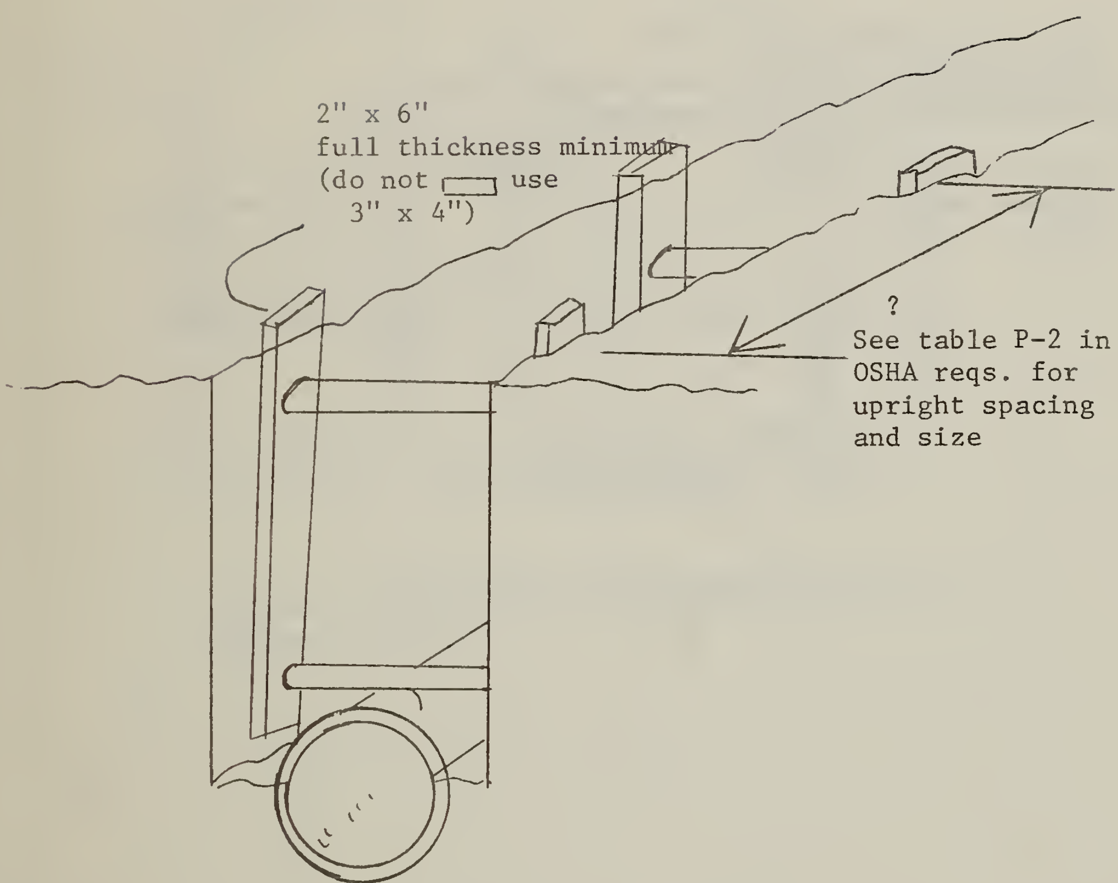
A-1

SLOPING SIDED DITCH WITH SUBDITCH
WITH VERTICAL WALLS - IN LIEU SHORING



