(2)					
2805.22	Strontium and Barium:				
2805.22.10	Strontium	kg	3.7% Free (A, E)		25%
2805.22.20	Barium	kg	3.7% Free (E)		25%

[FR Doc. 87-8393 Filed 4-14-87; 8:45 am]
BILLING CODE 3190-01-M

DEPARTMENT OF THE TREASURY

Public Information Collection Requirements Submitted to OMB for Review

Dated: April 9, 1987.

The Department of Treasury has submitted the following public information collection requirement(s) to OMB for review and clearance under the Paperwork Reduction Act of 1980, Pub. L. 96-511. Copies of the submission(s) may be obtained by calling the Treasury Bureau Clearance Officer listed. Comments to the OMB reviewer listed and to the Treasury Department Clearance Officer Department of the Treasury, Room 2224, 15th and Pennsylvania Avenue, NW., Washington, DC 20220.

United States Mint

OMB Number: New
Form Number: None
Type of Review: New
Title: Coin Survey
Description: The United States Mint intends to conduct a one-time random survey of the public. The survey examines coin demand forecasts which form the basis for short-term budget planning and long-term strategic planning. Among the factors included in the forecast model are the rate of coins lost annually and the stock remaining in circulation.
Respondent: Individuals
Estimated Burden: 4,175 hours
Clearance Officer: Myles Schulberg United States Mint 633-3rd Street, NW. Room 639 Washington, DC 20220
OMB Review: Milo Sunderhauf (202) 395-6880 Office of Management and Budget Room 3208, New Executive Office Building Washington, DC 20503

U.S. Customs Service

OMB Number: 1515-0061
Form Number: CF-1304
Type of Review: Extension
Title: Crew's Effects Declaration
Description: Customs Form 1304 is completed by the master of the arriving carrier to recover and list the crew's effects that are accompanying them on the trip but which are defined as merchandise under U.S. statutes and therefore must be manifested.
Respondents: Businesses
Estimated Burden: 20,983 hours

OMB Number: 1515-0002
Form Number: CF-7507
Type of Review: Extension
Title: General Declaration (Outward/Inward)
Description: The Customs Form 7505 allows the agent or pilot to make entry or exit of the aircraft as required by statute. The form is used to document clearance by the arriving aircraft at the required inspectional facilities and inspections by appropriate regulatory agency staffs.
Respondents: Businesses
Estimated Burden: 124,950 hours
Clearance Officer: B.J. Simpson (202) 566-7529 U.S. Customs Service Room 6426 1301 Constitution Avenue, NW. Washington, DC 20229
OMB Reviewer: Milo Sunderhauf (202) 395-6880 Office of Management and Budget Room 3208, New Executive Officer Building Washington, DC 20503

Alcohol, Tobacco and Firearms

OMB Number: 1512-0467
Form Number: ATF F 5000.24
Type of Review: Revision
Title: Excise Tax Return
Description: ATF F 5000.24 is completed by persons who are liable for excise taxes on distilled spirits, beer, wine, cigars, cigaretts, cigarett papers and tubes, chewing tobacco and/or snuff. The return is prescribed by law for the collection of these taxes. AFT uses the form to identify the taxpayer, the premises and period covered by the tax return, the taxpayer's liability and the adjustments affecting the amount paid.
Respondents: Businesses
Estimated Burden: 25,309 hours
Clearance Officer: Robert Masarsky (202) 566-7077 Bureau of Alcohol, Tobacco and Firearms Room 7011 1200 Pennsylvania Avenue, NW. Washington, DC 20226
OMB Reviewer: Milo Sunderhauf (202) 395-6880 Office of Management and Budget Room 3208, New Executive Office Building Washington, DC 20503

Dale A. Morgan,
Departmental Reports Management Officer.

[FR Doc. 87-8439 Filed 4-14-87;8:45am]
BILLING CODE 4810-25-M

Sunshine Act Meetings

Federal Register
Vol. 52, No. 72
Wednesday, April 15, 1987

This section of the FEDERAL REGISTER contains notices of meetings published under the "Government in the Sunshine Act" (Pub. L. 94-409) 5 U.S.C. 552b(e)(3).

FARM CREDIT ADMINISTRATION

Farm Credit Administration Board; Special Meeting

AGENCY: Farm Credit Administration.

SUMMARY: Notice is hereby given, pursuant to the Government in the Sunshine Act (5 U.S.C. 552b(e)(3)), of the forthcoming special meeting of the Farm Credit Administration Board (Board).

DATE AND TIME: The meeting is scheduled to be held at the offices of the Farm Credit Administration in McLean, Virginia, on April 17, 1987, from 10:00 a.m. until such time as the Board may conclude its business.

FOR FURTHER INFORMATION CONTACT: William A. Sanders, Jr., Secretary of the Farm Credit Administration Board, 1501 Farm Credit Drive, McLean, Virginia 22102-5090 (703-883-4010).

ADDRESS: Farm Credit Administration, 1501 Farm Credit Drive, McLean, Virginia 22102-5090.

SUPPLEMENTARY INFORMATION: This meeting of the Board will be open to the public (limited space available). The matters to be considered at the meeting are:

1. Final Regulations:
   Part 624—Temporary Regulations—Technical Amendments— Regulatory Accounting Principles
2. Proposed Amendments to Regulations:
   Part 611—Temporary Regulations—Capital Corporation Assessment
3. Policy Directives:
   FCA Approval of the Compensation of Farm Credit System Bank Chief Executive Officers
   FCA Approval of Exceptions to PCA Direct Loan Limitation
4. Administrative Matters:
   Schedule of Farm Credit Administration Board Meetings

Dated: April 10, 1987.

William A. Sanders, Jr.,

Secretary, Farm Credit Administration Board.

[FR Doc. 87-8518 Filed 4-13-87; 10:35 am]

BILLING CODE 6705-01-M

FEDERAL RESERVE SYSTEM BOARD OF GOVERNORS

"FEDERAL REGISTER" CITATION OF PREVIOUS ANNOUNCEMENT: April 10, 1987 (52 FR 11796).

PREVIOUSLY ANNOUNCED TIME AND DATE OF THE MEETING: 10:00 a.m., Wednesday, April 15, 1987.

CHANGES IN THE MEETING: Deletion of the following open item from agenda:

Proposals regarding fees for examination of Edge Act corporations, inspections of bank holding companies, and processing applications for banks and bank holding companies. (Proposed earlier for public comment; Docket No. R-0584)

CONTACT PERSON FOR MORE INFORMATION: Mr. Joseph R. Coyne, Assistant to the Board; (202) 452-3204.

Dated: April 10, 1987.

William W. Wiles,

Secretary of the Board.

[FR Doc. 87-8512 Filed 4-13-87; 10:12 am]

BILLING CODE 6210-01-M

Corrections

Federal Register
Vol. 52, No. 72
Wednesday, April 15, 1987

This section of the FEDERAL REGISTER contains editorial corrections of previously published Presidential, Rule, Proposed Rule, and Notice documents and volumes of the Code of Federal Regulations. These corrections are prepared by the Office of the Federal Register. Agency prepared corrections are issued as signed documents and appear in the appropriate document categories elsewhere in the issue.

DEPARTMENT OF AGRICULTURE

Agricultural Marketing Service

7 CFR Part 994

[Docket No. EMO-1]

Egg Marketing Order; Establishment of Programs Relating to Research, Consumer Education, and Advertising

Correction

In proposed rule document 87-7566 beginning on page 10984 in the issue of Monday, April 6, 1987, make the following corrections:

1. On page 10986, in the first column, in the last paragraph, in the second line, "of" should read "to".

2. On page 10988, in the third column, in the third line, "assessment" should read "assessments".

3. On page 10991, in the second column, in the last paragraph, in the third line, " 'handling' " should read " 'handle' ".

4. On page 10994, in the second column, in the second paragraph, in the fifth line, "at least 5 years," should read "at least every 5 years,".

5. On page 10997, in the second column, in the first complete paragraph, in the 15th line, "that a matter" should read "that as a matter".

6. On page 10998, in the second column, in the first complete paragraph, in the third line from the bottom, "procedure" should read "procedures".

PART 994—[CORRECTED]

7. On page 11001, in the third column, in the table of contents, "994.85 Counterparts." should read "*994.85 Counterparts.", "994.86 Additional parties." should read *994.86 Additional parties.", and "994.87 Order with marketing agreement." should read "*994.87 Order with marketing agreement.".

§ 994.85 [Corrected]

8. On page 11007, in the second column, in the first line, the section heading for § 994.85 should read "*§ 994.85 Counterparts."

§ 994.86 [Corrected]

9. On the same page, in the same column, in the ninth line, the section heading for § 994.86 should read "*§ 994.86 Additional parties."

§ 994.87 [Corrected]

10. On the same page, in the third column, in the first line, the section heading for § 994.87 should read "*§ 994.87 Order with marketing agreement."; and in the text of § 994.87, in the seventh line, "spend" should read "spent".

BILLING CODE 1505-01-D

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 721

[OPTS-50558; FRL-3174-4]

Ethanol, 2-Amino-, Compound With N-Hydroxy-N-Nitrosobenzenamine (1:1); Proposed Determination of Significant New Uses

Correction

In proposed rule document 87-6459 beginning on page 9508 in the issue of Wednesday, March 25, 1987, make the following correction:

On page 9511, in the third column, under **XII. Rulemaking Record**, in the first paragraph, in the third line, "OTS" should read "OPTS".

BILLING CODE 1505-01-D

FEDERAL COMMUNICATIONS COMMISSION

47 CFR Part 73

[MM Docket No. 87-20, RM-5544]

Radio Broadcasting Services; Caldwell, TX

Correction

In proposed rule document 87-4139 appearing on page 6026 in the issue of Friday, February 27, 1987, make the following correction:

On page 6026, in the first column, the Docket Number should read as set forth above.

BILLING CODE 1505-01-D

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[CA-940-07-4520-12, Group 920]

Plat of Survey

Correction

In notice document 87-6412 beginning on page 9548 in the issue of Wednesday, March 25, 1987, make the following corrections:

1. On page 9548, in the third column, the "Group Number" should read as set forth above.

2. On the same page, in the same column, under **Humboldt Meridian, Trinity County**, the first line should read: "T. 6 N., R. 6 E.".

BILLING CODE 1505-01-D

DEPARTMENT OF JUSTICE

Drug Enforcement Administration

21 CFR Part 1308

Schedules of Controlled Substances; Placement of Nabilone Into Schedule II

Correction

In rule document 87-7533 beginning on page 11042 in the issue of Tuesday, April 7, 1987, make the following corrections:

1. On page 11042, in the second column, under the **SUPPLEMENTARY INFORMATION**, in the fourth line from the bottom, after "Statement" add "of".

2. On the same page, in the third column, in the second paragraph, in the fourth line, "Scheduling" should read "Schedule".

§ 1308.12 [Corrected]

3. On page 11043, in the third column, in § 1308.12(f)(2), in the first line, "Nabiline" should read "Nabilone".

4. On the same page, in the same column, in § 1308.12(f)(2), in the second line, "(+)-*trans*-" should read "(±)*trans*-".

BILLING CODE 1505-01-D

NUCLEAR REGULATORY COMMISSION

[Docket No. 50-252]

Finding of No Significant Environmental Impact Regarding Proposed Amendment to Facility Operating License No. R-102; the University of New Mexico

Correction

In notice document 87-7428 appearing on page 10834 in the issue of Friday, April 3, 1987, make the following correction:

On page 10834, in the second column, in the first line, "1986" should read "1966".

BILLING CODE 1505-01-D

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 71 and 75

[Airspace Docket No. 86-AWP-18]

Proposed Alteration of VOR Federal Airway and Jet Routes; Nevada

Correction

In proposed rule document 87-5996 beginning on page 8920 in the issue of Friday, March 20, 1987, make the following correction:

On page 8920, in the third column, under **The Proposals**, in the first paragraph, in the ninth line, "40°07'35"N., long." should read "40°07'30"N., long.".

BILLING CODE 1505-01-D

federal register

Wednesday
April 15, 1987

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Part 1926

Occupational Safety and Health Standards; Excavations; Proposed Rule

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1926

[Docket No. S-204]

Occupational Safety and Health Standards; Excavations

AGENCY: Occupational Safety and Health Administration, Labor.

ACTION: Notice of proposed rulemaking.

SUMMARY: With this notice, the Occupational Safety and Health Administration (OSHA) proposes to revise a portion of the construction industry safety standards addressing excavations. The proposed revisions are intended to correct problems related to the use of existing standards.

The existing standards regulate the use of support systems, sloping and benching systems and other systems of protection as means of protection against excavation cave-ins. In addition, the standards regulate the means of access to and egress from excavations, and employee exposure to vehicular traffic, falling loads, hazardous atmospheres, water accumulation, and unstable structures in and adjacent to excavations.

The proposed revisions would use performance criteria where possible, rather than specification requirements. The proposed revisions would also consolidate and simplify many of the existing provisions; add and clarify definitions; reformat the standard to eliminate duplicate provisions and ambiguous language; provide a consistent method of soil classification; and give employers added flexibility in providing protection for employees.

This is another step in OSHA's plan to review its safety standards and to revise them as necessary to provide safer working conditions without unduly burdensome requirements. This proposal is being issued after appropriate consultation with the Advisory Committee on Construction Safety and Health (ACCSH).

DATES: Comments on this proposed rulemaking must be postmarked by June 15, 1987. Hearing requests must be postmarked by June 15, 1987.

ADDRESS: Comments and requests for hearings are to be sent to the Docket Officer, Docket No. S-204, U.S. Department of Labor, Room N-3670, 200 Constitution Avenue, NW., Washington, DC 20210.

FOR FURTHER INFORMATION CONTACT: Mr. James Foster, Director, Office of Information and Consumer Affairs, Occupational Safety and Health Administration, U.S. Department of Labor, Room N-3637, 200 Constitution Avenue, NW., Washington, DC 20210, (202) 523-8151.

SUPPLEMENTARY INFORMATION:

I. Background

A. History

Congress amended the Contract Work Hours Standards Act (CWHSA) (40 U.S.C. 327 et seq.) in 1969 by adding a new section 107 (40 U.S.C. 333) to provide employees in the construction industry with a safer work environment and to reduce the frequency and severity of construction accidents and injuries. The amendment, commonly known as the Construction Safety Act (CSA) (Pub. L. 91-54; August 9, 1969), significantly strengthened employee protection by providing for occupational safety and health standards for employees of the building trades and construction industry in Federal and Federally-financed or Federally-assisted construction projects.

Accordingly, the Secretary of Labor issued Safety and Health Regulations for Construction in 29 CFR Part 1518 (36 FR 7340, April 17, 1971) pursuant to section 107 of the Contract Work Hours and Safety Standards Act.

The Occupational Safety and Health Act (the Act) (84 Stat. 1590; 29 U.S.C. 650 et seq.) was enacted by Congress in 1970 and authorized the Secretary of Labor to adopt established Federal Standards issued under other statutes, including the Construction Safety Act, as occupational safety and health standards. Accordingly, the Secretary of Labor adopted the Construction Standards in 29 CFR Part 1518 as established Federal Standards in accordance with section 6(a) of the Act (36 FR 10466, May 29, 1971). Part 1518 was redesignated as Part 1926 later in 1971 (36 FR 25232, December 30, 1971). The standards in Subpart P of Part 1926, titled § 1926.650—General Protection Requirements; § 1926.651—Specific Excavation Requirements; § 1926.652—Specific Trenching Requirements; and § 1926.653—Definitions Applicable to this Subpart, were adopted as OSHA standards as part of this process.

The need for review and revision of § 1926.650 through § 1926.653 has been recognized by OSHA since the earliest days of the Agency's existence. Consequently, after a Notice of Proposed Rulemaking (36 FR 19083, September 28, 1971) and after a review by the Advisory Committee on Construction Safety and Health (ACCSH), several amendments of a technical nature were made to Subpart P (37 FR 3512, February 17, 1972). Subsequent to the adoption of those amendments, OSHA found it necessary to further amend the standard. After a Notice of Proposed Rulemaking (37 FR 15317, July 29, 1972) § 1926.652 was amended to require ladders as a means of access and egress in trenches greater than four feet (1.2 m) in depth—instead of three feet (.9 m) in depth (37 FR 24345, November 16, 1972).

In 1976, OSHA, in response to continued complaints concerning the adequacy of the standards in Subpart P, engaged the National Bureau of Standards (NBS) to study the compatibility of the technical provisions in the regulations with actual construction practice. In addition, NBS was to examine the state of the knowledge in geotechnical and structural engineering; to review the field experience accumulated since the promulgation of the standards; and to recommend potential modifications that could improve the effectiveness of the standards.

Findings and preliminary recommendations of the NBS studies were presented and discussed at a Federally-sponsored workshop in September 1978. Six reports were then completed as a result of the NBS work, and these were published in 1979 and 1980. Copies of these reports are part of the public record (Exs. 1 through 6).

As a result of the development of these recommended changes, private industry proposed and sponsored a series of five workshops (herein after referred to as the "workshops" or the "industry-sponsored workshops") in the spring and summer of 1981 to discuss and comment on ways to implement the NBS recommendations. An unpublished text was used at these workshops (Ex. 7). Final recommendations for technical changes to the standards incorporating the comments from the industry-sponsored workshops were prepared by NBS in May 1983 (Ex. 26).

Excavation-related accidents resulting in injuries and fatalities have continued to occur at construction sites despite the development and promulgation of the OSHA Construction Standards in 1971 and 1972. However, based upon examination of available data, this trend appears to be, at least in part, the result of non-compliance with existing OSHA standards, rather than a failure of the standards to address the hazards involved in excavation work. Based on a careful review of compliance problems and public comments received since 1972, OSHA believes that the present standard needs updating. The proposed

standard is intended to eliminate certain ambiguities, redundancies, and unnecessary provisions, and would change certain specific requirements into general requirements. In addition, the proposed standard addresses specific problem areas and provides requirements which are more feasible and practical than the existing requirements. The proposal is written in performance-oriented language where possible.

A draft of the proposed changes to the standard was reviewed by ACCSH in October 1982. Transcripts of this meeting are part of the public record (Ex. 8). The Committee's comments and recommendations, and those of other interested parties, have been carefully analyzed as part of the present proposed rulemaking. Many of the changes in the standard being proposed reflect the recommendations and suggestions of these participants. Relevant ACCSH comments are discussed below in Section III—"Summary and Explanation of the Proposed Standard." Committee discussions that were inconclusive have been considered, but are not discussed in this preamble. Several suggestions for changes to the draft standard were made by members of the ACCSH. OSHA seeks more discussion on these suggestions and is, therefore, raising the individual points as issues in this preamble.

B. Problems With the Existing Standards and Proposed Solutions

OSHA's efforts to revise its excavation and trenching standards were initiated primarily because the Agency has experienced difficulty in enforcing the existing standards. Several of these problems are discussed in detail below.

"Specific Excavation/Specific Trenching Requirements"

The first major problem with the existing standards is that because § 1926.651 and § 1926.652 are two separate sections, one entitled "Specific Excavation Requirements" and the other "Specific Trenching Requirements," the standards are not clear as to which of these requirements must be followed in trenches. It was intended that many of the excavation standards would also apply to trenches since a trench is a type of excavation.

The Occupational Safety and Health Review Commission (OSHRC) and one United States Court of Appeals, have sanctioned the application of the excavation standards in § 1926.651 to trenches (*Dobson Brothers Construction Company*, 3 BNA OSHC 2035 (R.C. 1976); and *D. Federico Company, Inc.*, v. *OSHRC and Usery*, 558 F. 2d 614 (1st Cir 1977) 5 BNA OSHC 1528, respectively). However, another Court of Appeals has held to the contrary that excavation standards cannot be applied to trenches (*Lloyd C. Lockrem, Inc.* v. *OSHRC*, 609 F. 2d 940 (9th Cir. 1979) 8 BNA OSHC 1316).

This proposal resolves the uncertainty left by these decisions and the language ambiguity of the existing standards by setting forth one set of requirements which are applicable to all excavations, including trenches. Where there are requirements intended to be applicable only to trenches—such as the requirement that ladders or equivalent means of egress be provided every 25 feet horizontally—the proposed standard makes it clear that the requirement applies only to those excavations which are also trenches (see proposed § 1926.651(c)(2)).

Excavations (Non-Trench)

A second major problem with the existing standards involves the requirements for protecting employees in nontrench excavations from the hazards of a cave-in. Existing § 1926.651(c) currently requires: "The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means." The term "danger from moving ground" is not defined in the standard and, thus, the standard does not specify when an employer must take any precautions to protect employees from a cave-in. Furthermore, the standard does not specify what degree of precaution an employer must take even when employees are exposed to a "danger from moving ground." Requirements in this regard are, however, contained in § 1926.651 (e), (f), (g), and (h).