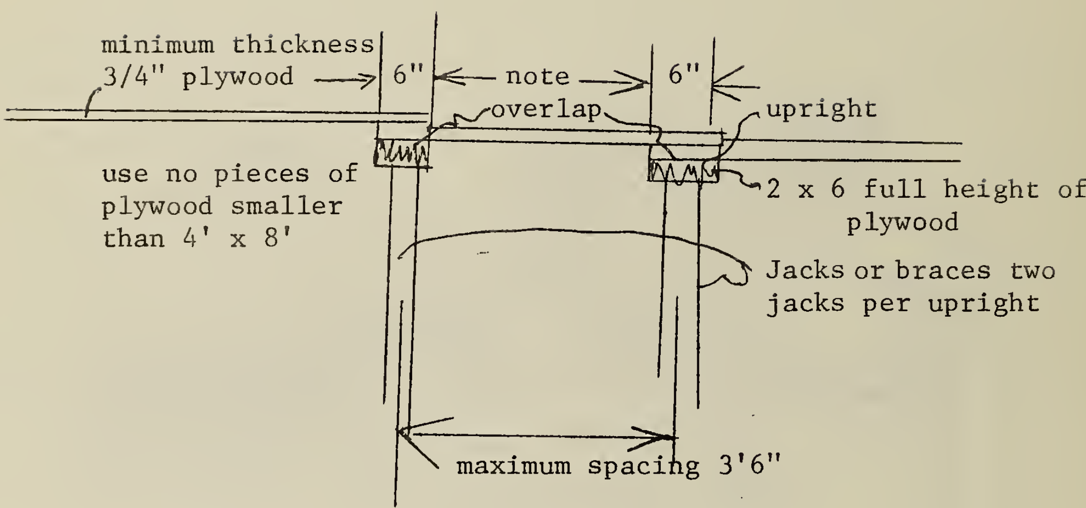
A-2

SKELETON BRACING



A-3

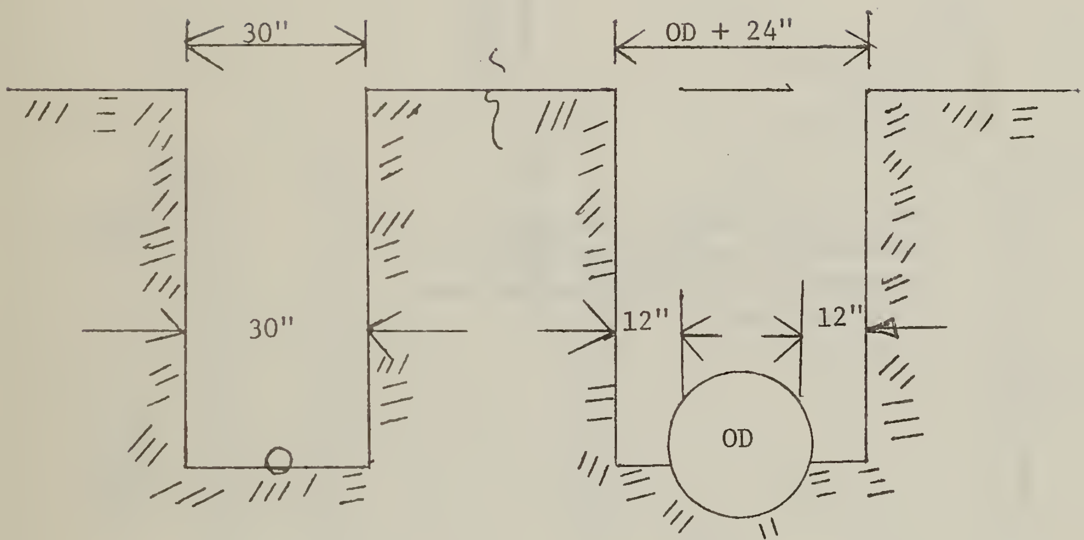
TIGHT SHEETING



For use in trenches up to 7 feet deep

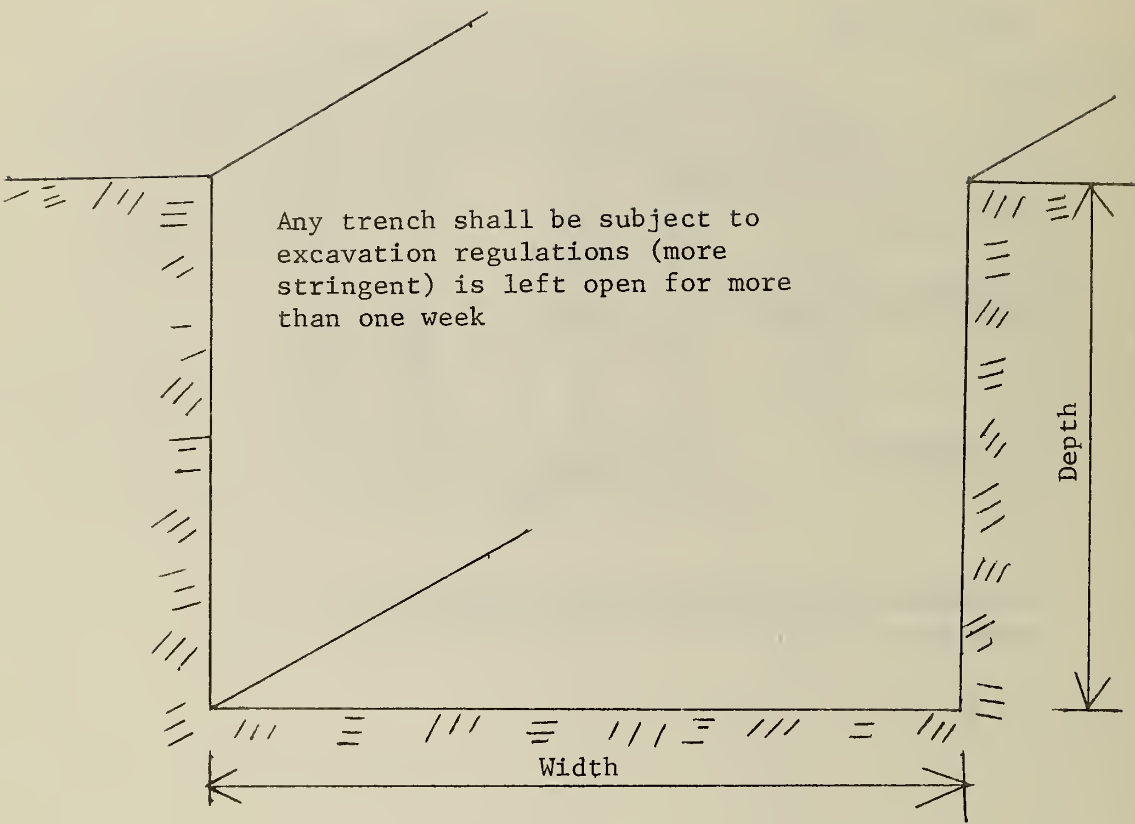
A-4

MINIMUM TRENCH WIDTH