This issue was resolved somewhat when the OSHRC, in agreement with the Secretary of Labor, interpreted the standard to require shoring or sloping in accordance with *Table P–1* of Subpart P, whenever employees are exposed to unstable soil in excavation sides (*M.J. Lee Construction Company*, 7 BNA OSHC 1140 (R.C. 1979); *Terra Motus Company, Inc.*, 5 BNA OSHC 1696 (R.C. 1977); *D. Federico Company, Inc.*, 3 BNA OSHC 1970 (R.C. 1976) affirmed on the grounds, 558 F. 2d 614 (1st Cir 1977) 5 BNA OSHC 1528). However, the problem was revived by two OSHRC decisions which are inconsistent with the cases mentioned above. In the first case, *Seaward Construction Company, Inc.*, 5 BNA OSHC 1422 (R.C. 1977), the OSHRC interpreted § 1926.651(c) to require sloping and shoring only if OSHA establishes that the ground to which employees are exposed is actually moving. In the second case, *Pipe-Rite Utilities Ltd., Inc.*, 10 BNA OSHC 1289 (R.C. 1982), the OSHRC, relying on *Seaward*, vacated a citation and did not address the other cases interpreting paragraph 1926.651(c).

These decisions reestablished the uncertainty as to when and to what degree an employer must slope, shore or otherwise protect employees in a non-trench excavation. OSHA has long maintained that employees exposed to potential cave-ins must be protected by shoring or sloping long before the excavation face is in imminent danger of collapsing.

Another problem with the standards for non-trench excavations is that the required degree of protection is not always easily determined. With regard to sloping, the existing § 1926.651(g) provides that "All slopes shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting." To find the angle of repose an employer must consult *Table P–1* which appears at the end of § 1926.652, "Specific Trenching Requirements." *Table P–1* is titled "Approximate Angle of Repose for Sloping of Sides of Excavations." The difficulty with *Table P–1* is that it describes the approximate angle of repose for various soil types in terms that are not the same as terms commonly used in the industry to classify soils. In addition, the terms are not defined in the standard. Thus, it is sometimes very difficult to derive the appropriate degree of sloping from this Table.

OSHA recognizes a problem with the term "angle of repose." The term is used in the standard in a manner which is inconsistent with its meaning in the civil engineering profession. In the American Society for Testing and Materials (ASTM) Standard D653–67, "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics," the term "angle of repose" is defined as follows: "The angle between the horizontal and maximum slope that a soil assumes through natural processes. For dry granular soils the effect of height is negligible; for cohesive soils the effect of height is so great that the angle of repose is meaningless." Thus, to talk in terms of a single "angle of repose" is technically inaccurate. The "angle of repose" for cohesive soil depends on the depth of the excavation, whereas the "angle of repose" for granular soil depends largely on densification and changes in environmental conditions of exposure, such as the drying process.

The proposal has sought to rectify these problems by setting forth requirements for the sloping of excavations that are clear and consistent with the terms used both in the civil engineering profession and in the construction industry. This is accomplished in proposed § 1926.652(b) which provides three options for sloping. These three options are: (1) Sloping to a specified angle from the horizontal in accordance with the most conservative assumptions as to soil conditions; (2) sloping in accordance with appendices A and B to Subpart P which allow steeper slopes after the employer has determined that the excavation is located in a soil which is suitable for a steeper slope; or (3) sloping in accordance with the directions of a qualified person *or* a qualified engineer.

In the proposal, OSHA permits a "qualified person" or a "qualified engineer" to design protective systems and structural ramp, to prepare tabulated data, and to determine if excavations below the footing of a foundation or retaining wall can be accomplished safely. The existing standard permits supporting systems to be designed by a "qualified person" (§ 1926.651 (f) and (k)). Additionally, existing § 1926.651(x) permits the "qualified person" to design ramps. Requirements for sloping (§ 1926.651(e) and § 1926.652(b)) and for excavations below footings or adjacent to structures (§ 1926.651 (n), (o)) imply that these are the responsibility of the "qualified person." Input received during the preparation of this proposal seems to indicate a "qualified person" as defined in § 1926.32(l) of the existing construction safety standards may have significant expertise in many phases of excavation work, but may well be unable to demonstrate any expertise specifically relating to the design of cave-in protective systems.

Modifying the standard to permit only a "qualified engineer" to undertake design responsibilities is one suggested remedy which the Agency is considering. However, considering the potentially adverse impact on small firms which do not normally employ engineers, OSHA is proposing to allow either a "qualified person" or a "qualified engineer" to perform design responsibilities provided that the design is in accordance with accepted engineering practice. The Agency is concerned about the qualifications necessary to design protective systems, and solicits public input on this issue.

Need for Clarification of Trench Requirements

OSHA has learned from its enforcement experience with § 1926.652 "Specific Trenching Requirements" that much can be done to clarify the meaning and intent of these standards. The key provisions of the current specific trenching standards are § 1926.652(b) (for trenches in soft or unstable soil) and § 1926.652(c) (for trenches in hard or compact soil).

The main difficulty with §§ 1926.652(b) and 1926.652(c) is that the terms "soft or unstable" and "hard or compact" do not, in some instances, provide sufficient guidance to employers as to the requirements applicable to a trench. The OSHRC has held that any trench requiring a slope less steep than 63 degrees from the horizontal under *Table P–1* must be considered to be in soft or unstable soil within the meaning of § 1926.652(b).

Since § 1926.652(c) requires a slope of not steeper than ½ to 1 for hard or compact soil, it is evident that these materials listed in Table P–1 as having a less steep angle of repose must be considered soft or unstable, and are therefore regulated by § 1926.652(o). (*Connecticut Natural Gas Corporation*, 6 BNA OSHC 1796, (R.C. 1978)).

Although the OSHRC ruling harmonizes the existing regulations, it is preferable for employers to know which requirements they are subject to before determining the extent to which they must slope, rather than determining the slope first and then determining the regulation with which they must comply. In some instances, this is not a difficult problem under the current standard. For example, for many granular soils, an employer is not going to have a problem determining that a slope of ½ to 1 (approximately 63 degrees from the horizontal) is inadequate, and that § 1926.652(b) applies to the trenches excavated in such soil. Indeed, the OSHRC has ruled that there is a rebuttable presumption that predominately sandy soils, unless cemented, are soft or unstable within the meaning of 1926.652(b). (*Duane Meyer d/b/a D.T. Construction Company*, 7 BNA OSHC 1560 ((R.C. 1979)). However, there are situations under the existing standard in which it is not easily determined which sloping angle applies. For example, if a trench is excavated in previously disturbed cohesive soil, the existing standard gives little guidance as to which standard applies or what constitutes an adequate slope under *Table P–1*. And, since the sloping requirements of § 1926.652 are contained in *Table P–1*, the shortcomings of that Table (previously discussed above under non-trench excavations) are also a problem with the existing standards regulating trenches. In addition to the technical misuse of the term "angle of repose," the Table classifies soils in a manner that is difficult to relate to the soil descriptions used in § 1926.652 (b) and (c), and the terms used are not the same as terms generally used in the construction industry.

The proposed standard rectifies these problems in two ways. First, it provides employers with a soil classification scheme in appendix A which describes the variables an employer can encounter; and secondly, it sets forth sloping and shoring requirements in accordance with the types of soil, as determined with respect to the soil classification system. As discussed above, the employer also has the option of sloping in accordance with the directions of a qualified person or a qualified engineer, or simply sloping under the conservative assumptions. In OSHA's opinion, the soil classification system in appendix A will make it much easier for employers to determine whether their slopes comply with OSHA's requirements.

Section 1926.652(c) has caused compliance problems in one other important respect. The standard requires sloping of at least ½ to 1 (horizontal to vertical) but requires only that sloping begin five feet (1.52 m) from the bottom of the trench. This standard has been interpreted as permitting a trench dug in hard or compact soil to be vertical for the first five feet (1.52 m) from the bottom, and sloped not more than 63 degrees from the horizontal beginning at the five foot (1.52 m) level (*Horowitz Brothers, Inc.*, 3 BNA OSHC 1131 ((R.C. 1975)).

OSHA believes that this interpretation is inadequate because it is dangerous to allow employees to work in a trench excavated in soils in which the sides are vertical for the bottom five foot (1.52 m) portion and then sloped starting at the five foot level. This is particularly true in a relatively deep trench in which the weight of cohesive soils adversely affects the stability of the trench side. OSHA has always interpreted and enforced this provision to require shoring or a trench shield in the unsloped, vertical sided portion of the trench.

To address this problem, this proposed standard clarifies that trenches and excavations be sloped or benched from the bottom, instead of from the five foot (1.52 m) level, unless a qualified person or qualified engineer designs an alternate configuration in

accordance with accepted engineering practices. Acceptable configurations for sloped excavations are illustrated in *Figure B–1* of appendix B.

OSHA believes that sound engineering principles dictate that the five foot deep vertical-sided portion should be shored. The National Bureau of Standards (Ex. 3) depicts a similar situation in figure A–2, but recommends a three foot maximum vertical-sided portion and a slope of not more than 1 H: 1 V (45°). Additionally, figure A–7 depicts another similar situation where the depth of the vertical-sided portion is approximately four feet deep, *shored,* and the slope is 1 H: 1 V (45°). OSHA solicits comment on the appropriateness, and costs and benefits of the above discussed configurations with special emphasis on the OSHA interpretation.

Existing § 1926.652(g)(1) provides that shoring be installed in accordance with *Table P–2,* "Trench Shoring-Minimum Requirements." This has been changed in the proposal to afford employers greater flexibility in designing shoring systems. In the proposal, employers can choose between several optional approaches for designing shoring. They can: (1) Conform to the specific requirements contained in Appendices A and C; (2) rely on other tabulated data prepared by a qualified person or a qualified engineer, including manufacturer's tabulated data or state regulations promulgated under an approved State plan and determined by OSHA to be "as effective as Federal regulations;" or (3) use a support system designed by a qualified person or a qualified engineer.

The proposal would assure that shoring that departs from the specific requirements of the appendices is designed by a person qualified to make the judgment that the shoring is adequate based on accepted engineering practices.

Trench Boxes and Shields

The requirements for trench boxes and shields are currently contained in § 1926.652(k). The requirements are not totally clear as to their intent with regard to the design of shields. For example, the standard requires that such devices "shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench." In addition, the standard defines a trench shield as "A *shoring system* (emphasis added) composed of steel plates and bracing . . . which support the walls of a trench. . . ." Shields may be constructed out of steel, but need not be, and they may provide support to the side of a trench. However, shields are more often used in a manner where they do not support the side but rather act as a barrier in the event a cave-in occurs. Because of the restrictive nature of the existing definition, and since the design of sheeting and shoring is tied to the requirements for timber shoring and sheeting set forth in *Table P–2* "Trench Shoring—Minimum Requirements," some observers have perceived a lack of flexibility on the part of OSHA regarding the design of trench shields.

Another problem with the existing requirements for trench shields is the lack of coverage addressing hazardous situations that arise out of the use of shields. Shields are used somewhat differently than shoring, and so situations arise when using shields that do not arise when using shoring. For example, shields are moved into position by sliding them along the trench bottom or by lowering them into position. Employees who are within the confines of a shield during its repositioning are subject to being injured if the shield suddenly shifts in an unintended way—a hazard not generally arising out of the use of timber shoring.

The requirements for trench boxes and shields in current § 1926.652(k) would be changed to allow employers more flexibility in the design of trench shields. The proposal would also clarify the way in which an employer must assure that shields provide equivalent protection to sloping or shoring required by the standard. It would allow an employer to use a trench box or shield designed under the direction of a qualified person or a qualified engineer, or from tabulated data prepared by a qualified person or a qualified engineer. Qualified individuals involved in the design of shield systems will use accepted engineering practices and their expertise and capabilities to assure that the systems can resist the loads imposed on shields.

For manufactured rather than job-made trench boxes or shields, the proposal would require that employers comply with all manufacturer's instructions which might affect the safety of employees. Because of the manufacturer's concerns with product liability, these instructional materials are intended to establish a method or methods which the manufacturer has determined will provide for safe installation and use of a product. The user is thereby on notice of the precautions set forth in these materials, and is responsible for implementing them. Additionally, requirements would be added that address the hazardous situations that arise during the course of using a shield, but are not now addressed in the existing standard. In OSHA's opinion, these requirements will assure that shield systems will adequately protect employees.

II. The Nature of Excavation Hazards and Accidents

Excavation Hazards

The primary hazard to which employees may be exposed during excavation work is that of a cave-in of the excavation. A cave-in occurs when the soil forming the side of the excavation can no longer resist the forces being applied to it. This situation results from either a reduction in the frictional and cohesive capacities of the soil to resist forces, or from exceeding the overall capacity of the soil to resist forces. Changing environmental conditions, such as freezing and thawing, or the addition or removal of water from the pores of the soil, can reduce the ability of the soil to resist forces. Dynamic loads from vibrations caused by nearby traffic or from construction operations, such as pile driving, can also reduce the ability of a soil to resist forces.

The addition of surcharge loads from spoil piles, or the placement of heavy equipment or material near the edge of an excavation, creates forces that can exceed the ability of the soil to resist. Likewise, the load imposed on the soil from adjacent structures can cause soil to cave in if the excavation is too near the structure.

There are several different methods of protecting employees from cave-ins. Protection can be provided by sloping or benching the sides of the excavation; by supporting the sides; or by placing a shield between the side of the excavation and the work area.

Sloping and benching provide protection by eliminating the cave-in hazard. Soil is removed so that a cave-in will not occur. Determining the proper slope or bench configuration for a particular situation can be a highly complex engineering problem. An insufficient slope for the conditions of exposure creates a hazard to employees.

Support systems are provided to add another factor of resistance to the forces that could cause a cave-in. However, the installation of a support system introduces material handling procedures, installation procedures, and removal procedures that can be hazardous in themselves unless accomplished in a safe manner. The possibility of a cave-in also continues to exist during the installation and removal of support systems.

As with sloping, determining what constitutes an adequate support system can also be a complex problem. The hazard of the support system being inadequate to resist the forces applied to it exists if the system has not been carefully designed. The system must have the capacity to resist all the forces that are anticipated or could reasonably be expected to be applied to it. Additionally, improperly installed support members, or the use of inadequate or damaged materials in a support system, could result in a system capacity less than that intended.

Shield systems, unlike support systems, do not eliminate the possibility of a cave-in or add to the factors resisting a cave-in. Shield systems do not prevent cave-ins, but instead provide a shelter to employees in the event that a cave-in occurs. Because a shield is a structure, it must be properly engineered to resist static and impact loads imposed during a cave-in in order to protect the employees within the area shielded. Lateral movement of shields is another hazard that must be considered when shield systems are utilized.

Shield systems most often protect only a very small portion of the area where a cave-in could occur. Employees are therefore exposed to a cave-in hazard if they stray from the protected area. This could occur during entry and exit procedures, or during periods of work activity, unless other precautions are taken.

In addition to cave-in hazards, and secondary hazards related to providing protection against cave-ins, there are several other hazards from which employees must be protected during excavation-related work.

Excavations frequently are made adjacent to existing structures. Excavation activity can create a situation where such structures are destabilized and collapse, thus endangering employees in and around the excavation.

Frequently, underground utilities are encountered and, if damaged, can expose employees to fire and explosion, rapid flooding, electrocution or the release of toxic substances.

Excavations are often made in or near streets, thus exposing employees to vehicular traffic due to both construction and non-construction activity.

Excavation operations include the loading and unloading of earth, fill and other construction material which creates the hazard of falling loads during these operations.

Exposure to hazardous atmospheres is another hazard that can be encountered during excavation work. Hazardous atmospheres can result from many sources related to both construction and non-construction activity. For example, some construction activities, such as welding, produce toxic fumes. Hazardous materials that have been carelessly dumped, or materials that leak from storage tanks underground, can create hazardous atmospheric conditions if the ground is excavated. Excavations near landfill areas can also possibly develop concentrations of hazardous substances from the decomposition of material within the fill.

Hazards related to methods of access and egress are common on excavation sites. Both construction equipment and employees enter and exit excavations. Earth and structural ramps can collapse if not properly designed and constructed to resist the loads imposed. Trips and falls can also occur where runways are not adequately constructed.

Accidents and Injuries

Studies show that excavation work is one of the most hazardous types of work done in the construction industry (Ex. 9 and Ex. 10). Accidents in excavation work occur more frequently than do accidents in construction in general. The primary type of accident of concern in excavation-related work is a cave-in. The actual number of cave-in accidents is not large when compared to the estimated total number of accidents occurring in all of construction. However, those that do occur tend to be of a very serious nature. Cave-in accidents are much more likely to be fatal to the employees involved than other excavation-related accidents.

The true extent of excavation-related injuries and deaths cannot be readily determined from available accident data such as those maintained by the Bureau of Labor Statistics (BLS). This is because a large number of cave-in accidents are classified under a general "accident-type" heading that does not specifically identify whether the accident involved a cave-in. For example, cave-in accidents are most likely to be recorded under the "accident-type" category of "caught in, under, or between." This category encompasses many accidents that are not excavation-related, such as those in which an employee becomes caught in the moving parts of machinery. There is no apparent way to separate out those accidents that are cave-ins.

Nevertheless, estimates of the number of injuries and fatalities occurring in excavations have been made. In a 1975 study, based primarily on a previous study of newspaper articles and other data made available from OSHA files, it was estimated that more than 100 persons were killed in excavation cave-ins each year (Ex. 11). In contrast, based on a recent report prepared by NIOSH and from OSHA's inspection data, it was estimated that at least 73 persons were killed each year in cave-in accidents and at least 97 persons were killed as a result of all excavation-related accidents (Exs. 24, 30, 31, and 32). Using the same data, OSHA has estimated a fatality rate due to excavation-related work injuries of .318 per 1,000 full-time workers and .427 per 1,000 full-time workers for SIC 1623. These rates are at least similar to, if not higher than the fatality rate of .290 per 1,000 full time workers due to all types of work injuries occurring in construction in general. The fatality rate for *trenching* work was estimated to be as high as 112 percent greater than the rate for construction in general.

Estimates of non-fatal injuries have also been made. California has reported that the ratio of non-fatal, lost-time injuries to fatalities for all types of accidents in sewer, pipeline, and trenching work was 50 to 1. That is, one fatality occurred for every 50 non-fatal, lost time injuries. In contrast, the ratio for all contract construction was 174 to 1 (Ex. 9).

In another report specifically related to cave-ins, California reported that the ratio of lost-time injuries to fatalities due only to cave-in accidents was 17 to 1. In contrast the lost-time work injuries to fatalities for all types of accidents in all industries was 250 to 1 (Ex. 10).

As a measure of the seriousness of cave-in accidents, Thompson and Tannenbaum stated that ratios of injuries to fatalities due to cave-ins as high as 10 to 1 and 14 to 1 have been reported (Ex. 11).

OSHA, using most recent data, has estimated that at least 6,790 non-fatal lost-time injuries related to excavation and trenching work occur annually. This estimate is based on the assumption that the ratio of non-fatal lost time injuries to fatalities is 70 to 1 for all types of accidents, including, but not limited to cave-ins in the construction industry (Exs. 24, 30, 31, and 32).

The following examples of recorded accidents will serve to illustrate the types of excavation-related accidents that injure and kill employees working in construction. The list reflects selected examples that are indicative of the types of accidents that have continued to occur. The list is not intended to address all types of excavation-related accidents that occur.

- *California, 1976.* The collapse of a trench took the life of a geologist. The trench was three feet wide, 13 feet deep, and had vertical walls that were not

shored. The geologist was warned that the ground was unstable, but ignored the warnings. Once inside the trench, he was quoted as saying, "This sure looks bad in here. It looks like it's going to cave in." Ten seconds later a cave-in occurred and completely covered him (Ex. 14, p. 15).

• *Indiana, September 1980.* An employee was fatally injured in a sewer trench when the sides of the trench collapsed. There was no shoring to support the sides of the trench and the sides were not sloped (Ex. 22).

• *Texas, March 1981.* Two employees were laying a utility pipe in a trench six feet deep. The sides of the trench caved in, killing one worker and seriously injuring the other (Ex. 19).

• *Utah, April 1981.* A worker was killed when a trench in which he was laying water pipe gave way. The victim was standing in a trench about five feet deep and three feet wide dug in sandy soil. The side of the trench caved in, crushing the man against the other side of the trench. Although his head remained above the soil, he died almost instantly from massive internal injuries to the windpipe, lungs and liver (Ex. 16).

• *California, 1968.* In one accident, a trench 13 feet deep was thought to be stable because it had sides of rock. During the digging, an old trench filled with backfill was encountered. A laborer who entered the trench to see how close the backhoe was digging to a sewer main was knocked down and buried when the backfill from the old trench caved in. Although his head remained above the piled earth, the worker died of suffocation and multiple internal injuries (Ex. 9, p. 5).

• *California, 1968.* A laborer was helping to install shoring in a trench about 10 feet deep, when the material caved in under the existing shoring, covering his feet and lower legs. Before he could be rescued, the whole side of the trench caved in, covering him completely. The accident was caused by the unstable bank material falling in below the bottom of the shoring system that extended to about two and one-half feet from the bottom of the trench. When this happened, the pressure on the hydraulic-type shores was released, causing them to collapse (Ex. 9, p. 3).

• *California, 1968.* A pipeline trench, 600 feet long and 15 feet deep, was dug in sandy soil. About 550 feet of pipe had already been laid, the shoring removed, and the trench backfilled. A worker was assigned to compact the backfill in the remaining 50 feet and to remove the shoring. He then removed a lower jack and threw it from the trench. When he tried to remove the upper shore, there was so much earth pressure on it he required help to force it free. When the shoring jack released, the earth wall collapsed, burying the employee in the trench (Ex. 9, p. 4).

• *Georgia, May 1965.* Two workmen were killed and six others injured when a building under construction collapsed. A backhoe being used to excavate a sewer line inside the building dug adjacent to a column and some five to 15 feet below it. The undermined column slid into the excavation, thus triggering the collapse. Workmen are reported to have noticed flaking of the soil prior to the collapse (Ex. 17, p. 29).

• *California, 1968.* A lateral trench was dug at right angles to a main trench that was eight feet deep. Digging in the lateral trench undermined supports of a six-inch water main, causing the pipe to sag and then break. The trench quickly filled with earth and water. Fellow workers could not pull a laborer who had been installing shoring in the lateral trench loose from the mud which came up to his knees. He was drowned as water filled the trench. It had been assumed that the water line was no closer to the trench than five feet because of the location of a fire hydrant above ground at that distance (Ex. 9, p. 4).

• *Missouri, November 1980.* Employees of a water company struck and ruptured a gas line while digging a trench. Five employees of the gas company were injured when an explosion occurred, followed by fire, during an attempt to repair the leak (Ex. 21).

• *Pennsylvania, July 1981.* An employee was caught in a trench cave-in, but was not killed. During the rescue, the employee suffered deep gashes on his back when rescuers attempted to free him with a backhoe. The employee later died from complications resulting from these injuries (Ex. 23).

• *Arkansas, December 1980.* One worker was killed and three others were seriously injured in a sewer trench cave-in. The three injured jumped into the trench to try to save the first man after a cave-in, but were themselves caught in a second cave-in (Ex. 20).

• *Nebraska, April 1968.* Three workers were killed in a cave-in of an unshored and unsloped trench. The workers had excavated a deep trench alongside a previously undermined bridge abutment to make repairs to the abutment. They were buried to their waists in a cave-in. Before they could be dug out, another cave-in buried them completely (Ex. 18, p. 31).

All such accidents are, of course, complex events and multiple issues must be addressed in order to protect against the human, equipment and environmental factors which can result in injury or death. Among these issues are: Knowledge of the hazards and where protection is required; the types of systems appropriate for use in particular situations; the proper construction, installation and removal of safety systems; proper supervision; proper work procedures; and proper inspection. Each of these topics is covered in the proposed revisions to Subpart P.

OSHA has determined that the available accident and injury data clearly establish a significant risk to employees working in and around excavations. A high rate of injuries has continued to occur in excavations throughout the 14 years since Subpart P was first adopted by OSHA. OSHA believes that this proposed revision of Subpart P will help reduce the current accident toll associated with excavation work.

III. Summary and Explanation of the Proposed Standard

This Notice of Proposed Rulemaking is intended to solicit data, views and arguments on the proposed revision of Subpart P. Comments and recommendations on the proposed revisions together with discussion, explanations, and supporting evidence are particularly solicited.

The reader should recognize that the standard proposed in this notice represents OSHA's current position with regard to the format and content of Subpart P. OSHA intends to evaluate the comments, recommendations, suggestions and evidence received in response to this notice. Based on the record of this rulemaking, the Agency will make modifications and changes in the final rule, where appropriate.

In order to facilitate the desired public comment, this notice not only includes the text and explanation of the proposal, but also identifies several issues to which OSHA directs the reader's attention for special consideration. OSHA wants to focus attention on these issues in order to encourage the submission of additional valuable information from interested persons.

Issues

1. It has been suggested to OSHA (Ex. 8, pp. 108–207) that the revision of Subpart P should include data on "standard practices" for protecting employees against cave-ins. This data would be in the form of tables and charts that could be understood and used by the journeyman worker. Employers would be required to "select" a system of protection from tables and

charts in Subpart P or, as an alternative, have a qualified engineer design the protective system. It has been suggested that OSHA include as "standard practice," generic tables and charts for metal hydraulic shoring, timber shoring, trench shields, protection for footing excavations such as bell-bottom pier holes, and sloping and benching systems.

A. What is the feasibility of this approach?

B. Do such tables and charts now exist?

C. How could such tables and charts be developed for use with manufactured systems without containing proprietary information?

D. With what method of soil classification should all such systems be correlated?

E. What limitations would apply to the use of generic tables and charts?

F. How could such tables and charts incorporate the flexibility needed to insure that technical advances in cave-in protection could be implemented rapidly?

G. In addition to any generic tables and charts that could be created, what supporting data would have to be included to explain their use and limitations?

2. In § 1926.652 of the proposal, OSHA would require, under certain circumstances, that protective systems (which are defined to include shoring, shields, sloping, underpinning, etc.) be designed by a "qualified person" or a "qualified engineer." The definition of "qualified engineer" that OSHA is proposing is new (See proposed § 1926.650(b)(13)). The definition of "qualified person" is provided in current § 1926.32(l).

OSHA has been asked to consider limiting design responsibilities to a "qualified engineer," thus eliminating the "qualified person" as used in the existing standard. This would set up a more stringent level of expertise for design responsibilities, but would exclude individuals who are fully capable of performing the required duties at the higher level of expertise, if they do not possess an engineering degree.

A great deal of debate on this issue has not provided a conclusive answer. (This is further discussed in this preamble in § 1926.650 title: *Scope, Application and Definitions Applicable to This Subpart.*) Since this issue has not been resolved satisfactorily, OSHA is proposing that design and tabulated data be prepared by either a "qualified person" or a "qualified engineer," in order to alert the public to the Agency's concerns.

In order to consider this issue further, OSHA requests comments on the following questions:

A. Should OSHA limit all design responsibility to a "qualified engineer"? Please provide detailed cost data, and rationale for the response.

B. What evidence is available to support that requiring a "qualified engineer" will decrease the risk of injuries and fatalities in excavation work?

C. Should OSHA limit design responsibilities to a "qualified engineer" in unusual situation (for example, excavations under the foundation of buildings)? Please provide a detailed response.

D. If OSHA does limit design responsibility to a "qualified engineer," is the proposed definition of "qualified engineer" adequate for the purpose of this proposal?

E. If the proposed definition is not acceptable, what is a more acceptable definition of "qualified engineer" for purposes of this proposal?

F. What are the reasons why OSHA should or should not require a "qualified engineer" to be a "registered professional engineer"?

G. Should OSHA recognize "experience", or other factors such as training, as a factor for determining the qualifications of an individual to design protective systems?

H. What objective criteria are available to enable the employer to evaluate experience or other factors as a qualification?

I. Should such criteria be incorporated into the standard? If so, how?

J. Information collected indicates that few small excavation firms employ or hire a "qualified engineer". If OSHA does limit design responsibility to a qualified engineer what would be the likely impact on small business? What would be the costs of such a requirement? Would the costs fall disportionately on small business?

3. In proposed § 1926.652, the requirements for designing protective systems are set forth. Several approaches, described as options, are given. Employers can, but need not, choose to follow appendix B for sloping and benching or appendix C for timber shoring in trenches. If employers choose to follow either of these appendices, then appendix A must also be followed.

Appendix A describes a method of classifying soil conditions. Some form of manual and visual testing is required in order properly to classify a soil in accordance with the system described in the appendix. This requirement is stated in paragraph (c)(2) of appendix A.

There are several visual and manual tests that are described in appendix A. However, these tests are only *recommended;* it is not required that any of these particular tests be conducted. It has been suggested to OSHA that specific tests, such as the penetrometer or vane shear tests for cohesive soils, or laboratory tests for granular soils, should be made *mandatory.*

As an alternative to using appendix A, OSHA could allow employers to use any visual and manual test to classify soil, but could establish a preference for particular tests in the following manner. OSHA could state that in the event that there is a disagreement between the employer and OSHA as to the proper classification of the soil, a classification predicated on either a laboratory test, penetrometer, or shear vane test would be considered more accurate than a classification that is not based on these tests. Further, in the context of litigation, any classification which is predicated on a laboratory test, penetrometer, or shear vane test would be given a presumption of reliability over any classification not based on one of the aforementioned tests. However, this presumption of reliability could be rebutted by the party relying on other methods of classification.

A. Is there a need to mandate specific tests? Please provide a detailed response.

B. What is the feasibility of mandating a specific test or of the suggested alternative?

C. What limitations, if any, are there to the use of any particular tests under given soil conditions?

D. Should additional testing requirements be made mandatory? If so, which ones?

E. If certain tests were made mandatory, how frequently would they have to be conducted?

4. In the proposed standard, appendix B sets forth provisions for sloping and benching. Use of this appendix is optional, but when it *is* used, the specified maximum allowable slopes are mandatory. In the proposed appendix B, the maximum allowable slopes specified vary, primarily with soil type and time of exposure. Time of exposure is expressed as short-term and long-term, with the division point at 72 hours. Flatter slopes are required in long-term excavations. (A discussion of the effects of the passage of time on the stability of excavation sides can be found in Ex. 5, pp. 20–30.)

It has been suggested that the concept of time, expressed as short-term and long-term, should not be used in the proposed standard, and that only one

set of maximum allowable slopes should apply, regardless of the length of time an excavation is open (Ex. 8, pp. 304–308).

(Note.—This issue is discussed in greater detail below in this Preamble in the Summary and Explanation of appendix B).

A. Should the standard recognize the effects of the passage of time on the stability of excavation sides?

B. If 72 hours is not an adequate dividing point between short-term and long-term, what length of time should constitute the short-term?

5. It has been suggested that when shields are used as protection against cave-ins, employers should be required to have the *design specifications* for the shields available at the worksite, and that shields also should be certified that they can in fact withstand the specified maximum loads (Ex. 8, pp. 295–302, and pp. 186–208).

A. What effects would such a requirement have on manufacturers of shields and users of shields?

B. What is the current industry practice regarding the availability of design specifications and certification of shields?

6. It has been suggested that when a support system is used as protection against a cave-in, employers should be required to have the design specifications, including a plan or drawing and a statement as to the system's limitations, available at the worksite (Ex. 8, pp. 392–398).

A. What effects would such a requirement have on employers?

B. What is the current industry practice regarding the preparation and availability of drawings indicating the layout of support systems in excavations including trenches?

7. It has been recommended by the Advisory Committee for Construction Safety and Health (ACCSH) to include a new fall protection requirement in the revision of Subpart P. This provision would require that some form of warning such as a warning line, cones, signals, or barricades be used along the edges of excavations that are five feet or more in depth to warn employees who work adjacent to excavations, but who are not directly involved with the excavation activity, that a fall hazard exists (Ex. 8, pp. 256–272, 278–288, 408–420). OSHA solicits comments on the need for such a provision.

8. OSHA is proposing that certain inspections be required (See proposed paragraph 1926.651(k)). It was recommended that OSHA also require that a written log or record be kept at the jobsite of these inspections (Ex. 8, pp. 390–391, 402–404). The purpose of the written log would be to help ensure that the required inspections are made. Public comment is requested on whether such a record should be required, what the format and content of the record should be, and what costs would be incurred as a result of such a requirement. If such a record is advisible, why would a certification not be sufficient?

9. It was suggested that OSHA include a new provision in the proposed standard that would require that a "top-man" be present to observe the work being conducted within the excavation, and to watch constantly for signs of danger when employees are in an excavation. This requirement would apply whenever a shield or any other protective device or system is used to protect employees against cave-ins.

A. To what extent would such a requirement help to increase safety in excavation work?

B. What other job duties, if any, could be assigned to the "top-man" without impairing the duty to watch for signs of danger?

C. What should be the responsibilities of the "top man" in the event that a dangerous situation is identified?

D. What costs would be incurred as a result of adding such a requirement?

10. Section 1926.652 of this proposal allows three options for providing employee protection by sloping, and four options for the use of shoring. OSHA is considering allowing a fourth option to address sloping. This option would permit the use of tabulated data and would have similar requirements to Option Three which addresses shoring. The intent would be to allow the use of tabulated data based on a recognized soil classification system and prepared by a qualified person or a qualified engineer, in designing sloping and/or benching systems in a larger geographic area (for example a county or a portion of a county), as opposed to the proposed sloping Option Three which is site specific. OSHA solicits comments, opinions and data related to the feasibility of adding a fourth option to those addressing sloping. Additionally, OSHA needs to know if this type of data is currently available, and what restrictions should be applied if this type of option were to be allowed.

11. Section 1926.652(g)(1)(iv) of this proposed revision prohibits employees from being inside shields when the shields are being installed, removed or relocated. OSHA has been asked to permit employees to remain inside shields during repositioning (moving the shield along a trench as work progresses), if employees use proper precautions. OSHA solicits comments and opinions on the feasibility of this request and additionally requests input as to what work practices, precautions, etc., should be required if this practice is permitted.

12. The proposed appendix A to Subpart P of Part 1926 provides a consistent soil classification system for use with the standard. Under this system, hardpan and caliche soils are considered "Type A" soils. OSHA has been asked to consider moving hardpan and caliche soils to the stable rock classification, thereby relaxing the protective measures required in these types of soils. OSHA solicits comments, information and opinion on the feasibility and potential cost and benefits, of this request. Please supply supporting data. For the purpose of this issue, "caliche" means a hard soil layer cemented by calcium carbonate found in arid and semiarid regions; and "hardpan" means a hard, unbroken subsoil, or bedrock.

13. Section 1926.651(g)(2)(ii) of this proposal addresses bell bottom pier holes. OSHA has received oral comments indicating that this subject warrants additional coverage under a separate section in Subpart P due to the hazards associated with this type of excavation. OSHA solicits comments and opinion on the need for a separate section addressing bell bottom pier holes and additionally requests input as to what this section should address.

14. OSHA has been asked to permit the use of established regional practices for the construction of protective systems. The Agency feels this added flexibility could be beneficial, but that some criteria need to be established in order to insure that these practices indeed are effective. Some criteria that the Agency is considering are: Approval by local authorities (regional, state, municipal); and, a proven safety record of at least five years of successful application without any failures.

OSHA solicits comments and opinion on the use of established regional practices, and on criteria that should be used to determine if these practices are effective.

15. Under the current standard, a qualified person can determine the angle of repose for sloping, out the standard requires that this determination and the design of the slope be based on evaluation of specific factors (1926.651(e)), and refers the person designing the slope to *Table P–1* (1926.652 (a) and (b)).

Proposed § 1926.652(b)(3) differs from the current standard, in that if the employer chooses to use a qualified person or qualified engineer, the standard does not provide any

"minimum requirements" for slope design, or require evaluation of specific factors. Instead, OSHA requires that the designs be prepared by a qualified person or a qualified engineer, be in accordance with accepted engineering practice, and include an indication of the magnitude and configuration determined to be safe for the project.

A similar situation exists concerning proposed § 1926.652(c)(4) related to design of shoring systems.

In view of the greater flexibility provided the employer under this approach, OSHA solicits comments and opinions on the appropriateness of allowing this degree of employer discretion and requests input on how implementing these options would effect the degree of employee safety provided.

In addition, in order to ensure the adequacy of designs prepared by either a qualified person or a qualified engineer, and to provide a degree of consistency in these designs, OSHA requests input on the appropriateness of requiring that *specific* information be included on the design. The following factors are being considered: Types of soil test performed and results; intended or expected load conditions, environmental considerations; and design limitations. OSHA is open to the suggestion of other factors which could be included in the design.

Proposed Changes and Revisions to Subpart P

OSHA will evaluate, on the basis of all the evidence submitted to the public record, the likely effectiveness of the proposed revised and new provisions and will include in the final rule only those revised and new requirements for which a significant reduction in the risk of incurring injuries or fatalities would be supported by the final record.

The following discussion explains the significant substantive changes to Subpart P being proposed by OSHA. In the discussion, a paragraph citation preceded by the letter "E" refers to a paragraph in the existing standard (Part 1926). All other citations are to the proposal.

Section 1926.650—Scope, Application and Definitions Applicable to this Subpart.

Overview. Section 1926.650 contains two paragraphs. The first is a new statement describing the scope and application of the proposed revision of Subpart P. The second contains the definitions applicable to this subpart. This second paragraph replaces existing § 1926.653. Several of the proposed definitions are new, while others are revisions of existing definitions. Some existing definitions have been dropped, and therefore do not appear in this proposal. Specific changes are discussed below.

Discussion. Section 1926.650(a) states that this subpart applies to all open excavations made in earth surfaces and that excavations are defined to include trenches. OSHA is proposing this scope and application paragraph to help clarify where the standard will apply. Under the existing format, with separate sections for excavations and for trenches, questions of applicability have often been raised. The new format should eliminate these questions. The new application statement is intended to alert the user to the fact that whenever the word "excavation" is used in the proposed standard, it applies to all excavations, including those falling within the definition of a trench. However, it should be noted that OSHA jurisdiction does not apply to excavations, which fall under the statutory authority of other Federal agencies to prescribe or enforce occupational safety or health regulations, if that authority is being exercised.

While most of the proposed requirements in the proposal apply to all excavations, some (for example, § 1926.651(c)(2)) apply only to excavations which also meet the definition for trenches. Where a provision is intended to apply only to trenches, the intention is clearly stated in the standard.

Proposed § 1926.650(b) lists and defines all major words used in the proposed standard. Many of the definitions are the same as those in the existing standard, although some have been reworded for uniformity or greater clarity. The following words have been added to or changed from the existing definitions:

(b)(1) "Accepted engineering practices." This definition was revised to convey a more accurate concept of the intent of the definition. This is evidenced by the use of the phrase "standards of practice" instead of the term "standards," which has a particular meaning in relation to OSHA regulations. The term "registered architect" was dropped at the suggestion of the ACCSH and also as suggested in the workshops (Ex. 26). It was felt the term was inapplicable to the subject matter.

The definition of "accepted engineering practices" has been in use since the standard was first promulgated in 1971. It has been suggested, however, that the definition could be further improved if the words "or other duly-licensed or recognized authority" were dropped from the definition. The definition would then read as follows:

"Accepted engineering practices" means those requirements or practices which are compatible with the standards of practice required by a registered professional engineer."

It is felt that the portion of the definition that would be dropped is unclear, and that such language defines "accepted engineering practice" as something broader and less demanding than the standards required by engineers.

It has also been suggested to OSHA that "accepted engineering practices" should be defined as being limited to and not just "compatible with," the standards of practice required of a registered professional engineer, because it can be more readily determined whether or not a particular practice conforms to that level of standard required by a registered professional engineer.

Another suggested change is to add language that defines "accepted engineering practices" as those practices that are described in published literature, such as textbooks that are used or referenced in a university engineering curriculum.

OSHA is undecided about these issues, and has determined that additional information addressed to these issues is desirable. Therefore, OSHA requests that specific comments directed toward these issues be submitted during the comment period.

(b)(2) "Bell-bottom pier hole." The definition for this term replaces the definition for a similar term, "belled excavation," found in paragraph E § 1926.653(d). Although defined, the term "belled excavation" is not used elsewhere in the current standards. Instead, the term "bell-bottom pier hole" is used, in paragraph E § 1926.652(f).

The wording of the new definition revises the current wording. The new definition defines a "bell-bottom pier hole" as "a type of shaft or footing excavation" whereas the current definition of "belled-excavation" is defined as "a part of a shaft or footing excavation."

These changes are being made to make the standards more clear and consistent.

(b)(3) "Benching" (Benching System). This definition has been added to the standard. Benching is one method of protecting employees against cave-ins that is specifically mentioned in the proposed standard. The existing standard makes no mention of benching as a method of protection.

(b)(4) "Cave-in." This definition is new. This term replaces the terms "moving ground" and "hazardous ground movement," neither of which is defined in the existing standard. This deficiency has led to confusion as to what is meant by these terms. OSHA believes the new term more accurately and consistently conveys the intended concept of the hazard, while reflecting current industry terminology.

There is no specific quantity of earth material that constitutes a cave-in. The definition therefore does not address a specific quantity of material. Instead, it describes the mechanisms of the hazard and its results.

(b)(5) "Competent person." This definition is identical to the definition in § 1926.32(f) of Subpart C of the current Construction Safety and Health Standards. The term is used throughout existing Subpart P but is not defined within the Subpart, nor is any explicit reference made to the existing definition in Subpart C. Therefore, this definition would be added to Subpart P to help those regulated by the standard. A "competent person" is required in this Subpart wherever an assessment must be made of the working conditions with respect to safety. For example, the standard requires that a "competent person" monitor conditions that have been determined to be safe but could deteriorate quickly into hazardous conditions.