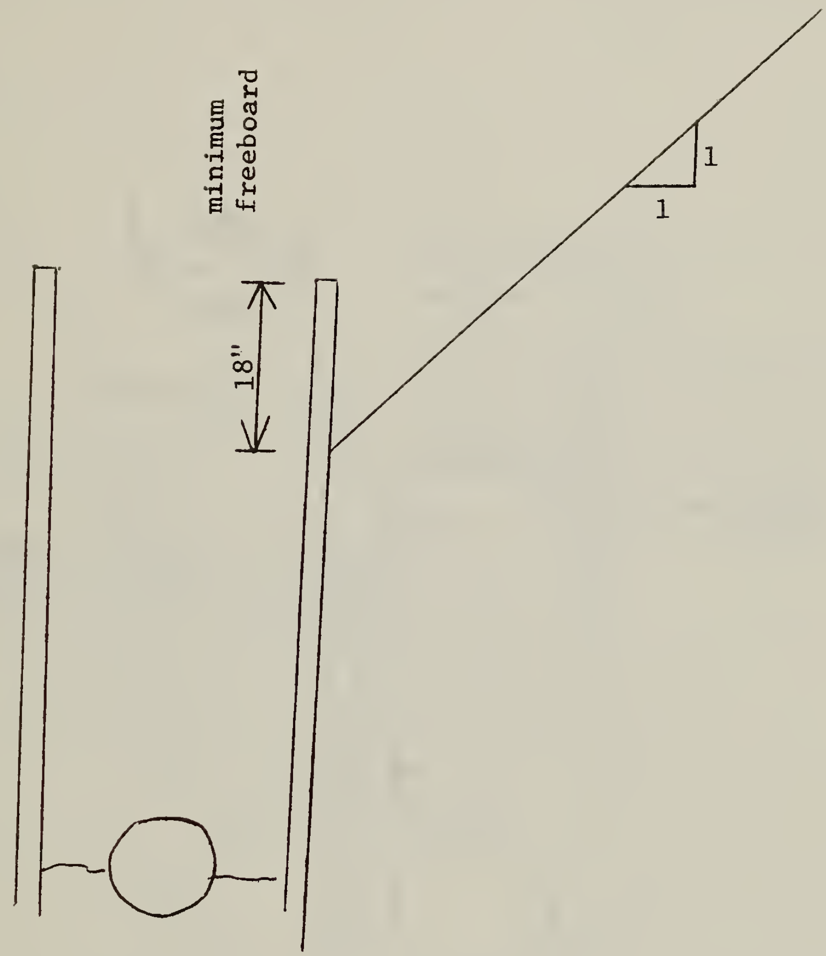


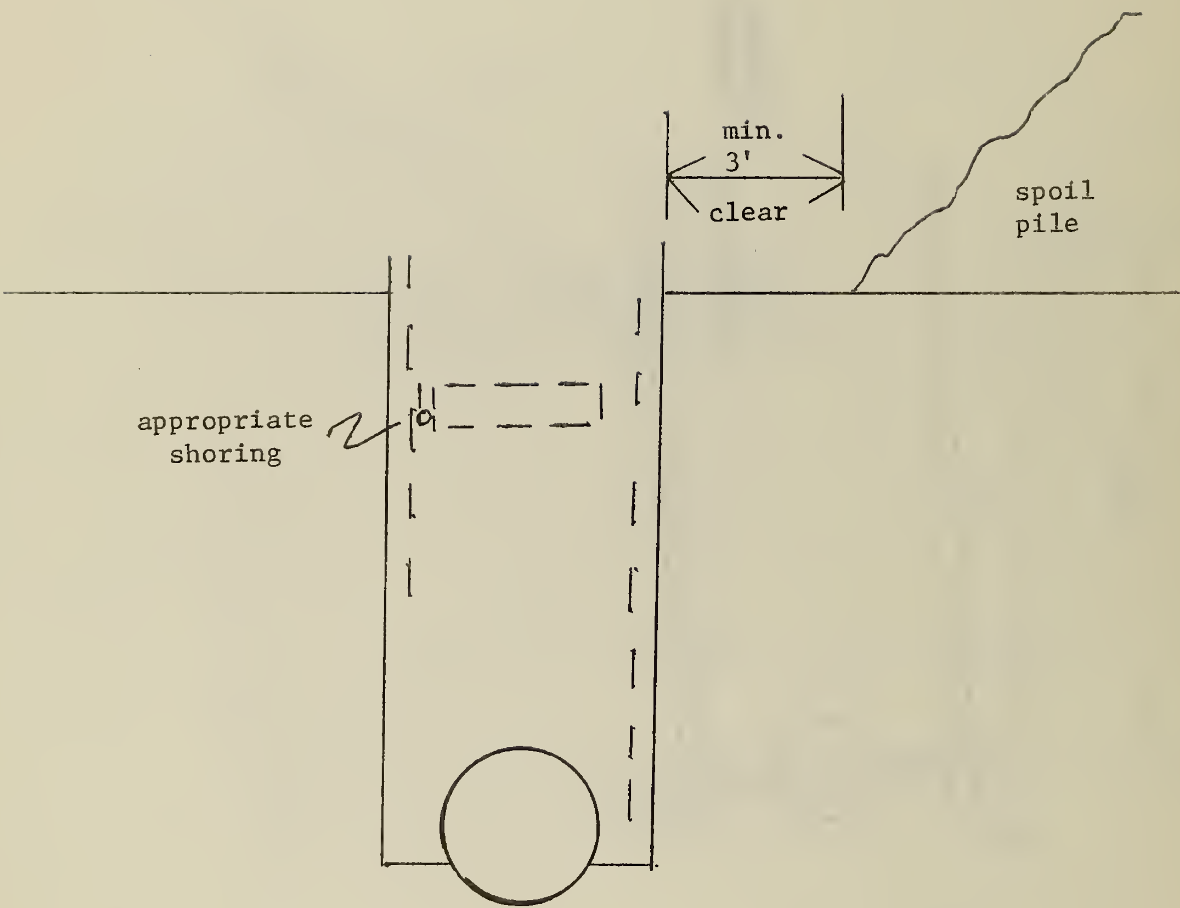
A minimum of 12" on each side of pipe for workman to stand