(b)(6) "Crossbraces." This definition replaces the existing definition "Braces (trench)" and remains essentially unchanged. The term "stringers" would be dropped from the current definition and replaced with the term "wales." The existing standard defines "wales" and "stringers" identically as "the horizontal members of a shoring system whose sides bear against the uprights or earth." OSHA believes use of the term "wales," which is more consistent with industry terminology, would improve the definition of "crossbraces." (See discussion for proposed paragraph (b)(28) of this section for more detail regarding the term "stringers.")

(b)(7) "Excavation." This definition has been modified only slightly from the existing definition in order to clarify and to convey more properly (along with the definition of "trench") the intended meaning. The word "cut" has been added to describe a type of excavation in accordance with accepted industry terminology. The word "trench" is added to remove any doubt that excavations, for purposes of this standard, include trenches.

The definition currently in E § 1926.653(f) contains a second sentence dealing with trenches and depth-to-width relationships. The concept of this sentence now appears in the definition of "trench" in revised form.

(b)(8) "Faces" or "Sides." This definition has not been changed. However, use of the term "walls" has been dropped from the standard. OSHA believes the interchangeable use of two terms, "faces" and "sides," instead of three separate terms, will help simplify the standard.

(b)(9) "Failure." This is a new definition. This definition is intended to apply to protective systems and to the members and connections of protective systems, where applicable. Use of the concept of "failure" introduces a measure for the performance of protective systems, their members and their connections. Such a measure is not present in the existing standard. This concept should help clarify the intent of the standard and the duty of employers to provide adequate protective systems.

(b)(10) "Hazardous atmosphere." This definition is new. It is taken with some modification from the definition of "Hazardous substance" in E § 1926.1926.32(k). The word "toxic" was added at the suggestion of the ACCSH.

There are several references to hazardous atmospheric conditions throughout the existing standard, i.e., E § 1926.650(g), E § 1926.651(v), and E § 1926.652(f). These provisions are grouped together under the single heading of *Hazardous atmospheres* in this proposal. The definition is provided to clarify further the intent of the proposed standard.

(b)(11) "Kickout." This definition is changed by substituting the new term "crossbrace" for the current term "brace," and by dropping reference to the term "shore." The first change is made for purposes of consistency in the use of terms. The second change is made in order to clarify the definition. The term "shore," as used in the current definition of "kickout," is not defined. However, in accordance with accepted industry terminology, a "shore" is considered to be a vertical member, such as a post, or as defined in the current standard, an "upright." It is not OSHA's intention however, to define "kickout" as failure of any vertical member. Therefore, use of the term "shore" is dropped in the proposed revisions of "kickout."

(b)(12) "Protective system." This definition is new. References are made throughout the proposal to "protective systems." The approach taken in the proposed standard is to classify under the concept of "protective system" all systems and methods of protecting employees from cave-ins, material that may roll or fall from an excavation face or into an excavation, and the collapse of adjacent structures.

(b)(13) "Qualified engineer." This definition is new. The term is used in the proposed standard as an option to a qualified person where *design* of protective systems and structures, such as ramps, is required.

As discussed in the *Issues* section of this preamble, there is extensive debate on the merits of requiring only a "qualified engineer" to perform design functions. OSHA is requesting additional information in order to resolve this controversy. The following discussion is provided as background on this issue.

The current definition of "qualified" in § 1926.32(1) provides: "Qualified" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project."

The existing definition has been criticized as inadequate by the Advisory Committee on Construction Safety and Health (ACCSH) (Ex. 8, pp. 112–186), in that it is too broad in its scope and is not specific enough. For example, it has been suggested that under the existing definition, an individual who lacks an understanding of the principles upon which designs of complex structures are based, could nevertheless be considered "qualified" on the basis of experience in excavation work alone. It has also been suggested that to allow a "qualified person," as currently defined in § 1926.32(1), to determine the degree of sloping would *allow* any person with any amount of experience in trenching to decide to slope as little as possible even if it entails risk of a cave-in.

OSHA's enforcement experience with the use of "qualified" person where there has been an accident or injury indicates that trenching experience has often been used as a rationale to misapply the current standard, and to provide protective systems which are inadequate either by accepted engineering standards or by *Tables P–1* and *P–2;* or to provide no protection at all. Considering the number of trench cave-ins each year, OSHA questions the considerations that were used to make some assessments, and solicits comment on the need to require specific criteria that must be met and documented by qualified persons or qualified engineers under proposed § 1926.652 (b)(3) and (c)(4).

OSHA is not entirely convinced that requiring a "qualified engineer" for all

design responsibilities, as was suggested, is the appropriate solution. Many individuals without an engineering degree are capable of designing an adequate protective system, while persons with engineering degrees may lack relevant experience in design of protective systems for excavations. Additionally, OSHA needs to consider the availability of engineers to fill the anticipated need generated by such a requirement; the willingness of the available engineers to assume the liability for the design; and, the impact of the compliance costs, especially to small business.

As discussed above, the Advisory Committee on Construction Safety and Health (ACCSH) considered the adequacy of the existing definition (Ex. 8) and suggested the following, more specific definition for this Subpart: " 'Qualified person' means a registered professional engineer in a civil, structural, or soil mechanics discipline with specific education in excavation shoring techniques, or an individual with five year's experience in excavation shoring techniques."

This definition, however, would allow an individual with five years of experience in excavation work to prepare designs regardless of whether the individual had demonstrated ability in design of protective systems. OSHA does not believe there is a justification upon which to base any requirement for a specific amount of experience, be it five years or any other specific period. Further, the ACCSH definition refers only to experience or education in shoring techniques. Thus, the issues of which individuals should be allowed to make determinations on *sloping*, and what would constitute adequate experience in *sloping*, are left unanswered by the ACCSH definition.

OSHA believes, however, that experience is a significant factor that can contribute to the overall qualifications that an individual possesses to design complex systems. In OSHA's opinion, a definition is needed which emphasizes that a thorough understanding of engineering principles as practiced in excavations is necessary, and which also identifies that relevant experience is an important factor in determining if an individual is "qualified."

Further, in OSHA's opinion, a person need not be a "registered professional engineer" in order to be "qualified" for purposes of this Standard, as is suggested in the ACCSH definition. This is true because an individual may be fully able to design adequate protective systems but may not have attained recognition as a "registered professional engineer." To attain this recognition, an individual must pass a written examination. Such examinations are administered by each state. Certain qualifications are required before an individual will be allowed to take the test. Typically these include a combination of education from an approved institution and specific engineering related work experience. In some instances, individuals without the required education can substitute greater amounts of experience and become eligible for the examinations. Because of these requirements, there can be individuals qualified to design protective systems who are not eligible to obtain registration.

Another reason OSHA does not believe registration should be required is because registration is usually not specific with regard to a specific engineering discipline. An individual could become a registered professional engineer but be unable to design a cave-in protective system because of a lack of education and experience in the essential knowledges necessary for this work.

OSHA has developed a proposed definition of "qualified engineer." This definition is used in this proposal in conjunction with "qualified person." OSHA seeks comment on the proposed definition of "qualified engineer," and the current definition of "qualified person" and solicits suggestions on how to improve these definitions.

While OSHA believes that the continued use of a "qualified person" will provide significant protections to reduce the incidence of injuries and fatalities in excavation work, commentors are urged to provide data, in as much detail as possible, addressing the comparative effectiveness of a "qualified engineer" requirement. In making its final determination, OSHA will rely on the information and data received.

(b)(15) "Qualified person." This definition is identical to that in § 1926.32(e) and is included here for convenience.

(b)(16) "Sheeting." This definition is new. The definition is one of several that define the various members of a support system. It is intended to add consistency and clarity to the standard.

This definition contains some wording from the current definition of "sheet pile" (E § 1926.653(i)). The definition for "sheet pile" has been dropped since the term is not used in the proposed standard. "Sheeting" is a broader term. It includes all special types of sheeting, including sheet piles, where the purpose is to retain earth in position.

(b)(17) "Shield." This definition is new and it replaces the existing definition of "Trench shield" found in E § 1926.653(p).

The concept of a shield, as used in the proposed standard, is different from the concept of a shield concept defined in the existing standard. The new definition does not place any limits on the material from which a shield may be constructed.

The major difference in definition, however, is the manner in which shields are defined to provide protection. Unlike the current standard, the proposed standard does not refer to shields as devices which provide protection to employees by supporting the sides of an excavation and thereby preventing cave-ins. Shields generally do not prevent cave-ins, but, rather, protect employees from cave-ins that do occur. They provide a limited but safe sheltered space for employees to work within.

Shields are one of several types of protective systems that may be used to guard employees from cave-ins and other hazards. Some shields are designed to be expandable. Once in place they can be altered such that their faces are pressed against and actually begin to support the sides of the excavation. In this configuration, depending on the degree of support provided, such a device may also be considered to be a support system.

(b)(18) "Shoring" (Shoring system). This definition is new. The term "Shoring" is frequently used in the existing standard. Its use is maintained in the proposed standard. The definition is provided to clarify what is meant by the term since it is undefined in the present standard.

(b)(20) "Sloping" (Sloping system). This definition is new. As with "shoring," this term is used frequently in both the existing standard and the proposal to refer to a method of protecting employees against cave-ins. The definition is provided to lend consistency to the proposed standard and to clarify what is meant by "sloping."

An existing definition of "slope" found in E § 1926.653(1) is not used in the proposal because the concept defined in this definition is not applicable in the proposed standard. The existing definition states that "slope" means "the angle with the horizontal at which a particular earth material will stand indefinitely without movement."

The new definition of "sloping" is a broader concept referring to a "system" or "method" of protecting employees by preventing cave-ins. The slope or

multiple slopes used in a sloping system will vary with the soil types involved and the conditions of exposure, i.e., loads and environmental conditions. However, the slopes used need not be those that will prevent any movement of the slope indefinitely. The requirement is that employees be protected from a cave-in of the slope and from loose material that may fall or roll from the slope while there is employee exposure to the possibility of such hazards.

(b)(21) "Stable rock." This is a new definition. There is no definition for rock or rock conditions in the existing standard. Reference is made to rock in the existing standard in the footnotes to *Table P–2*, "Trench Shoring—Minimum Requirements." The footnotes state that "Shoring is not required in solid rock, hard shale, or hard slag."

It is recognized in the industry that excavations in rock normally do not present a cave-in hazard because of the inherent stability of rock, and the ability of rock to carry loads. However, rock varies to a great extent in its ability to remain intact while exposed, just as soils do. There are conditions that are found in some rock formations, such as fractures and seams of less stable material, that present a serious hazard. When such conditions are encountered in rock, it cannot be considered stable.

The proposed definition for "stable rock" has been developed from the definition that was proposed by the National Bureau of Standards (NBS) at the workshops. Originally, NBS used the term "unfractured rock," instead of "stable rock." However, many comments were made that it is impossible to excavate any rock without fracturing it in some way. The Construction Advisory Committee suggested that the definition be changed to "stable rock" (Ex. 8, p. 356). This recommendation was incorporated into the NBS definition.

Rock conditions that are unstable, i.e., cannot be excavated with vertical sides and remain intact while exposed, can be made equivalent to stable rock if a proper system is used to support the excavation side. A note to this effect is placed at the end of definition of "stable rock" to alert the user to this possibility.

(b)(22) "Structural Ramp." This definition has been added to differentiate between ramps made from soil or rock and ramps built from materials such as wood or steel.

(b)(23) "Support system." This is a new definition. There is no definition of support system in the existing standard. However, examples of supporting systems are given in E § 1926.651(f), such as "supporting systems; i.e., piling, cribbing, shoring, etc., ..." The concept of a support system as used in the proposed standard remains the same as in the existing standard. The definition is included to provide a more clearly defined concept.

As previously discussed, within the structure of the proposed standard the concept of "protective system" is used. A "support system" is one type of protective system. It is further noted that a "shoring system" is a type of support system. Support systems are more broadly defined than shoring systems to include structures that support adjacent structures or underground facilities, whereas shoring systems are defined as systems that support the sides of an excavation.

(b)(24) "Tabulated data." This definition is new. It is included to clarify OSHA's intent that tables and charts contained in State regulations of State plan states are acceptable for use under the option provided by proposed § 1926.652(c)(3).

(b)(25) "Trench (Trench Excavation)." This definition remains basically unchanged from the existing definition in E §1926.653(n). The changes that have been made are for the purpose of clarifying the definition. For example, the words "trench excavation" have been added to indicate more clearly that trenches are considered to be excavations.

A Note has been added to the end of the definition of the word "trench." The substance of this Note comes from the second part of the existing definition of "excavation" found in E § 1926.653(f) and deals with depth-to-width relationships in trenches. The wording has been revised to indicate more clearly how a portion of a large excavation can become a trench, for purposes of the proposed standard, as a result of creating a relatively narrow space between the side of an excavation and a structure that has been constructed in the excavation.

The proposal is structured such that most of the provisions apply to all types of excavations. However, some of the provisions of Subpart P apply only to excavations that are trenches. For example, § 1926.651(c)(2) sets forth requirements for means of access and egress in trenches, and § 1926.652(c)(1) sets forth the option of using Appendices A and C for determining the configuration of timber shoring in trenches. Those provisions in the proposal that apply only to trenches are clearly indicated by use of the word "trench" within the provision.

(b)(28) "Uprights." This definition revises the existing definition in E § 1926.653(r). The definition is changed so as to be more consistent with definitions of other shoring system members that are in the proposed standard, and to expand on the concept of the term.

The term "uprights," as used in the proposed standard refers only to upright members used in trench shoring systems. Such uprights are usually spaced some distance apart when in position. Normally uprights are referred to as "sheeting" when they are positioned such that they are very closely spaced, in contact with adjacent uprights, or interconnected. The proposed definition of "uprights" is intended to clarify the application of the proposal in each of these positions.

(b)(29) "Wales." Paragraph E § 1926.653(s) of the current standard refers the reader to paragraph E § 1926.653(m) for the definition of "Wales." Paragraph E § 1926.653(m) states that "stringers" (wales) are "the horizontal members of a shoring system whose sides bear against the uprights or earth." However, the term "stringers" is also referred to in paragraph E § 1926.650(d) as the supports for plank steps, which is inconsistent with its definition.

OSHA is proposing to address this problem by dropping use of the word "stringers." In the proposal, only the term "wales" is defined and used to refer to the horizontal members of a shoring system. The term "stringers" does not appear in the proposal and need not be defined.

For reasons to be discussed below, the following terms which are contained in the current standard are not used, and therefore need not be defined in the proposal: E § 1926.653(b) "Angle of repose"; E § 1926.653(c) "Bank"; E § 1926.653(n) "Hard, Compact soil"; .E § 1926.653(j) "Sheet pile"; E § 1926.653(l) "Slope"; E § 1926.653(m) "Stringers"; E § 1926. 653(o) "Trench jack"; E § 1926.653(q) "Unstable soil"; and E § 1926.653(t) "Walls."

The term "angle of repose," as defined in the existing standard, is not consistent with its use in the civil engineering field. The existing definition in E § 1926.653(b) defines "angle of repose" as "the greatest angle above the horizontal plane at which a material will lie without sliding." The specific standards in E § 1926.651(e), E § 1926.651(g) and E § 1926.651(h) speak of determining the "angle of repose," excavating to the "angle of repose," and flattening the "angle of repose," all of which suggest that a single "angle of repose" can be determined for any particular soil. However, in the American Society for Testing and Materials (ASTM) Standard D 653–67,

"Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics," "angle of repose" is defined as follows:

"Angle between the horizontal and maximum slope that a soil assumes through natural processes. For dry granular soils the effect of height is negligible; for cohesive soils the effect of height of slope is so great that the "angle of repose" is meaningless."

What this essentially means is that there is no one "angle of repose" for a given type of soil, for in practice, most soils encountered have some degree of cohesion. In addition, while the "angle of repose" for granular soils is unaffected by the height of the cut, it does change in response to densification, and in changes in environmental conditions or exposure.

The concept of "angle of repose," as used in the current standard, differs from that accepted by the civil engineering community and has led to confusion as to the meaning and intent of the standard. To eliminate this confusion, OSHA believes that use of the term "angle of repose" should not be continued. Therefore, it is not used in the proposed standard.

The term "bank" is defined in paragraph E § 1926.653(c) as "a mass of soil rising above a digging level." This definition is not entirely clear in its meaning because the use of the term "digging level." The OSHRC has interpreted the term "digging level" to mean "the level at which digging is commenced" (2 BNA OSHC 1130). Under this interpretation, the sides of trenches would not be considered "banks" because the sides of trenches would be below "the digging level" rather than above it. However, the wording of paragraph E § 1926.652(a) suggests that sides of trenches be included in the meaning of the term "bank." For example, paragraph E § 1926.652 states:

"Banks more than five feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins." (Emphasis added). The OSHRC interpretation does not conflict with the above wording. However, the paragraph goes on to state: "*Trenches less than five feet in depth shall also* be effectively protected. . . ." (Emphasis added). Thus, the wording of paragraph E § 1926.652(a) seems to equate "banks" with sides of trenches, in contradiction to the OSHRC interpretation. In addition, it is stated in paragraph E § 1926.652(a): "Refer to Table P–1 as a guide in sloping of banks." *Table P–1* is titled "Approximate Angle of Repose for Sloping of Sides of Excavations." Thus, "banks" and "sides" are again seemingly equated, in contradiction to the OSHRC interpretation.

OSHA is proposing to eliminate the use of the term "bank" to eliminate the problems discussed above.

The terms "hard, compact soil" and "unstable soil" in the current standard describe particular soil conditions. These terms are not used in the proposal. In the reformatting of the proposed standard, all references to particular soil conditions have been deleted from the standard itself, and appear instead in the appendices. Furthermore, all soil conditions are defined in the appendices in a completely new soil classification system which does not use the terms "hard, compact soil" or "unstable soil."

The reasons for eliminating the definitions for "sheet pile," "slope," and "walls" have been discussed above in the discussions of paragraphs (b)(15), (b)(19) and (b)(8) respectively.

The term "trench jack" is not used in the proposal and need not be defined.

Section 1926.651—General Requirements.

Overview. Proposed § 1926.651 contains requirements for the protection of employees against several different types of hazards of excavation-related work. The section is arranged with eleven major paragraphs, most of which are revisions of the current requirements in sections E § 1926.650, E § 1926.651, and E § 1926.652. Changes have been made to clarify ambiguous language and eliminate redundant requirements. Some paragraphs have been reformatted to improve ease of understanding. Other revisions have been made to clarify OSHA's intentions as to the scope and application of current provisions of the excavation standard. New requirements have been added to protect employees against known hazards where gaps in coverage currently exist.

Discussion. Paragraph (a), "surface encumbrances," requires that surface encumbrances that are located so as to create a hazard to employees be made safe or removed. The hazard presented by surface encumbrances, including trees and boulders, primarily arises if excavation operations undermine or otherwise cause such encumbrances to become unstable and fall or collapse onto employees. Surface encumbrances can also impede smooth traffic flow on excavation sites. The wording of this requirement is changed only in a minor way from the existing requirement in E § 1926.651(b).

The requirement applies to all employees involved in construction activities at the worksite. The existing paragraph includes the wording "involved in excavation work or in the vicinity thereof at any time during operations." OSHA proposes to drop this additional wording as it is redundant.

The requirement that surface encumbrances be removed or made safe "before excavating is begun" does not appear in the proposal. In many instances, it is not feasible to remove all surface encumbrances from a site before excavating is begun simply because the site is too large. The proposal would require such removal whenever surface encumbrances are encountered.

Paragraph (b), "Underground installations," specifies the requirements for dealing with existing utility and other underground installations that may be encountered during excavation operations. These requirements are based on those in existing paragraph E § 1926.651(a). This existing paragraph has been reformatted. Four separate subparagraphs are proposed to improve clarity.

Underground installations include all types of utility lines either in service or abandoned. They also include foundations and underground storage tanks of all kinds.

Employees may be exposed to serious hazards as a result of damage to underground installations. Flooding, shock, asphyxiation, electrocution, fire and explosion, and collapse of undermined installations are some of the hazards that result when underground installations are damaged. These hazards can be eliminated if the locations of underground installations are properly identified prior to excavation, and if such installations are properly supported or protected when excavation takes place near them.

Paragraph (b)(1) specifies that the "estimated location" of underground installations "that maybe encountered during excavation work shall be determined prior to opening an excavation." This requirement differs from the existing requirement which requires only that an effort be made to determine whether such installations will be encountered and, if so, where such underground installations are located.

At the suggestion of the Advisory Committee (Ex. 8, p. 358), the proposed requirement is more stringent than the existing rule. OSHA believes that the proposed revision is needed to prevent many of the accidents involving damage to underground installations and to

protect employees from such accidents. The proposed language will insure that the effort to locate existing installations is carried to the point where, at the very minimum, an estimated location is determined.

It is recognized that the existence of underground installations is not always readily apparent. However, in many locations there are features which would indicate the presence of underground installations. An example of this would be in a housing subdivision where there are no utility poles. It could reasonably be assumed that certain utilities are underground in this situation. The proposal also recognizes those situations in which underground installations are not known to exist beforehand, but can be determined through the exercise of reasonable diligence prior to excavating.

Paragraph (b)(2) requires that utility companies be contacted and advised of proposed work before the start of actual excavation. Frequently utility companies can help verify the locations of the underground facilities. This requirement is unchanged from the existing standard.

Paragraph (b)(3) requires that as the excavation approaches the estimated location of an underground installation, the exact location be determined. This requirement is unchanged from the existing standard. There are several ways to locate the exact location of underground installations. These include careful probing and hand digging. In the February 1972 amendments (37 FR 3512), the original language, which stated "... the exact location shall be determined by careful probing or hand digging ..." was changed to allow other, equally effective means of locating such installations. OSHA is proposing to expand the provision to provide examples of methods of locating these installations.

Paragraph (b)(4) requires that underground installations be removed, protected or supported as necessary when uncovered to safeguard employees. This proposed provision is intended to prevent injuries suffered by employees which result from damage to exposed installations, contact with energized lines, the collapse of unsupported installations and other similar exposures. The existing requirement requires only that installations be properly supported. This is insufficient to protect employees adequately. Removal or protection of exposed installations are other means to protect employees that at times can be more appropriate.

Paragraph (c) sets forth the requirements for access to and egress from excavations. These requirements are found throughout the existing standard in E § 1926.650 (b), (c), and (d), E § 1926.651(x) and E § 1926.652(h). The requirements have been grouped into a more logical order but have not been changed to any great extent. These requirements address hazards resulting from inadequate design and construction of ramps and runways and from inadequate placement of exits in trenches.

Paragraph (c)(1) specifies five general requirements for the design and construction of ramps and runways.

Paragraph (c)(1)(i) requires that structural ramps be "designed by a qualified person, a qualified engineer or a person under the direction of a qualified engineer, in accordance with accepted engineering practices." This differs from the existing requirement in E § 1926.651(x) which requires ramps to be "designed *and constructed* by *qualified persons* in accordance with accepted engineering practices." (Emphasis added.) The requirement for design by "qualified persons" was also changed so that the language used would be consistent with other language and requirements in the proposal.

The actual *construction* of ramps is usually not spoken of in terms of engineering practices. Therefore, OSHA is proposing to revise the existing language to maintain this distinction. The proposed language would require that structural ramps be "constructed in accordance with their design" instead of in accordance with accepted engineering practice.

This paragraph addresses the hazard of structural ramps collapsing under heavy vehicle or personnel load conditions because of underdesigned members or connections. In some large excavations, ramps of steel or wood are provided for vehicle access and egress. More frequently, however, earthen ramps are used. These earthen ramps are created out of material that is left in place as the excavation is made. Such earthen ramps are not considered structural ramps. For this reason, the word "structural" is added to clarify when design of particular ramps by a qualified individual is necessary. OSHA requests comment and data on whether structural ramps used by a limited number of employee (5 or less) should be required to be designed by a qualified individual or alternatively, should structural ramps be a certain height before a qualified individual is required?

Paragraphs (c)(1)(ii) through (c)(1)(v) address the hazards of trips, slips and falls. These requirements are the same as the requirements in existing paragraphs E § 1926.650(b), E § 1926.650(c) and E § 1926.650(d). The words "raised walkways," "walkways" and "sidewalks" have been dropped in the proposal since these terms are embodied in the concept of runways.

Paragraph (c)(2) requires that a safe means of egress be located in trenches four feet (1.2 m) in depth so as to require no more than 25 feet (7.6 m) of lateral travel for employees. This requirement is the same as in existing paragraph E § 1926.652(h). Ladders, stairs, or ramps are considered adequate to meet this requirement. As defined in proposed definition § 1926.650(b)(14), ramps may be constructed in the earth, and therefore this means of exit is added to the list of examples of acceptable methods of egress.

Paragraph (d), "Exposure to vehicular traffic," requires that employees exposed to vehicular traffic be provided with and wear warning vests made of reflectorized or high-visibility material.

Employees, particularly those involved in trenching work, frequently work where vehicular traffic flow is maintained in close proximity to the excavation operations. Employees may be assigned to direct traffic flow onto or off of construction sites or adjacent to construction sites. These employees are exposed to the hazard of being struck by such vehicles. This hazard is increased during dark or near-dark periods of the day. The provisions of this paragraph are intended to reduce this hazard.

This requirement differs from the existing requirement in paragraph E § 1926.650(f). The words "be instructed to" have been deleted. The proposed requirement is for employees to "wear" such vests, whereas the current standard states: "Employees . . . shall be instructed to wear. . . ." This change is necessary to clarify the intent of the standard.

Paragraph (e), "Exposure to falling loads," requires that no employee be permitted under loads handled by lifting or digging equipment. In addition, it requires that employees stand away from vehicles that are being loaded or unloaded to avoid being struck by any spillage. These requirements are basically unchanged from the existing requirements in E § 1926.650(h). The words "power shovels, derricks, or hoists" were changed to "lifting or digging equipment" in the first sentence. This change was made to make the requirements apply more generally to all kinds of lifting or digging machines rather than be limited to those listed, as is implied in the existing standard. In this way, backhoes and other such equipment are clearly intended to be included in these requirements.

In the second sentence, the words "or unloaded" were added. OSHA believes that the hazard to employees from loads falling during unloading is just as great as during loading. Therefore, this requirement was added to ensure the safety of employees during these operations.

A note within paragraph (e) indicates that operators of vehicles may remain in cabs that provide adequate protection from falling loads during loading and unloading operations. This is consistent with safe industry practice and current OSHA standards in E § 1926.601—"Motor Vehicles."

Paragraph (f), "Warning system for mobile equipment," addresses the hazard of equipment being driven over the edge of an excavation. The requirement states that where the operator does not have a clear and direct view of an excavation, and he or she is required to operate equipment adjacent to or approaching that excavation, then a warning system such as barricades, hand or mechanical signals, or stop logs shall be utilized. The warning system is intended only to warn the operator as to the location of the edge of the excavation. It can, but need not, be designed to prevent a vehicle from being driven over the edge of an excavation.

This requirement replaces the requirement in existing paragraph E § 1926.651(s). That paragraph requires: "When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed."

The language of the current standard is unclear as to its intended meaning because of use of the word "substantial." Use of this word makes it difficult to determine if the intent of the rule is to prevent mobile equipment from going overboard into an excavation or if the intent is to remind an operator not to proceed any further toward the edge of an excavation.

Due to the nature of some of the heavy mobile equipment that is operated on construction sites, it is often impractical to construct barricades substantial enough to prevent equipment from going overboard into an excavation. On trenching sites, where lengths of an excavation are often open for great distances, or for very short periods of time, requiring barriers of such magnitude would place an unreasonable burden on the employer. Use of such systems can also impede efficient out safe methods of backfilling.

It is OSHA's opinion that there are equally effective and far less costly alternatives available to protect workers in and around excavations from the danger of mobile equipment. Therefore, the proposed requirement would both clarify when warning systems are needed and identify the types of warning systems that are acceptable to protect vehicle operators and workers in excavations. OSHA believes that signals from observers can be used effectively for purposes of protecting employees against the hazard in question. Signals are currently specified in other existing standards as an acceptable means of guiding mobile equipment when this equipment is backing up. In § 1926.601(b)(4), it is stated:

(4) No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

(i) The vehicle has a reverse signal alarm audible above the surrounding noise level; or

(ii) The vehicle is backed up only when an observer signals that it is safe to do so.

The language of the proposal recognizes that methods of signaling can be considered effective and clarifies the intent of the existing mobile equipment requirements.

An additional revision is being proposed regarding paragraph E § 1926.651(s). The words "if possible the grade should be away from the excavation" currently appear at the end of the existing paragraph. Although the language is advisory it does provide an example of a safe practice to follow in addition to the required practices. OSHA is, therefore, proposing that this advisory language be maintained.

Paragraph (g), "Hazardous atmospheres," contains requirements for preventing employee exposure to hazardous atmospheres through the use of testing and controls. It also sets forth requirements for the use of emergency rescue equipment where hazardous atmospheric conditions exist or could develop during work in an excavation.

The existing standard contains provisions in paragraphs E § 1926.650(g), E § 1926.651(v) and E § 1926.652(f) for protecting employees against hazardous atmospheric conditions. Generally, the existing language is not specific regarding testing requirements, and it may not be clear as to how the requirements set forth in Subpart P interface with requirements set forth in Subparts D and E, "Occupational Health and Environmental Controls" and "Personal Protective and Life-saving Equipment," respectively. Therefore, language has been added to clarify these areas, as noted below.

Paragraph (g)(1) addresses atmospheric testing and controls. Language has been added to clarify that the requirements in paragraphs (g)(1)(i) through (g)(1)(iv) are in addition to the requirements set forth in Subparts D and E.

Paragraph (g)(1)(i) requires testing for oxygen deficiency or gaseous conditions in excavations greater than four feet (1.2 m) in depth where these conditions exist or could reasonably be expected to exist. Further, it is required that the testing be done before employees enter the excavation. If no employees enter such an excavation, testing need not be done. This differs from the existing language which requires that: "In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested."

The definition of "confined" or "enclosed space" in existing paragraph E § 1926.21(b)(6)(ii) includes ". . . open top spaces more than four feet in depth such as pits, tubs, vaults, and vessels." The four foot (1.2 m) depth requirement in the proposed rule was added to clarify where testing is required for excavations, and to be consistent with this existing definition.

The existing language requiring that tests be performed "where oxygen deficiency or gaseous conditions are possible" was changed to a requirement that OSHA believes is more reasonable, but still provides worker protection. Taken literally, the conditions listed in the existing language are possible in any given excavation if the proper circumstances are present. However, in some circumstances these hazardous atmospheric conditions are more likely to be expected to exist or occur than in other circumstances. For example, work involving the extension or maintenance of sewer utility or gas utility systems, work near refineries or near areas where petroleum distillates are handled or stored, and work near landfills or hazardous waste dumps are situations where hazardous atmospheric conditions could occur (Ex. 8, pp. 224–226, 369–370). Atmospheres in excavations in such situations must be tested.

However, it is OSHA's opinion that it is not reasonable to require that all excavations be tested routinely since it is unlikely that oxygen deficiency or gaseous conditions will occur in the vast majority of situations. Where the conditions are such that these hazards could not reasonably be expected to occur, OSHA believes that routine testing should not be required. Accordingly, the requirement is written to reflect what OSHA believes to be a more reasonable approach to testing.

The examples cited above of areas that are more likely to be hazardous are not intended to be a comprehensive list.

There are many unique circumstances that could result in the formation of a hazardous atmosphere in excavation-related work. An excavation that is free of hazardous atmospheric conditions on any particular day may not be safe the following day. To ensure that employees are continually protected against the development of hazardous atmospheres in excavations, OSHA is proposing to require that daily inspections (not necessarily involving air testing) for evidence of potentially hazardous atmospheric conditions be conducted by a competent person. This requirement is in proposed § 1926.651(k)(1). It is intended that such inspections be conducted to identify areas or situations where hazardous atmospheric conditions exist, or could reasonably be expected to exist, during the course of work. Where such areas or situations are identified, the requirements of paragraph (g) apply.

Proposed paragraph (g)(1)(ii) is being added to clarify when protection against exposure to oxygen deficiency is required, and to identify the precautions that are acceptable to prevent such exposures. Oxygen deficiency is not specifically defined in the existing excavation standard. However, the existing requirements for air quality for supplied air in E § 1910.134(d)(1), which has been identified as applicable to the construction industry, states that "Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G–7.1–1966." This specification denotes a concentration of 19.5 percent oxygen as the lower limit for synthesized air. Additionally, in existing standard E § 1910.94, a concentration of oxygen of 19.5 percent is a lower limit that is specified. Therefore, the 19.5 percent limit for oxygen is specifically identified in the proposed standard in order to be consistent with the existing requirements and to clarify when testing and protection are required.

The existing standard requires that employees subjected to oxygen deficiency be protected with approved respiratory protection as set forth in Subpart D. However, the use of increased ventilation can be as effective or more effective in dealing with oxygen deficient atmospheres. Therefore, this type of protection is also identified as acceptable in the proposal.

Paragraph (g)(1)(iii) addresses the hazards posed by the accumulation of flammable gases. The proposed standard requires that adequate precautions be taken to prevent employee exposure to atmospheres containing a concentration of flammable gas in excess of 20 percent of its lower flammable limit (LFL). This differs from the existing requirement which states in E § 1926.651(v): "When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated."

As stated, the existing provision requires that ventilation be provided when a flammable gas exists in any concentration or, as an alternative, that sources of ignition be eliminated. OSHA believes that this requirement is too restrictive at low concentrations of flammable gas in the atmosphere, but not nearly restrictive enough where high concentrations exist. By indicating a limit to the allowable concentration of a flammable gas, the proposal notifies employers of the level of performance required to protect employees.

Paragraph (g)(1)(iv) is a new requirement that is added to clarify further the intention of the existing requirements for testing. Testing is not an effective method of preventing exposure to hazardous atmospheres if it is used only to detect hazardous conditions initially and then not used again. Therefore, the proposal requires the employer to conduct additional testing to ensure that atmospheres remain safe whenever controls are used that are intended to reduce the levels of atmospheric contaminants to acceptable levels.

Paragraph (g)(2)(i) requires that emergency rescue equipment be readily available wherever hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This requirement is different from the existing requirement in E § 1926.651(v) only to the extent that the requirement for the equipment to be "attended" is deleted in the proposal. The manner in which the word "attended" is used in the current standard implies that personnel be with and responsible for the equipment even when not in use. This is not the intent of the standard, and this word is being dropped.

Paragraph (g)(2)(ii) requires that employees entering bell-bottom pier holes, and similar pier hole footing excavations that are not belled at the bottom, wear a harness with a lifeline, and that the lifeline be individually attended. These requirements are based on those in existing paragraph E § 1926.652(f).

The existing requirements in E § 1926.652(f) apply only to bell-bottom pier holes. These holes are a special type of footing excavation into which employees descend to inspect the hole configuration. However, employees are also at times required to descend, to conduct similar inspections, into similar footing excavations that are not belled at the bottom. These employees must be protected against the same hazards that can exist in bell-footings. Therefore the language of the proposal is changed to reflect this need.

The purpose of this requirement is to allow rapid rescue of an employee in the limited space of these special types of excavations without exposing other employees to the associated hazards. Because of the configuration and unusual depths of this type of excavation, an oxygen deficient or other hazardous atmosphere could occur very quickly, requiring rapid removal of any exposed employee.

The intent of the requirement that lifelines "shall be individually manned that while the lifeline is actually in use, personnel be assigned to oversee the individual to whom the lifeline is attached.

The current standard provides that lifelines "sgall be individually manned and be separate from any line used to *remove* materials excavated from the bell footing" (emphasis added). The proposal would revise this language to require that lifelines "shall be separate from any line used to *handle* materials . . . ." (emphasis added). This clarification is to indicate that the lifeline must be separate from any line used to *remove or supply* any materials from or to the footing excavation.

Paragraph (h), "Protection against water accumulation," contains four provisions that address the accumulation in and the control and removal of water from excavations. Water is present, or very likely to be present, during the course of work in many excavations. Water accumulation can result from surface water entering the excavation, from ground water, from rain or melting snow, or from leaking or damaged utilities such as water or sewer lines. Water creates muddy or slippery surfaces that expose employees to slips and falls. Rapid accumulation, such as from a damaged water supply line, has even resulted in drownings (Ex. 9). The action of water against the sides of excavations can cause undermining and cave-ins. Accumulated water will saturate the sides of excavations and weaken them to the point where cave-ins are very likely to occur even in very shallow excavations. Further, where protective systems are in place, accumulated water can adversely affect the capacity of the systems.

The existing requirement in E § 1926.651(p) states: "Water shall not be allowed to accumulate in an excavation." Taken literally, accumulated water in any amount, in any part of an excavation, violates the existing standard. However, OSHA does not believe this to be the intent of the standard. At times, such as during sudden rain storms, for example, or when snow melts, it is impossible to keep some amount of water from accumulating. Additionally, in excavations which employees do not enter, but where there is accumulated water, there is no exposure to a hazard. Further, there are certain excavations, such as long trenches, where water accumulated in isolated sections would not pose a hazard because employees would not enter those sections.

OSHA is proposing to revise the existing requirement to recognize that not all water accumulated in excavations poses a hazard. In addition, it is OSHA's opinion that it is not always necessary to remove all water from an excavation in which employees are expected to work. Paragrapn (h)(1), as proposed, allows employees to work in excavations in which there is accumulated water, or in which water is accumulating, but only under the circumstances where such conditions have been anticipated and adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions could range from providing dewatering equipment to special cave-in protection.

Work can be conducted safely in excavations when there is accumulated water. For example, the record contains information on a pipeline contractor who installed several miles of pipe in a trench where the water table was only three to four feet below the surface of the ground (Ex. 25). The work required the use of divers to place sections of pipe at depths of up to 18 feet. Employees were protected from cave-ins of the sides of the trench by the use of shields.

Depending on the amount of water and the particular hazard in question, the precautions necessary to protect employees adequately will vary. Employers are alerted to this by the Note following paragraph (h)(1). The Note identifies several examples of the types of protection that might be necessary to provide an adequate level of protection. These include the use of special support or shield systems, dewatering to control the level of water, and the use of a safety harness and lifeline.

Paragraph (h)(2) addresses the use of water removal equipment as a means to control the accumulation of water. These proposed rules require that such equipment be monitored by a competent person to ensure proper operation.

Water removal or control is generally undertaken to provide a dry work area. The process can also be used to contribute to improved stability of excavation sides, and it is done in emergencies when sudden inflows of water occur. When the equipment that is used to remove or control the flow of water into excavations malfunctions, hazards that were eliminated when the equipment was working can become significant.

The requirements in paragraphs (h)(2) are new. The existing standard does not directly address water removal operations but, as discussed above, it requires that water not be allowed to accumulate in excavations. The type of water removal equipment needed in any given circumstance will vary depending on the volume of water that must be removed or controlled. In a very large excavation, for example, failure of water removal equipment may affect only a portion of the area within the excavation. Therefore, the precautions to be taken will, of course, also vary in the event failure of the equipment occurs. Such precautions could involve removal of all employees to a safe area if they are all exposed. Where the problem is more isolated, only the employees in the area that are exposed to the added danger would have to be removed.

Paragraph (h)(3) requires that suitable means be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. This requirement is unchanged from the existing requirement in E § 1926.651(p) except for minor word revisions.

Paragraph (i), "Stability of adjacent structures," contains three paragraphs that address the hazard of unstable structures adjacent to excavations. The collapse of unstable structures endangers employees in excavations and in the area around excavations. Structures can become unstable when excavation takes place close enough to the structures so as to reduce the ability of the soil to support them.

Paragraph (i)(1) requires that support systems be provided for the protection of employees and to ensure the stability of structures that are endangered by excavation operations. This requirement is unchanged from the existing standard in E § 1926.651(o). The words "support systems" are used to be consistent with the remainder of the proposed standard. The three examples of support systems generally used for this purpose—shoring, bracing and underpinning—are unchanged from the current standard.

Paragraph (i)(2) prohibits excavating below the level of the base or footing of any foundation or retaining wall. However, there are four exceptions to this prohibition. The first two exceptions are unchanged from the existing requirements in E § 1926.651(n). These are: Paragraph (i)(2)(i), which reads "a support system such as underpinning is provided to ensure the safety of employees and the stability of the structure," and paragraph (i)(2)(ii) which reads "the excavation is in stable rock." Minor revisions to the language have been made for consistency with the language used in the proposal.

The third and fourth exceptions are new and have been added to clarify the intent of the standard. This clarification is necessary because the existing standard can be interpreted to apply only to excavation at and immediately below foundations or retaining walls. However, the loads imposed on the soil at the excavation site from adjacent structures are not limited to the immediate area of the structure, but also extend some distance from the structure. This distance varies with the depth of the excavation. Generally, this distance can be estimated as being equal to the depth of the excavation. Thus, a critical plane is formed sloping up from the bottom of the excavation toward the structure at an angle of 45 degrees (one horizontal to one vertical or 1H:1V). If the footing or foundation remains completely below this plane, then the conventional assumption is that it probably will not be affected by excavation operations. The possibility remains, however, that the stability of the structure could be affected in some way. Calculating the effect that excavation activity has on the soil supporting a structure is a highly complex procedure involving expertise in soil mechanics, structural analysis, judgment, and experience. While the discussion above is in terms of generalities, each circumstance must be evaluated on the specifics of the situation.

Therefore, to address this situation, and to recognize that special skills are needed to evaluate such situations, the third exception to the general prohibition against excavation adjacent to buildings and structures is added in the proposal in paragraph (i)(2)(iii). This exception would permit excavation whenever "a qualified person, a qualified engineer, or a person under the direction of a qualified engineer determines that the structure is sufficiently removed from the

excavations so as to be unaffected by the excavation activity."