A-5

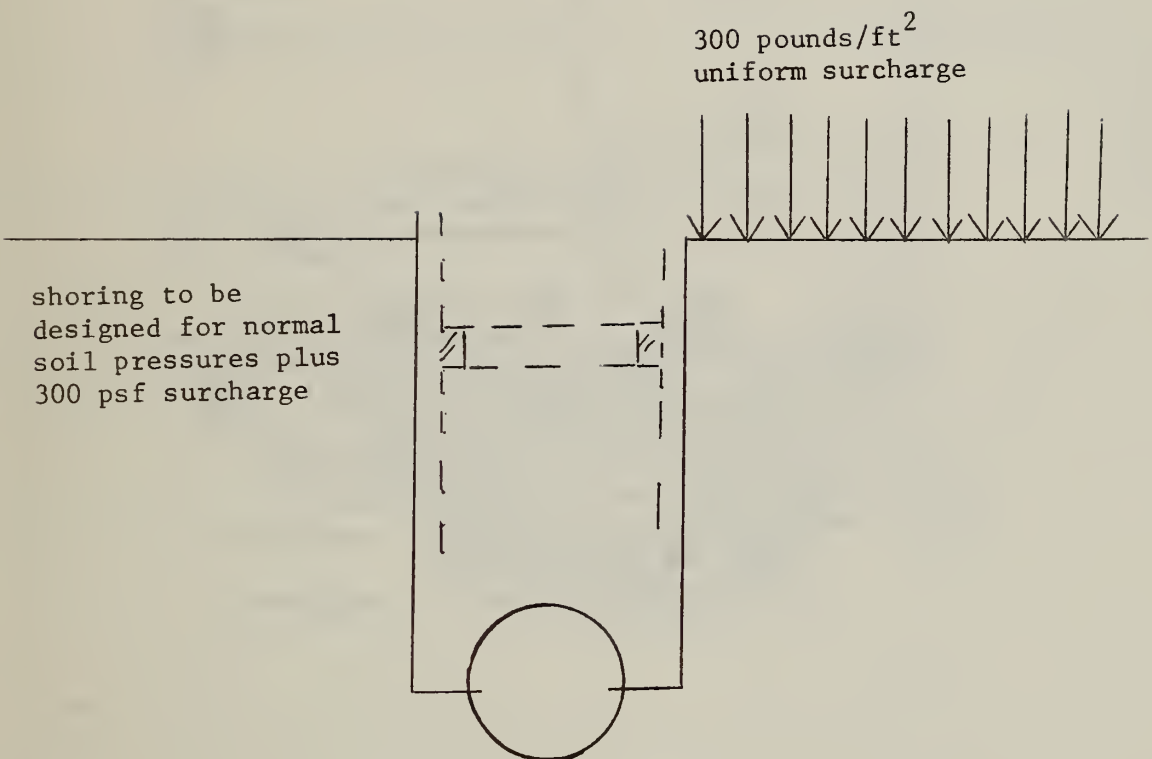

Any trench shall be subject to excavation regulations (more stringent) is left open for more than one week
Depth
Width