The fourth exception to the prohibition against excavating adjacent to structures recognizes that some excavation activity will not present a hazard to employees. It states in paragraph (i)(2)(iv) that such excavation is permitted whenever "a qualified person, a qualified engineer, or a person under the direction of a qualified engineer determines that such work will not pose a hazard to employees." Where it is determined that no hazard to employees will occur, such excavation activity can proceed below the base of the foundation. Such a situation could occur if a building were on a continuous concrete footing, such as a grade beam, and excavation was undertaken in a very limited area below the footing. Where the footing could safely span the excavation, no instability in the structure would occur. Again, each circumstance must be evaluated on the specifics of the situation.

Paragraph (i)(3) prohibits excavation under sidewalks and pavements unless employees are protected from the collapse of such structures. This applies not only to employees in the excavation but to employees who may be required to use the undermined structure. This requirement revises the existing language of E § 1926.650(a) which requires that sidewalks be shored to carry a minimum live load of 125 pounds per square foot.

The existing requirement does not protect employees adequately because it does not cover all pavements, but only "sidewalks." Loads on pavements during construction operations frequently can exceed the minimum load specified. Therefore, the proposal would cover pavements as well as sidewalks. In addition, the live load specification has been changed to a more performance-oriented requirement to be consistent with the overall approach taken in this proposed standard. OSHA believes that the performance language will provide the employer greater flexibility in determining the most effective means of protecting employees.

Paragraph (j), "Protection of employees in excavations," contains requirements for the protection of employees from the hazards of cave-ins, loose rock or soil that could fall or roll from an excavation face, and from material that could fall or roll into an excavation. These requirements are contained in three separate paragraphs.

Paragraph (j)(1) requires that employees in excavations be protected from cave-ins in excavations by the installation or use of an adequate protective system which meets the requirements of proposed § 1926.652 "Requirements for protective systems." This requirement is written in performance-oriented language, which is consistent with the approach of the overall proposed standard. This paragraph consolidates and replaces several existing requirements and paragraphs. The existing paragraphs affected include E § 1926.651(c), E § 1926.652(m), E § 1926.651(q), E § 1926.652(a), E § 1926.652(b), E § 1926.652(c), E § 1926.652(e), E § 1926.652(f), and E § 1926.652(k).

The existing standard is arranged in a format consisting of § 1926.651, "Specific Excavation Requirements" and § 1926.652, "Specific Trenching Requirements." Each of these sections contains provisions designed to protect employees against cave-ins. The substantive requirements for "excavations" often overlap those for "trenches." Thus, an excavation employer is not always sure which of the current standards apply to a particular situation.

Some of the current requirements indicate when cave-in protection is required and provide some flexibility as to how it is to be provided. For example, E § 1926.651(c) states: "The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means."

On the other hand, some provisions set forth specific means of compliance. For example, E § 1926.652(f) states: "Employees entering bell-bottom pier holes shall be protected by the installation of removeable-type casing of sufficient strength to resist shifting of the surrounding earth."

Some of the current requirements specify the earth conditions in which cave-in protection is required. For example, E § 1926.652(b) states: "Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. (See Tables P–1, P–2 . . .:)"

In *Table P–1,* terms such as "compacted angular gravels," "compacted sharp sand," and "average soils" are used to describe the earth conditions. In *Table P–2,* terms such as "hard, compact," "likely to crack," and "soft, sandy, or filled" are used to describe the earth conditions.

Other requirements specify when special or additional precautions are necessary. For example, E § 1926.651(m) states: "Special precautions shall be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of material comprising a face and the slope of such seams and joints."

The existing requirements do not appear in any specific order. In addition, it is not always clear which provisions apply to a given situation. However, the one common feature of all the existing requirements is that cave-in protection is required. Therefore, based on this central requirement, OSHA is proposing to revise its existing standards to allow any of several types of protective systems to be used, provided that the system will provide protection against cave-ins. OSHA intends this revision to be more performance-oriented than the current standard, while providing greater clarity and guidance as to what steps the employer must take to protect employees from cave-ins.

OSHA believes that there is a potential for a cave-in in virtually all excavations. However, experience has shown that the probability of a cave-in depends upon the combined effects of many factors (Ex. 5). These factors include the depth of the excavation, the type of soil involved, the ability of the soil to resist stress, the stress imposed on the soil from the weight of the soil itself and from static and dynamic surcharge loads, and from changes in the ability of the soil to resist stress due to exposure to environmental conditions over a period of time. In recognition of the low probability of a cave-in occurring in certain circumstances, the proposal, as does the current standard, sets forth two exceptions to the requirement to provide cave-in protection.

Paragraph (j)(1)(i) states that excavations in stable rock are exempt from cave-in protection requirements. This exception is consistent with the existing standard which states in Note (1) to *Table P–2* that "shoring is not required in solid rock, hard shale, or hard slag." The term "stable rock" is used in the proposed standard instead of the above terms and is defined in § 1926.650(b)(20) of the proposal.

The second exception, which is stated in paragraph (j)(1)(ii), allows the suspension of the requirement to provide cave-in protection in excavations less than five feet (1.5 m) in depth, *but only if a competent person first examines the ground* and finds no indication that a cave-in should be expected (emphasis added).

The exception in paragraph (j)(1)(ii) continues the existing exception applying to excavations less than five feet in depth. In addition, it clarifies that cave-in protection is not required only after a competent person first examines the ground and finds no evidence that a cave-in is expected.

The existing standard in paragraph E § 1926.652(a) states: "Trenches less than five feet in depth *shall also be effectively protected when examination of the ground* indicated hazardous ground movement is expected" (emphasis added). On its face this requirement does not clearly require that an examination first be conducted. However, paragraph E § 1926.651(i) states: "Daily inspections of excavations shall be made by a competent person. If evidence of possible cave-ins or slides is apparent. . . ." This paragraph clearly establishes that such inspections must be conducted by a competent person. The proposal clarifies that inspections must first be conducted before an employer can use the exception of not providing cave-in protection in excavations less than five feet in depth. There would be a presumption that excavations less than five feet deep need to be protected unless there is a determination by a competent person that such protection is not needed.

Paragraph (j)(2) addresses a hazard similar to cave-ins, although not of the same magnitude. Loose rock or soil could fall or roll from an excavation face and, in sufficient volumes endanger an employee even when an adequate cave-in protective system is in place. For example, when a shield is used in conjunction with sloping, the possibility exists for material to loosen and slide down and over the top of the shield, thus endangering employees.

The existing standard, E § 1926.651(j), addresses this hazard. It states: "Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means." The proposed standard does not change the requirement other than to revise the language for improved clarity. References to rock bolting and benching are removed. Rock-bolting and benching are considered types of primary support system intended to prevent cave-ins. They are not generally used to prevent material from falling into an excavation after the primary cave-in protective system is in place.

Proposed paragraph (j)(3) requires that employees be protected from excavated or other materials or equipment that could fall or roll into excavations. This protection can be accomplished by keeping all material and equipment at least two feet (.61 m) from the edge of excavations or by the use of sufficient retaining devices. The proposed requirement does not change the existing two foot (.61 m) setback requirement in E § 1926.651(i). It is, however, written in more concise language.

The intent of this requirement is to protect employees against excess material falling into excavations. Obviously, materials such as excavated soil and stored construction supplies also place a superimposed load on the edge of the excavation. Such loads can be the cause of cave-ins and must be considered when determining what protection is necessary under other provisions of the standards.

The application of the existing two-foot setback requirement to trenching has been questioned in the past because the requirement appears in existing § 1926.651 "Specific Excavation Requirements," and not in § 1926.652 "Specific Trenching Requirements." However, the requirements in paragraph (j) of § 1926.651 have always applied to all excavations, including trenches. The format changes in the proposal, as well as other changes, have been made to clarify this question of application.

Paragraph E § 1926.651(i)(1) states that ". . . material shall be effectively stored and retained. . . ." Similarly, in E. § 1926651(i)(2), it is stated that ". . . the employer may use effective barriers or other effective retaining devices. . . ." Interested persons have expressed concern as to what these provisions require and have indicated that they should be clarified in the proposed revision.

As stated above, the intent of these requirements is to prevent material or equipment from falling or rolling into excavations. The level of protection necessary to prevent this from occurring will vary in most instances. Simply placing material two feet (.61 m) from the edge of the excavation could be sufficient in one instance, while use of a barrier could be the most effective method in another situation. However, use of a barrier in addition to the distance requirement could be necessary in yet another instance in order to "keep" materials from entering the excavation. The capacity of any barrier or retaining device must be independently determined so as to meet the needs of the particular situation and to comply with the standard.

The proposed language of § 1926.651(j)(3) is written in performance-oriented language and requires "the use of retaining devices that are sufficient to prevent material or equipment from falling or rolling into excavations." The duty to provide protection is clearly stated, but the employer is allowed some discretion in determining the necessary capacity of the retaining devices by use of the word "sufficient." Clearly a device is "sufficient" (and "effective") if it can be shown to be able to resist any forces that may reasonably be expected to be applied to it.

The language of the existing requirement in paragraph E.651(i) is different from the language that was originally promulgated. As originally promulgated in 1971, the requirement was stated as follows: "Excavated or other material shall not be stored nearer than four feet from the edge of any excavation and shall be stored and retained as to prevent its falling back into the excavation" (36 FR 7389, April 17, 1971). Upon the recommendation of the Advisory Committee for Construction Safety and Health (ACCSH), it was proposed to change this provision to require that "In excavations which employees may enter, which are more than five feet in depth, excavated or other materials shall be stored and retained four feet or more from the edge of the excavation. In excavations which are five feet or less in depth, all materials shall be stored and retained at least two feet from the edge of the excavation" (36 FR 19088, September 28, 1971).

This amendment was proposed "in order to allow more flexibility in storing and retaining excavated materials adjacent to an excavation, while at the same time insuring the safety of those employees working in the excavation site" (37 FR 3513, February 17, 1972). The comments in response to the proposal indicated that the proposed change was too rigid to allow employers digging shallow trenches (less than five feet in depth) and having narrow rights-of-way to meet the requirement. Alternative methods of storing and retaining such material were suggested which would provide equivalent employee protection.

The ACCSH considered the comments submitted in response to the proposal, and the suggestions made by the OSHA staff, and as a result recommended that the language proposed be changed "to permit all appropriate alternative methods which will protect employees working in excavations from the hazards of falling materials" (37 FR 3515, February 17, 1972). The ACCSH recommendations were adopted and the proposed language was revised to become what are now the existing requirements in paragraph E § 1926.651(i).

OSHA has received comments concerning the existing two foot (.61 m) requirement. It has been suggested that this requirement be changed to one foot (30.5 cm) for excavations five feet (1.52 m) or less in depth. No data to support this suggestion has been submitted to OSHA other than the comment that such a requirement is practical and adequate.

OSHA is not proposing to make that suggested change at this time. However, OSHA requests that specific comments regarding this issue be submitted during the comment period.

Paragraph (k), "Inspections," requires that daily inspections of excavations, the adjacent areas, and protective systems be made for evidence of any hazardous condition. It also requires that the inspections be made by a competent person. If hazardous conditions are identified, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to insure their safety. These requirements consolidate existing requirements in E § 1926.650(i), E § 1926.651(d), and E § 1926.651(o).

The existing requirement in E § 1926.650(i) states: "If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard employees." This is the only requirement that specifically identifies what is necessary if a hazardous condition is identified, and it only applies to evidence of cave-ins or slides. It is OSHA's opinion that during the course of work in excavations other hazardous conditions can develop, and that the object of daily inspections must be to identify these conditions as well as to take precautions to protect employees. Therefore, the proposed requirement is written with this intent.

The existing provision also requires that "all work in the excavation shall cease . . . ." OSHA recognizes that in many instances a hazardous condition may be limited to only a small area of the excavation. For example, inspection might reveal a weakness in the support system which increases the possibility of a cave-in in a small area of a very large excavation. In such a situation, OSHA does not believe it is necessary to require that "all work" throughout the entire excavation cease until this isolated problem is repaired. Therefore, OSHA is proposing to change the requirement to require that "exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety." The obligation is on the employer to determine which areas are hazardous, and which employees are exposed to those areas.

Section 1926.652—Requirements for protective systems.

Overview. Section 1962.652 contains requirements pertaining to protective systems. These include a combination of performance-oriented requirements and more specification-oriented requirements.

The requirements are arranged so that the duty or performance-oriented requirements are stated in the beginning of the section.

The seven major paragraphs address: (a) Capacity of protective systems; (b) design of sloping and benching systems; (c) design of support systems, shield systems, and other protective systems; (d) materials and equipment; (e) installation and removal of support systems; (f) sloping and benching systems; and (g) shield systems.

The last three paragraphs primarily address work practices that are required, whereas the first four paragraphs address the adequacy of the system designs and materials.

Some of the requirements and language of this section are new. However, the major portion are revisions or consolidations of existing provisions.

Paragraph (a), "Capacity of protective systems," is new language that has no counterpart in the current standard.

Paragraphs (b) and (c) contain design requirements for protective systems that are presented as options that employers can choose among. The format and contents of these paragraphs are significantly different from the current standard.

Paragraph (d), "Materials and equipment," consolidates existing requirements in paragraphs E § 1926.651(1) and E § 1926.652(d). In addition, new requirements are added pertaining to the use of manufactured materials and equipment, and provisions applying to damaged material or equipment.

Paragraph (e), "Installation and removal of support systems," combines existing, revised and new requirements. The existing requirements affected are E § 1926.652(d), E § 1926.652(f), E § 1926.652(i), E § 1926.652(j) and E § 1926.651(f). New requirements are included prohibiting application of excessive loads, and allowing limited excavation below the bottom of support systems.

Paragraph (f), "Sloping and benching," contains a requirement addressing work on slopes. This is a new requirement.

Paragraph (g), "Shield systems," contains requirements that address the use of shields in excavations. These requirements are new.

Discussion. Paragraph (a) is a twofold requirement. First, it requires that protective systems be designed in accordance with the requirements of paragraphs (b) and (c) of § 1926.652. Second, it requires that protective systems have the capacity to resist, without failure, all loads that are intended or could reasonably be expected to be applied to or transmitted to the system.

The existing standard does not contain a requirement directly addressing the capacity of protective systems. Such a requirement, however, is consistent with the approach taken in this proposal which utilizes performance-oriented language where possible. As discussed earlier, proposed § 1926.651(j)(i) sets forth those situations in which cave-in protection is required, and identifies the hazards from which employees are to be protected. Therefore, the employer must first select a protective system for these conditions and hazards. Once a protective system has been selected, proposed § 1926.652(a) sets forth performance criteria that must be met by that system. It provides that "protective systems shall have the capacity to resist, without failure, all loads that are intended or could reasonably be expected to be applied or transmitted to the system." The paragraphs immediately following § 1926.652(a) address different methods and approaches that can be used to provide the required level of protection.

Section 1926.652(b) contains requirements for the design of sloping and benching systems. This paragraph provides three sets of alternatives that are available to employers who decide to use sloping and benching as a means of cave-in protection. Design of other types of cave-in protection is addressed in § 1926.652(c).

The alternative requirements are arranged in order of increasing degree of performance required, based upon the degree to which the employer performs soil classification and analysis.

In the first option, § 1926.652(b)(1), employers who do not want to make any effort to classify the soil are required to cut excavation sides to angles that are not greater than either of two specified angles, depending on the length of time the excavation will be open. In § 1926.652(b)(1)(i), the requirement is to slope at an angle not greater than one and one-half horizontal to one vertical (34 degrees measured from the horizontal) for excavations that will be open for 72 hours or less. In § 1926.652(b)(1)(ii), the requirement is to

slope at an angle not greater than two horizontal to one vertical (27 degrees measured from the horizontal) for excavations that are to be open longer than 72 hours.

In OSHA's opinion, the slopes required by this paragraph are safe for virtually all soils. Since, under this option, the employer is not required to make any attempt to differentiate between more stable and less stable soil types, the slopes required are conservative to ensure that employees will be protected adequately in those instances where poor soil conditions are encountered.

The required slope angles specified are identical to the slope angles that are required for the worst soil condition determined under Option (2) below. As will be explained below, the employer is required, under the second option, to differentiate between more stable and less stable soil types. Steeper slopes are allowed in soils determined to be more stable. By requiring slopes, in Option (1), that are the same as the worst case under Option (2), a necessary level of consistency in the requirements is maintained. If steeper slopes were allowed under Option (1), the situation could arise where an employer would be required to slope an excavation to a greater degree after making an effort to determine the soil type than would be required if no soil classification had been made at all. Sloping is set at a worst case angle in Option (1) to assure that protection is provided even where the employer makes no determination of soil type or stability.

In § 1926.652(o)(1)(iii), the requirements state that the configurations of slopes excavated under Option (1) must conform to the configurations illustrated in *Figure B–1* of Appendix B to Subpart P. This is to assure that slopes permitted under Option (1) are at least as protective as those set forth under the second design option in § 1926.652(b)(2).

In the second design option, § 1926.652(b)(2), designs must be in accordance with the conditions and requirements set forth in Appendices A and B to Subpart P. In brief, Appendix A is a method of classifying soil and rock conditions taking into account soil, environmental, and load conditions. Appendix A divides all soils into four classifications: Stable Rock, Type A, Type B and Type C. (See discussion for Appendix A below.) Appendix B contains requirements specifying the maximum allowable slopes for each of the four classifications. In stable rock, vertical sides are allowed. For Types A, B, and C the maximum allowable slopes vary, with steeper slopes allowed for Type A. The allowable slopes vary depending on whether the exposure is long-term or short-term. For purposes of the proposal, long-term is considered to be greater than 72 hours, while short-term is 72 hours or less. (NBS recommended 72 hours as the dividing line between long and short-term (Ex. 26.)) Slopes are required to be less steep in the long-term than in the short-term. This is because in the long-term excavation sides are much more likely to be exposed to excessive loads or to factors which cause a reduction in the ability of the excavation side to remain stable, or both—significantly increasing the likelihood of a cave-in. The range of slopes allowed varies from one-half horizontal to one vertical (1/2H:1V) for Type A, short term, to 2H:1V for Type C, long term. Appendix B also contains illustrations of five types of sloping and benching systems that are acceptable. (See discussion for Appendix B below.)

In general this proposal is expected to result in a net cost reduction, however some provision may result in cost increases. One such example could be the use of proposed *Table B–1* for sloping versus current *Table P–1*. Please provide specific examples where cost increases or decrease could occur. In your response please indicate the number of jobs in which these potential cost increases or decreases would occur.

The requirements of Appendices A and B are mandatory when design Option (2) is chosen. In the third option, § 1926.652(b)(3), three requirements are set forth. The first, § 1926.652(b)(3)(i), requires that sloping and benching systems be designed in accordance with accepted engineering practice by a qualified person or a qualified engineer. However, a person under the direction of a qualified engineer is also allowed to design sloping and benching systems under this option, because in this relationship, the qualified engineer would still be *responsible* for the design. The term "qualified engineer" is defined in proposed § 1926.650(b)(13).

A second requirement under this option, in § 1926.652 (b)(3)(ii), is that designs be in written form and include, as a minimum, the following information: (a) An indication of the magnitude of the slopes that were determined to be safe for the particular project; (b) an indication of the configurations that were determined to be safe for the particular project; and (c) the identity of the qualified individual responsible for the design.

The third requirement, set forth in § 1926.652(b)(2)(iii), is that at least one copy of the design be maintained at the jobsite while the slope is being constructed. After that, the design need not be kept on the jobsite, but a copy must be made readily available to the Secretary upon request.

In OSHA's opinion, these requirements are necessary for use in enforcing the standard, and also to increase the likelihood that adequate designs will be prepared. Under this option, the employer is allowed a wide range of discretion to determine the degree of the hazard and to determine the necessary level of protection against the hazard. It provides no specific restrictions as to maximum allowed slopes or configurations that an engineer could design. Therefore, under this option, slopes steeper than those allowed under the first two options could conceivably be used. Configurations different from those allowed under the first two options could also be used.

Option (3) is the most performance-oriented of the options provided and relies heavily on the competence and expertise of the person selected by the employer to design the system.

In order to ensure the adequacy of designs prepared under Option 3, OSHA is considering requiring that these designs provide additional information such as: What soil tests were performed and the results of those tests; what are the intended or expected load conditions; what consideration was given to environmental conditions; and, what are the limitations of the design. The Agency solicits opinion and recommendations on this subject.

Because of the wide discretion allowed, OSHA believes that stricter requirements are needed to verify that design requirements have been met. Therefore, OSHA is proposing that designs be in written form, and that they be made readily available to the Secretary upon request.

In OSHA's opinion, requiring that designs be in written form will not impose a significant burden upon employers. When an employer utilizes an individual to design a sloping and benching system, the results of the design effort must be communicated to the employer, and to those responsible for implementing the design, in some manner. Customarily this is not done orally, but by the preparation of a written plan. In OSHA's opinion, these requirements reflect current industry practice.

OSHA is revising the portions of Subpart P relating to sloping for several reasons. The existing standard allows only one approach to be used to determine the degree of slope required to protect employees against cave-ins. This approach requires that excavations

be sloped to the "angle of repose." As noted earlier, this term, as currently defined, does not conform to its use in civil engineering and has resulted in considerable confusion in the field. In addition, the existing approach is not consistent with OSHA's desire to place greater emphasis on the use of performance-oriented standards. More flexibility is possible by allowing the employer the choice to use any of several acceptable approaches to provide the required level of safety for employees.

OSHA is also revising the standard so as to provide greater clarity as to what is required of the employer. Interviews with contractors have indicated that some provisions in the existing standard relating to sloping are difficult to understand (Ex. 3).

This difficulty is due apparently to the limitations of the present format in which specific requirements relating to sloping appear in various places in the standard but in no apparent order. It also results from the fact that the soil types currently specified in *Table P–1* (compacted sharp sand, average soil, etc.) are not defined. The use and application of the terms "hard, compact soil" and "unstable or soft material" in the current standard have been the source of considerable confusion and have resulted in considerable litigation. In addition, there are other related format problems that have been discussed previously in this Preamble.

It was stated earlier that the existing Subpart P is divided into two sections containing specific requirements. § 1926.651 is titled "Specific Excavation Requirements" and § 1926.652 is titled "Specific Trenching Requirements." In § 1926.651 there are several references to sloping. These references appear in paragraphs E § 1926.651(c), E § 1926.651(d), E § 1926.651(g), E § 1926.651(h), E § 1926.651(j), and E § 1926.651(m). These requirements specify can be used as a method of protection against that sloping cave-ins and require that when sloping is used that "all slopes be excavated to at least the angle of repose. . . ." In addition, it is required that adjustments be made to the angle of repose, i.e., flattening, when certain conditions are present. These requirements are not presented in a concise, logical order and there is no guidance given to the employer in § 1926.651 indicating either what the "angle of repose" is or to what degree it must be adjusted for the specific conditions mentioned. Although *Table P–1* does give an indication of certain "angles of repose," this Table is located in § 1926.652 and no direct reference to the Table is made in § 1926.651. Further, as discussed earlier, there are technical problems with the use of the term "angle of repose." (See *§ 1926.650—"Scope, Application, and Definitions Applicable to this Subpart."* The discussion of the term "angle of repose" follows the discussion of proposed definition (b)(27) "Uprights.")

In current § 1926.652, reference to sloping appears in paragraphs E § 1926.652(b), E § 1926.652(c), and E § 1926.652(k). These requirements, in general, are intended to give more specific guidance to employers as to the degree of sloping required. *Table P–1* is referenced in both paragraph E § 1926.652(a) and paragraph E § 1926.652(b), but the language of the existing standard is apparently not sufficiently clear for some employers regarding the use of *Table P–1*. For example, in paragraph E § 1926.652(a), it is stated "Refer to *Table P–1* as a *guide* in sloping of banks." (Emphasis added.) Some employers have contended that the table is, therefore, not mandatory. However, paragraph E § 1926.652(b) is phrased in a manner more consistent with its intended mandatory nature.

Other difficulties have arisen relating to specific terms used in the current standard. For example, 45 degrees is indicated in *Table P–1* as the appropriate angle for sloping "average soil." "Average soil" is not defined in the existing standard, nor are the other terms used in *Table P–1*. Further, only two terms used in the standard itself to describe soils are presently defined. These terms are "hard compact soil" and "unstable soil." Neither term appears in *Table P–1*, and even paragraphs E § 1926.652(b) and E § 1926.652(c) use somewhat different terms "unstable *or* soft" and "hard *or* compact." (Emphasis added).

OSHA has concluded that these difficulties can be eliminated, and at the same time a more effective standard for sloping can be created. OSHA believes that the best way to address these difficulties is to revise significantly the language and format of the current standard.

OSHA is, therefore, proposing a format that allows employers to choose from among the three design alternatives described earlier—alternatives that allow the employer some flexibility to determine the degree to which excavation sides must be sloped to protect employees against cave-ins.

The calculation of the degree to which excavation sides must be sloped to protect employees against cave-ins can be a difficult task. This is true because there are many factors that must be taken into account which affect the stability of sloped excavation sides. These factors include: The soil type and its ability to resist stress; changes in the ability of the soil to resist stress due to the effects of exposure to environmental conditions such as freezing, thawing, or rain; loads imposed due to the particular configuration of the excavation; and loads imposed due to the presence of water or the variation of the water content of the soil. Other factors include: Loads imposed by the presence of structures, equipment, overlying material or stored equipment or material; and loads imposed due to dynamic forces such as vibration from equipment, blasting, traffic, or other sources.

Employers have to contend with soil as it is found in place. However, soil conditions cannot be depended upon to remain constant on any particular construction site. As a material used in construction, soil is unreliable because there is no control over its structural quality; its properties vary from place to place and change with the passage of time due to environmental exposure. There are an infinite number of combinations of conditions and factors that can affect its stability. Because soil is so variable, a great degree of caution must be exercised when relying on its strength to provide a sloping system with a desired level of protection.

There are practices that are accepted by the engineering community that can be followed to determine safe slopes for most situations. These practices involve analyzing soil samples to determine properties of the soil; evaluating intended or expected load conditions and sequences; and considering the possible effects of environmental exposure. Soil analysis can be accomplished in the field, using simple field testing techniques. Soil analyses can also be done more extensively and accurately in the laboratory. Slope stability analysis is often used to predict the behavior of a slope. Full scale models have also been used to predict expected behavior.

In OSHA's opinion, however, it is not feasible or necessary to require a rigid soil exploration and analysis program, or a slope stability analysis, for every trench or other excavation that is made. To avoid such specifications in the standard, OSHA is proposing two options in which the required slope angles are specified. In the opinion of the Agency, these two approaches will serve the needs of the industry and provide safe working conditions for employees. OSHA also recognizes that

the first two options could be unnecessarily restrictive in some situations. Thus, OSHA is proposing the third design alternative to allow the employer to determine the degree of protection required for any particular circumstance. Under this option, the employer is allowed to assess the soil conditions, the load conditions, and the effects of environmental conditions and to then determine the slope required to protect employees. There are certain restrictions imposed on employers who use this optional approach—primarily that the employer must rely on a "qualified person," a "qualified engineer" or a person under the direction of a "qualified engineer" to determine the safe slope.

It was suggested that OSHA require only a "qualified engineer" for the third option because of the complexity of designs involving soil analyses, interpretation of soil test results, and determination of slope stability. This suggestion was based on the opinion that a person with education and training in these areas is needed to assess properly the factors and conditions that affect the stability of the protective system. OSHA realizes that in order to become "qualified" some amount of experience is required. A person can gain experience by working under the direction of a person who is already a qualified engineer. It will be acceptable for designs to be prepared by a person who works under the direction of a qualified engineer. In this relationship, the qualified engineer would still be responsible for the soundness of the design. Therefore, OSHA is proposing that designs be done by a "qualified person," a "qualified engineer" or by a person under the direction of a "qualified engineer."

Additionally, experience in trench or excavation work alone, without appropriate understanding of engineering methods and principles, is not sufficient to be considered "qualified" to do analysis and design work. NBS has stated that "the number of accidents involving older, and presumably more experienced, personnel tends to refute the argument that experience alone is an adequate factor in judging trench wall stability" (Ex. 5, p. 5).

Different methods of analysis and design are used depending on the type of system that is being designed. Under the existing definition in § 1926.32(1), some critics contend that any person with some experience in trench excavation could conceivably be considered "qualified." OSHA has noted on the basis of its enforcement experience in inspecting excavations and excavation cave-ins, as well as on the NBS study, that experience alone in excavating trenches does not necessarily qualify an individual sufficiently to determine whether a particular soil will stand at a particular slope. Others argue that possession of an engineering degree *alone* doesn't necessarily qualify an individual to make these decisions, or guarantee that the designs prepared by these engineers will provide sufficient protection for employees.

It has been suggested that in order to be "qualified" a person should be a "registered" or "licensed" engineer (Ex. 8, pp. 107–208). In OSHA's opinion, a person need not be in possession of a license in order to be "qualified," nor does OSHA believe that possession of a license "guarantees" a person's qualifications to design cave-in protective systems. Many people who hold licenses to practice engineering have studied engineering principles and methods that are unrelated to the analysis and design of cave-in protection. A license may be evidence that an engineer has the background and capabilities to perform the analysis and design work required by the proposal, but only if it indicates specific knowledge and expertise in soil mechanics. It does not always indicate such specific expertise.

OSHA is proposing the new definition of "qualified engineer" which may be used to deal with the need for expertise in the design and installation of protective systems, and requests that specific attention be given to the proposed definition during the comment period.

In developing the overall approach related to the design of sloping and benching systems, and to protective systems in general, OSHA has considered other formats and alternatives. For example, a draft proposed standard was submitted to the ACCSH for review and comment on October 13 and 14, 1982. Transcripts of this meeting are part of the record of this proposed rulemaking (Ex. 8). In that draft, OSHA was considering a format that required that "all protective systems shall be designed by a 'qualified person' in accordance with accepted engineering practice to resist without failure all loads intended to be applied or transmitted to such systems." However, an appendix contained material that could be used to design sloping and benching systems in all excavations, or timber shoring in trenches. This approach was more in line with the one in the existing standard. The draft noted that protection systems designed in accordance with the appendix would meet the design requirements of the draft standard. This essentially gave employers two design options.

The ACCSH recommended a format whereby the employer would have the two design options more clearly identified. The employer would either have to follow the "standard practices" allowed in the appendix or, in the alternative, be required to have designs prepared by a "qualified person." However, the ACCSH recommended that the "qualified person" should be defined as a registered professional engineer, with expertise in civil engineering, soil mechanics or structural engineering; or a person with at least five year's experience in excavation work. Further, the ACCSH recommended that where this alternate approach to the design of protective systems was taken, the employer should be required to have on the project site plans and specifications for the designs (Ex. 8). The concern was that designs of protective systems should be undertaken only by persons with particular qualifications, such as licensed professionals, who could prove their qualifications by means of a license, or by someone who had extensive experience doing such work even though such a person did not have a formal education, i.e., an engineering degree. The basis for the suggestion to require plans and specifications on the project site was to make the requirements more enforceable, and to help ensure that the proper attention was given to the designs.

OSHA then gave consideration to a concept wherein two design options were clearly identified. The first option was to follow the requirements of the appendix; the second was to have a "qualified person" design the protective systems. However, in this concept, OSHA's intention was to define the "qualified person" using the existing definition in § 1926.32(1). This definition has been in use since the construction standards were first promulgated in 1971. However, as noted above, some commenters believe that the current definition does not incorporate a requirement that the "qualified person" have the specific expertise that is necessary for the proper design of protective systems. In recognition of the concern expressed by interested parties that adequate designs be prepared, OSHA considered other requirements that were to be linked to the design requirements. The first such requirement would provide that designs be based on

the results on specific analyses. Required analyses of the soil were considered, as well as analyses of possible load conditions. Second, OSHA would have required that designs be certified by the person responsible for the design. The certification would have been a statement to the effect that the design was done by a qualified person and was based on the results of the required analyses.

This approach was criticized as being unenforceable because under the existing definition of "qualified person," any employee with a minimum of experience in excavation work might be deemed to be "qualified." Critics contend that this could result in almost anyone being authorized simply on the basis of several years of experience in digging trenches to prepare the designs and certify the designs and to be in compliance with the standard. It was felt that the result would be inadequate designs and, thus, inadequate protection against cave-ins. This approach seemed to give total discretion to employers to determine the extent of the hazard, and to determine the required means to abate the hazard without providing OSHA with an adequate means to enforce the problems while maintaining flexibility and performance orientation, OSHA then developed the proposed approach which is used in the present proposal.

This approach continues to permit a "qualified person," as defined in 1926.32(l), to have design responsibility, but introduces the concept of a "qualified engineer" as an alternative. In order to ensure the adequacy of the designs prepared by either a "qualified person" or a "qualified engineer" and to provide a degree of consistency in these designs, OSHA is considering requiring that additional data be provided on all these designs. This is discussed earlier in this preamble where several types of data are specifically mentioned (soil tests and results, expected load conditions, environmental considerations and design limitations). The Agency solicits comment on the type of data essential to making these determinations and the appropriateness of requiring them to be included as part of the design.

This approach also highlights OSHA's concern related to ensuring safe working conditions without being overly restrictive by prohibiting design of protective systems by persons that have the knowledge, expertise and capabilities to do so, but lack an engineering degree.

OSHA has concluded that a standard utilizing the alternatives allowed in the present proposal would be more effective than the approach found in the existing standard. This is because of the added flexibility employers would have to determine the most feasible option for their particular circumstances. It is also because the proposal would help to remove most of the difficulties of interpretation and application experienced with the existing standard. The organization of the proposed standard is improved over the existing standard. Terms and phrases are more clearly defined and used. Thus, the misunderstandings that frequently occur using the existing standard would be reduced.

OSHA hopes that the proposed approach, as well as the specific options allowed, and the specific angles and configurations allowed, will be carefully considered during the comment period.

Paragraph (c) of § 1926.652 contains requirements that apply to the design of support systems, shield systems, and protective systems other than sloping and benching systems. The requirements in this paragraph are set forth in a format similar to those set forth in paragraph (b)—Design of Sloping and Benching Systems. Paragraph (c) is subdivided into four paragraphs. Each of the four paragraphs is an option employers can elect to follow to meet the requirement to provide cave-in protection.

The first option, in paragraph (c)(1), applies to the design of timber shoring in trenches. When employers elect to use this option, the requirements state that: "Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in Appendices A and C to this Subpart."

Basically, as noted earlier, Appendix A sets forth a method of classifying soil conditions into four types: Stable Rock, Type A, Type B, and Type C. Stable Rock, however, is exempt from the requirement to provide cave-in protection. (See proposed § 1926.651(j)(1)(i).)

Appendix C contains data to be used to select timber shoring for use in trenches that are up to 20 feet (6.1 m) in depth. Soil conditions must first be classified as Type A, Type B, or Type C, in accordance with Appendix A. Appendix C contains three tables, one for each of the soil types, from which various configurations of shoring can be selected. Appendices A and C are discussed later in this Preamble in greater detail.

The second option, paragraph (c)(2), allows the use of designs based on or drawn from manufacturer's tabulated data. The manufactured systems generally addressed by the paragraph include metal hydraulic shoring and shields. In the past, manufacturers have developed tabulated data that indicated the conditions for which their various products could be used.

The requirements of § 1926.652(c)(2)(i) state that designs "that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, limitations, and warnings issued or made by the manufacturer." In § 1926.652(c)(2)(ii), it is required that "deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed when the manufacturer issues specific written approval." A third requirement, in § 1926.652(c)(2)(iii), states that manufacturer's specifications, recommendations, limitations, and warnings, and the approval required in § 1926.652(c)(2)(ii), be in written form at the jobsite during construction of the protective system. After that the data may be stored off the jobsite, but a copy shall be made readily available to the Secretary upon request.

A trend in the construction industry has been to use and rely more and more on products that are manufactured systems of protection. The design of particular products such as trench shields can be highly complex. A single manufacturer is likely to have available a range of products, each intended for use in different circumstances. The employer is concerned with using a product that is intended for use in a particular situation.

It is, therefore, incumbent on the employer to ascertain all that the manufacturer specifies or recommends regarding the use of a particular product, and then use the product accordingly.

An employer, then, is allowed a degree of discretion as far as choosing a particular product for use. In OSHA's opinion, the likelihood that manufactured products will be used in the manner intended will be enhanced if the specifications and recommendations that the employer uses to select such products, including the limitations set by the manufacturer on their use, is required to be at the jobsite while the system is being constructed and made readily available to the Agency upon request. Therefore, OSHA is proposing such requirements.

In the third option, paragraph (c)(3), it is specified that designs can be selected from other tabulated data, such as tables and charts, that have been prepared by or under the direction of a qualified person or a qualified engineer. The use of State regulations, promulgated under an OSHA approved

State plan and determined to be "as effective as" Federal regulations, is acceptable to meet the requirements of this provision. Additionally, this paragraph is intended to allow employers to develop and use general designs that can be used repetitively and that meet the needs of their particular circumstances. OSHA recognizes that the design of protective systems can be a highly complex engineering procedure that involves elements of soil mechanics and structure engineering. In reality, each case is unique. Therefore, repetitive use of a general design must be done with caution. Designs for general applications have limits that must not be exceeded or the safety of employees will be endangered. Tabulated data, therefore, can only be used safely when the necessary information is provided that explains the limitations of the data and demonstrates that the system is safe under prevailing soil, load, and environmental conditions.

OSHA is proposing, therefore, new requirements that are intended to increase the likelihood that tabulated data will be used properly. These new requirements are set forth in four paragraphs within paragraph (c)(3).

In paragraph (c)(3)(i), it states that designs "shall be selected from and be in accordance with tabulated data, such as tables and charts."

In paragraph (c)(3)(ii), it is explicitly stated that the tabulated data shall be prepared by a qualified person, a qualified engineer or a person under the direction of a qualified engineer.

In paragraph (c)(3)(iii), it is required that the data be in written form. It is also required that at a minimum, certain information be included with the data. Basically, the information required includes instructions for the use of the data, the limits of application of the data, identification of pertinent parameters that affect the selection of a protective system drawn from the data, and identification of the qualified individual responsible for the preparation of the data. In paragraph (c)(3)(iv) it is required that at least one copy be maintained at the jobsite while the protective system is being constructed and that it be made readily available to the Secretary upon request.

In OSHA's opinion these requirements for documentation are needed to provide a balance to the wide discretion that is allowed employers in providing a system of protection, and in order to assure that employees are adequately protected.

In the fourth design option, paragraph (c)(4), the requirements are stated in three paragraphs within paragraph (c)(4). In paragraph (c)(4)(i), the requirements state that protective systems shall be designed in accordance with accepted engineering practice by a qualified person, a qualified engineer, or by a person under the direction of a qualified engineer. This option gives employers the flexibility to design protective systems for unique applications. There are no specific restrictions or limitations regarding the application of designs allowed under this option. The employer, through the qualified individual, is thus given wide latitude to judge the degree of the hazard present and to determine the degree of protection required.

OSHA recognizes, because such wide latitude would exist under this provision, that the possibility of abuse of the discretion allowed would also exist. OSHA is, therefore, proposing additional requirements that are intended to increase the likelihood that the protective systems designed under this option will be adequate to protect employees. The first of these additional requirements is stated in paragraph (c)(4)(ii). It states: "Designs shall be in written form," and must, at a minimum, include "a plan indicating the sizes, types, and configurations of the materials to be used in the protective system," and "the identity of the qualified individual responsible for the design." The other additional requirement is stated in paragraph (c)(4)(iii). That paragraph states that "At least one copy of the design shall be maintained at the jobsite during the construction of the system, and the design shall be made readily available to the Secretary upon request."

These requirements are similar to those proposed by OSHA in § 1926.652(b)(3) for sloping and benching. The discussion of those requirements is equally applicable for the requirements proposed under the subject paragraph, especially the discussion on requiring more data related to selection factors used to determine the design.

Strong support has been voiced by the ACCSH for requiring designs by specially qualified personnel (EX. 8). As discussed under § 1926.652(b) above, there is concern that the existing definition of "qualified" in § 1926.32(1) is not adequate because it implies that, on the basis of experience alone, a person could be considered qualified. Because design of protective systems can be a difficult engineering problem, it requires special expertise, and it is crucial that adequate designs be used. Interviews with contractors indicate that the primary reason for the failure of protective systems is a lack of an adequate design of systems (Ex. 3).

OSHA would like to receive comments specifically addressing these proposed requirements. OSHA again requests that these proposals be carefully considered and that comments and views be submitted during the comment period.

There are many paragraphs distributed throughout the existing standard that set forth requirements pertaining to the *use* of shoring and other protective systems. Existing paragraphs (c), (m), (o), and (q) of § 1926.651, and paragraphs (b), (c), (e), and (f) of § 1926.652 state when use of a protective system is required. Other existing paragraphs contain requirements pertaining to the *design* of such systems. These include paragraphs (e), (f), and (k) of § 1926.651; and paragraphs (d), (g), and (k) of § 1926.652. These existing requirements have been revised and reorganized in the proposal in order to make the standard easier to follow and understand.

Some of the shoring requirements in the current standards have been criticized as being either too inflexible or too difficult to understand. For example, *Table P–2*, "Trench Shoring—Minimum Requirements," has been criticized by contractors as too inflexible (Ex. 3). *Table P–2* specifies sizes of timber shoring members but generally only specifies one configuration of members for any particular case. Each case is defined by three parameters: Soil condition, trench depth, and width of trench. OSHA notes that interpreting the Table as not allowing any deviation from the specified configurations is an inaccurate and overly restrictive reading of *Table P–2*. The Table only indicates certain configurations that will provide the required minimum protection. Other configurations that provide equivalent or greater protection are acceptable.