A-6

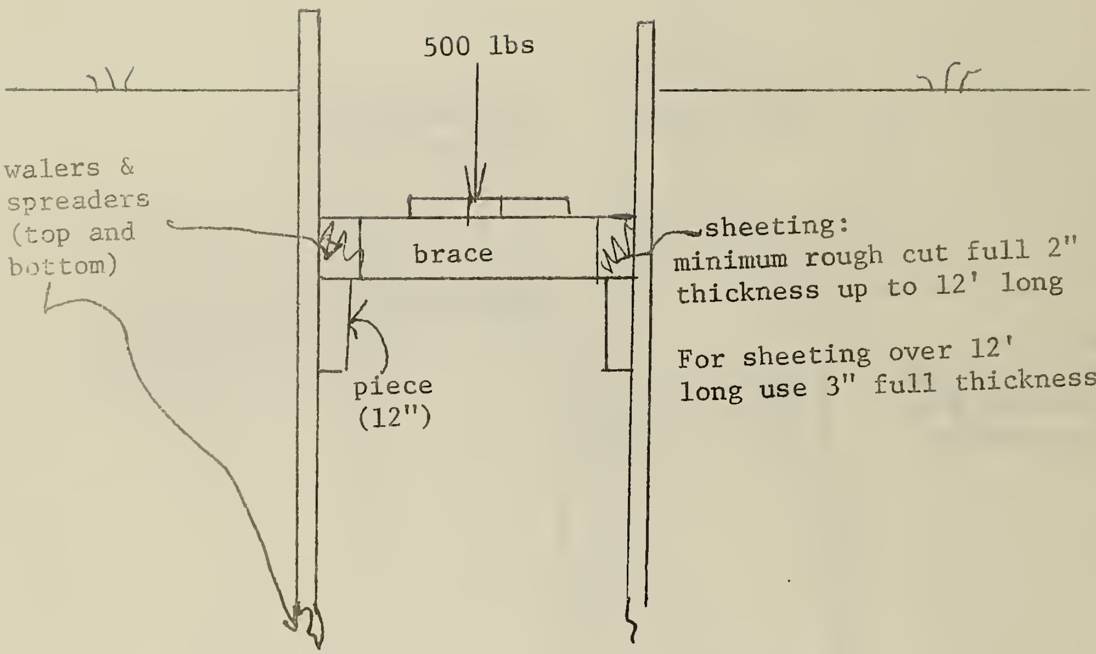

minimum
freeboard
18"
1
1



A-8


300 pounds/ft2
uniform surcharge
shoring to be
designed for normal
soil pressures plus
300 psf surcharge

A-9


500 lbs
walers &
spreaders
(top and
bottom)
brace
piece
(12")
sheeting:
minimum rough cut full 2"
thickness up to 12' long
For sheeting over 12'
long use 3" full thickness

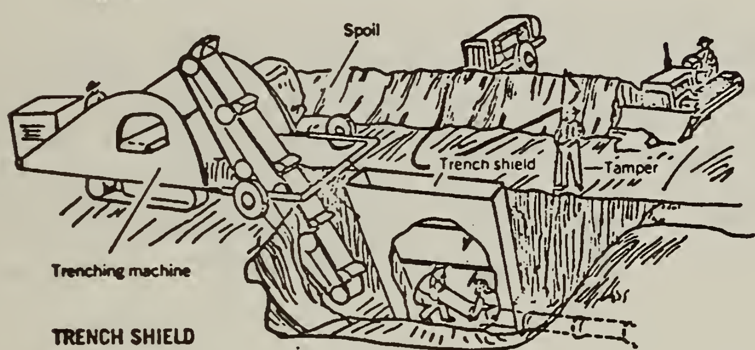
Excavating and Trenching Operations

Safe Work Practices Series

U.S. Department of Labor
Occupational Safety and
Health Administration
July 1975

OSHA 2226

Figure 3.



TRENCH SHIELD

11

This is inappropriate as an example; does not look like any existing equipment

A-11

NBS-114A (REV. 9-78)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO.	2. Gov't Accession No.	3. Recipient's Accession No.
	NBSIR 80-1988		

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5. Publication Date

March 1980

6. Performing Organization Code

7. AUTHOR(S)

Jimmie Hinze and Nicholas J. Carino

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, DC 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Department of Labor
Occupational Safety and Health Administration
Washington, D.C.

13. Type of Report & Period Covered

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

[ ] Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Results of a field study of trenching practices, safety related problems in trenching, and the effect of the Occupational Health and Safety Administration (OSHA) regulations for excavation, trenching and shoring are presented. The data were gathered from over 100 interviews with contractors and foremen in various regions of the country and from the answers to questionnaires sent by contractors' associations to their membership. The data indicate: 1) the technical aspects of trenching work, 2) the industry's opinion of the current OSHA regulations, and 3) factors affecting safety performance in trenching work.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Construction safety; construction standards; excavation; safety regulations; shoring; trenching.

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