Another problem with *Table P–2* is that selection of a configuration is based on soil classifications and soil conditions that are not currently defined in the standard. The terms are not used in a manner that is consistent with the way other similar terms relating to soil conditions are used in the standard. Thus, it is difficult at present to use *Table P–2* to select the proper protection.

Another criticism that has resulted from a misunderstanding of the current standard is that the standard is ambiguous with regard to allowing the use of protective systems other than timber shoring. However, as a clarification, it should be noted that

several such protective systems are mentioned in the existing standard. These include shoring, sloping, use of shields, support systems, bracing, and sheet piling. In a footnote to *Table P–2,* trench jacks and steel sheet piling are specifically indicated as being acceptable substitutes for wood members. However, the lack of mention of other systems, particularly metal hydraulic shoring, has led to the mistaken impression among some interested persons that such systems are not allowed by the standard. OSHA emphasizes that this is not the case, either with the current standard or in the proposal.

In developing this proposal, OSHA has attempted to clarify the application of these and other provisions of the standard, and has made every effort to remove ambiguities and sources of confusion that have arisen in the current standards. Overall, the proposed requirements are intended to provide a greater degree of flexibility by providing the employer with alternative approaches that yield the same end result. The employer is free to choose the approach that is most feasible for any particular circumstance. Wide latitude is granted, but it is balanced and checked by requirements that are intended to make the standard enforceable.

OSHA is interested in the views of those affected by these proposed requirements and therefore again requests that comments be submitted that are directed specifically to the requirements proposed here.

Paragraph (d), "Materials and equipment," addresses the hazard to employees resulting from the use of damaged or defective items in protective systems. The material and equipment is relied upon to have a certain degree of structural capability. The loss of this capability due to defects or damage can result in the failure of a protective system.

Paragraph (d)(1) requires that materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

Paragraph (d)(2) addresses manufactured equipment. It requires that such material be used and maintained in a manner consistent with the manufacturer's recommendations and in a safe manner so as to protect employees from hazards.

Paragraph (d)(3) requires that where equipment is damaged while in service, it be examined by a competent person for its suitability for continued use. When it is unsuitable, the material or equipment must be removed from service.

The existing requirements in E § 1926.651(1) and E § 1926.652(d) address the condition of materials used for support structures and systems. These requirements have been consolidated into proposed paragraph (d)(1), which covers all elements of protective systems, and which extends to other types of protective systems such as shields.

The existing standard does not refer specifically to manufactured items. Equipment such as shields and metal hydraulic shoring are used extensively in the industry today. However, to assure their safe use, these items must be used in strict accordance with the manufacturer's recommendations and instructions. In addition, the existing standard does not clearly address the problem of material becoming damaged while in use. Often material and equipment used in temporary protective systems are designed with only a slight factor of safety. If the equipment is damaged, there may be no factor of safety and employees are in immediate danger. Proposed paragraphs (d)(2) and (d)(3) address the need for employees to be protected in these circumstances.

Paragraph (e), "Installation and removal of support systems," contains requirements for the protection of employees during installation and removal of support systems.

Installation and removal of support systems are particularly hazardous periods in excavation work which can involve significant material-handling activity. Additionally, partially completed support systems will not react to loads in the same manner as the completed structures. Individual members can become overloaded and fail, leading to a general failure of other portions of the support system. Therefore, employees can be exposed to cave-ins, the collapse of adjacent structures, or collapse of the support system if the employees are not properly protected during installation and removal.

Paragraph (e)(1) contains six requirements that address these hazards. Four of these requirements are based on existing requirements found in three existing paragraphs, E § 1926.651(f), E § 1926.652(j), and E § 1926.652(1). The existing provisions have been grouped into a more logical, easier-to-follow format under only one paragraph heading. The requirements in E § 1926.652 that apply currently to specific trenching situations only would be extended to cover all excavations because the hazard addressed by those requirements exists whenever support systems are being installed or removed.

The other two proposed requirements are new. These specifically require protection for employees from cave-ins, the collapse of structures, or from being struck by members of the support system. The proposal requires, in addition, that individual members of support systems not be subjected to loads exceeding the design loads of those members.

Paragraph (e)(2)(i) contains a new provision that allows excavation to a level not greater than two feet (.61 m) below the bottom of the members of a support system of a trench. It applies *only* to trenches. This provision is one of the provisions recommended to OSHA by NBS based upon their studies (Ex. 6). It helps to clarify what was meant by the phrase "installed so as to be effective to the bottom of the excavation" found in E § 1926.652(d) of the current trenching standards. The proposed provision recognizes that trench support systems in some instances need not always be installed to the bottom of the excavation. If designed to resist the forces calculated for the full depth of the excavation, the system can be fully effective, even if it does not extend to the bottom.

Paragraph (e)(2)(ii) requires that installation of support systems be closely coordinated with the excavation of trenches. This is a revision of E § 1926.652(i). The Construction Advisory Committee suggested that this requirement be dropped (Ex. 8, p. 400) because it seemed to apply to all trenches even where there would be no employee exposure to cave-in hazards, i.e., where no employees enter the trenches. However, this paragraph is intended to apply only where employees are exposed to cave-in hazards. All OSHA standards apply only where there is potential exposure of employees to hazards, and therefore it is not considered necessary to state this for every requirement.

Coordination of installation of the support system with the excavation of the trench will reduce the possibility that a cave-in will occur. The longer a trench is open, the more likely it is to cave-in. Essentially, where employees will be expected to enter a trench, it is a safe work practice to install the support system as soon as possible after excavation. OSHA believes that this proposed requirement is necessary to assure employee safety in trenches.

Paragraph (f), "Sloping and benching systems," contains a new requirement prohibiting employees from working on the faces of excavations at levels above

other employees; except when adequate protection against falling material is provided. Obviously, employees can dislodge loose material and cause it to fall to lower levels. This dislodging activity, in fact, may be their work assignment. Employees at lower levels can be struck by falling material. With adequate protection from a barricade, net, shield or other protective device, this situation need not be hazardous.

Paragraph (g), "Shield systems," contains new provisions. These requirements are arranged in two paragraphs.

Paragraph (g)(1) contains four general requirements which basically address work practices not spelled out in the existing standard.

Shields, by their nature, provide protection only in the area within the structure. The remainder of the excavation is generally left unsupported and unshielded. Employees entering or exiting shields through these unprotected areas would be exposed to cave-in hazards. Therefore, the proposal would prohibit employees from passing through such areas to reach the shield.

Generally, shields are designed to be moveable. Employees would be exposed to unexpected shifting of the shield during installation, removal, or relocation. Therefore, when shields are being moved, employees are prohibited from being within the shield. (See Issue 11 above.)

Shields do not normally prevent cave-ins, but do protect employees in the event of a cave-in. The possibility exists that the magnitude of the forces imposed on a shield during a cave-in could shift the shield laterally if it is not restrained against such movement. If the employees are in the shield, this lateral movement could be hazardous. The proposal requires that shields be installed in a manner to restrict lateral movement in the event of the application of sudden lateral loads such as during a cave-in. One method of accomplishing this in trenches is to excavate the trench so that it is only as wide as is necessary to install the shield.

Shields are protective devices that must be specially designed and constructed. Because of the highly variable nature of soil conditions and loading caused by soil movement, shields have strict limitations on their use. These limitations are established by the manufacturer for manufactured shields, but in some situations shield systems are constructed on-site. It is more difficult to ascertain the limits of such shields. The design of shields is addressed in § 1926.652(c) of the proposal. However, in practice, load conditions could occur which a particular shield might not have been designed to support. For example, crossbraces might not have been designed to support vertical loads in addition to compressive loads. To deal with this protential hazard, the proposal would prohibit employers from subjecting shields to loads other than those considered in their design.

Paragraph (g)(2) applies only to trenches. It allows excavation in certain circumstances of earth material to a level not greater than two feet (.61 m) below the bottom of shields. The reasoning behind this is identical to that discussed in paragraph (e)(2)(i) above.

Relocated and Deleted Paragraphs. The fall protection requirements in existing paragraph E § 1926.651 (t) and (w) are not included in the proposed revision of Subpart P. These provisions, which require fall protection at remotely located excavations and on walkways or bridges crossing over excavations, respectively, would be relocated in Subpart M—Fall Protection, and would be redesignated as § 1926.500 (h) and (i). This action is consistent with OSHA's intention to locate all provisions relating to fall protection in construction together under one Subpart.

OSHA currently published a proposed revision of its fall protection standards in Subpart M. (See **Federal Register,** November 25, 1986). When this proposal is published as a final rule the excavation fall protection provisions incorporated will be placed in a new Subpart M.

OSHA is proposing to delete the following existing paragraphs: E § 1926.650(e), which requires personal protective equipment as set forth in Subpart E; E § 1926.651(r), which requires that blasting be performed in accordance with Subpart U; and E § 1926.651(y), which requires that ladders be in accordance with the requirements of Subpart L. These references are redundant in that they require nothing different or in addition to the requirements set forth in the respective subparts. In addition, they might mislead an employer into assuming that other subparts not referenced do not apply to excavations. The requirements of Subparts E, U, and L remain applicable to employees working in and around excavations as do the other subparts of Part 1926.

OSHA is proposing that paragraph E § 1926.652(g) also be deleted. This paragraph presently states: "Minimum requirements for trench timbering shall be in accordance with Table P–2." It also requires that compressive stresses in timber braces and diagonal shores not be in excess of certain allowable values as computed using the given formula. The requirements of this paragraph are not consistent with the approach taken in the proposal, which does allow the employer to select trench timbering from tables, but does not make the tables minimum requirements for all trench shoring.

In addition, OSHA believes that the equation set out in E § 1926.652(g)(2) is not appropriate for continuation in the standard. This equation is intended to be used for determining the maximum allowable compressive stress in braces and diagonal shores in a wood shoring system. OSHA has determined that the equation should not be carried forward because it is outdated. The use of the specified equation, in a slightly different form, was originally contained in the USA Standard A10.2—1944, "Safety Code for Building Construction." Since that time, new equations for determining allowable compressive loads have been developed. These newer equations are described in the "Timber Construction Manual" published by the American Institute of Timber Construction. The second edition was published in 1974. The more modern equations take into account the shape of the member, i.e., square or round, and the kind of wood used to produce the member. Allowable stresses, i.e., the maximum stresses to which a member should be subjected, vary depending upon the species of wood being considered. The equation given in E § 1926.652(g)(2) does not account for either of these factors.

However, even with the improved equations, OSHA does not believe that the newer equations should be specified in the revised standard. First, in OSHA's opinion, these equations are not necessary. As pointed out above, the particular equation specified is used only to determine the maximum allowable stress to which a certain structural member should be subjected. Today, such information generally is available in tabulated form for most species and grades of wood. Therefore, it is not necessary to use an equation in the standard and calculate maximum allowable stresses. Furthermore, knowing the maximum allowable stress alone is of little value. The *actual* stress to which a member is subjected or expected to be subjected must also be known and a comparison made between the actual and allowed stresses. If the actual stress exceeds the maximum allowable, then the particular member could not be used. Computing the actual stress, however, can be a highly complex engineering problem.

Another reason why use of equations is not required in the proposal is that

they address only one type of load situation. For example, the current equation is only intended to be used to calculate the maximum allowable compressive stress for wood members acting as columns under axial compressive loads. However, members are often subject to eccentric loads or lateral loads that create bending stresses in them. These other actual stresses, alone or in combination with axial compressive forces, may be critical. Therefore, the maximum allowable and actual stresses for various load conditions need to be considered in addition to the one load condition currently specified in the standard.

A final reason why specification of the given equation should be discontinued is that it applies only to wood members. Much less wood is used today than in 1944 when use of the equation was recommended. Other materials, primarily steel and aluminum, are used more frequently today and different equations are used to calculate allowable stresses in members of these materials.

OSHA is proposing, therefore, no longer to require the use of such specific equations. In OSHA's opinion, the alternatives set forth in the proposal for design of protective systems will provide added flexibility for the employer while increasing the degree of safety afforded the employees.

OSHA is also proposing other deletions. Two tables which are part of the present standard would be deleted by the proposal and would be replaced by material to be contained in the Appendices to the standard. The contents of these Appendices are discussed in detail below. *Table P–1*, "Approximate Angle of Repose for Sloping of Sides of Excavations," would, in effect, be replaced by Appendices A and B, which provide a detailed soil classification scheme and sloping requirements for the employer who selects the second option for designing sloping system protection.

Similarly, *Table P–2*, "Trench Shoring-Minimum Requirements," would be replaced with material in Appendices A and C.

Appendix A—Soil Classification

Appendix A details a method of classifying earth deposits, taking into account various environmental conditions, site-specific conditions, and soil-specific conditions. The results of the categorization of soils in accordance with this method would then be used subsequently to determine the level of protection against cave-ins that is required to protect employees.

It is not required in every instance that employers use this Appendix as the basis of classifying earth conditions. Use of this Appendix is an option that employers may choose. The option to use this Appendix is stated twice in the standard. First, it is stated in § 1926.652(b)(2) as one option that may be used to determine the requirements for sloping and benching. The option is stated a second time in § 1926.652(c)(1) as one option that can be used to determine the requirements for timber shoring. It should be noted again that the employer is required to select one of the options set forth in § 1926.652(b) if using a sloping system, or in § 1926.652(c) if using shoring, shields, or another system. When an employer chooses an option where this Appendix is to be used, *the employer must then adhere faithfully to the requirements and provisions of the Appendix.* The Appendix then becomes mandatory.

Appendix A is arranged into four major paragraphs. These are: (a) Scope and Application; (b) Definitions; (c) Requirements; and (d) Recommended Visual and Manual Tests.

The first paragraph states the scope of the Appendix and when it is applicable. Terms used throughout the Appendix are defined in the second paragraph. The requirements for making soil classifications are set forth in the third paragraph and basically state that the classifications, as defined in the previous paragraph, shall be determined based on the results of visual and manual analyses. Recommended visual and manual analyses are described in the fourth paragraph.

OSHA recognizes that all or none of the particular analyses described in the fourth paragraph may apply at any one time, and that other tests could be developed or used which would meet the intent of the standard. Therefore, these analyses are recommended, but not mandatory.

This soil classification system, as with all soil classification systems, is not intended for universal application. OSHA does not intend that the system be used to replace analysis and testing for engineering design. OSHA does not require sampling and testing for engineering design in the current standard, and does not believe it is warranted to require these procedures in the proposal. The decision to conduct a more sophisticated soil sampling and testing program, as with the current standard, would be left to the employer's discretion in the proposal. When an engineering analysis is desired, OSHA recommends that other presently accepted methods of soil sampling and testing be used. Such methods as those adopted by the American Society for Testing and Materials (ASTM) are accepted methods.

This soil classification system is being proposed in an effort to address a deficiency in the existing standard. The existing standard does not rely on a consistent method of classifying soils, but relies on terms that cannot be easily quantified, such as "hard and compact" and "soft and unstable." Further, there is an inconsistency in the terminology currently found in Subpart P. For example, one set of terms is used in *Table P–1* which indicates recommended slopes in certain materials, primarily granular. A different set of terms to describe soils is used as the basis of the divisions of *Table P–2* which specifies mininum requirements for timber shoring in trenches.

The soil classification system that is being proposed is intended to eliminate this deficiency. It is intended to provide construction personnel and OSHA Compliance Officers with a common language that can be used to assess the requirements and adequacy of sloping and shoring systems used to prevent cave-ins.

The proposed soil classification system was developed by the National Bureau of Standards (NBS). The background of the system is explained in more detail in Exhibit 5. OSHA has incorporated this classification system in the proposal based on the recommendations of NBS, after consultation with the ACCSH, and after a review by interested parties at the five industry-sponsored workshops. In addition, OSHA has used several American Society for Testing and Materials (ASTM) Standards, as well as other sources, to obtain information that, in OSHA's opinion, was needed to supplement and clarify the NBS recommendations. The ASTM Standards include:

(1) Designation: D653–67 (Reapproved 1973)—"Standard Definitions of Terms and Symbols Relating to SOIL AND ROCK MECHANICS," (Ex. 27).

(2) Designation: D2487–69—"Standard Method for CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES," (Ex. 28).

(3) Designation: D2488–69—Standard Recommended Practice for DESCRIPTION OF SOILS (VISUAL—MANUAL PROCEDURE)," (Ex. 29).

OSHA has used these sources to clarify and provide additional information in paragraph (b) of the Appendix, "Definitions," and in paragraph (d), "Recommended Visual and Manual Tests."

One example of the use of supplemental information involves the development of the definition of "cemented soil." NBS makes reference to cemented soil in its recommended definition of Type A soil, but provides no discussion as to what constitutes cemented soil other than to suggest that soils referred to as "hardpan" or "till" are examples of cemented soil.

Cemented soils are most commonly composed of granular, or course-grained particles. Carbonate salts—calcium carbonate being the most common—are the primary chemical agents that provide the cementation of the particles of soil. The action of the cementing agents adds to the strength of the soil by binding the particles together so that the soil can resist a greater degree of stress.

The quantity of the cementing agent in a soil sample can be estimated by subjecting a soil sample to a solution of dilute hydrochloric acid and visually noting the intensity of the reaction. Unfortunately, this test does not give a good indication of the strength of the cemented soil. However, a satisfactory estimate of the relative strength of a cemented soil can be made by conducting a dry strength test. This is a test that is conducted by crushing dry soil samples between the fingers. The dry strength test is used primarily for estimating the strength of fine-grained soils, i.e., clays, which have cohesive qualities. Conducting this test on cemented coarse-grained soils, however, can give good estimates of relative strength that are equivalent to the strength estimates of fine-grained soils.

In ASTM D2488 (Ex. 29), in a description of the dry strength test, it is noted that: "The presence of high-strength water soluble cementing materials, such as calcium carbonates, may cause exceptionally high dry strength. . . ." In the dry strength test, "high" strengths are indicated if "the sample cannot be crushed to powder by finger pressure, even though the sample may be broken." "Very high" strength is indicated "if the sample cannot be broken between the thumb and a hard surface." In another reference (*Handbook of Soil Mechanics,* Volume 1, p. 98, by Arpad Kezdi) under a discussion of the dry strength test, it is stated: "If the sample resists crushing by finger pressure altogether, the soil is an inorganic clay of high plasticity, or a coarse-grained soil aggregate cemented by some high-strength binder (e.g., calcium carbonate or iron oxide)."

Based on the discussions of cemented soils in this literature, OSHA has supplemented the NBS recommendations by developing a definition of "cemented soil" with the intent of clarifying the NBS recommendations. The definition of "cemented soil" is intended to include those soils that exhibit strengths at least equivalent to the strengths required for Type A cohesive soil. The result of this will be that some soils containing a slight amount of a cementing agent will not be considered as cemented soil, as such soil will not exhibit sufficient strength.

The soil classification system being proposed has not been used in practice. However, in OSHA's opinion, use of this system will be a major improvement over the terminology and practices used in the existing standard. Because this system has not been used in practice, OSHA believes that careful consideration and comment on this system by those affected by this standard should be undertaken. Therefore, OSHA requests that particular attention be given to the proposed soil classification system and to the issue of soil classification in general.

Appendix B—Sloping and Benching

This Appendix sets forth the requirements for sloping and benching when those methods are used for protecting employees against cave-ins.

Employers are not required in every instance to use this Appendix. Therefore, in this respect, it is not mandatory.

This Appendix is provided as one option that employers can use to meet the requirement to provide cave-in protection for employees. The option to use this Appendix is stated in § 1926.652(b)(2). It is the second option employers may choose to follow to determine the requirements for sloping and benching protective systems. When this option is chosen by the employer, *the provisions of this Appendix become mandatory.*

The slopes required vary, and are dependent upon the type of soil in which the excavation is made. To use this Appendix, soils must first be classified in accordance with the provisions of Appendix A to this Subpart—"Soil Classification."

Paragraph (a) of the Appendix is a scope and application statement.

Paragraph (b) sets forth applicable definitions. Two particularly important concepts are defined. These are "maximum allowable slope" and a concept based on a time of exposure. This time concept is expressed using the words "short-term" and "long-term."

In this Appendix, slopes are expressed as maximum allowable slopes. The maximum allowable slope is the steepest incline from the horizontal that will be acceptable under the most favorable site conditions for a particular type of soil. These slopes vary with the soil type in which the excavation is made, and the length of time that the excavation is open. In addition, the depth of the excavation is specifically taken into account in one instance. In Type A soils, the maximum allowable slope for the short-term can only be used in excavations up to 12 feet (3.6 m) in depth.

"Short-term exposure" means a period of time less than or equal to 72 hours. "Long-term exposure" is greater than 72 hours. The three-day or 72 hour dividing line is from an NBS recommendation based on the discussions at the industry-sponsored workshops (Ex. 26). OSHA solicits comments on whether this time frame is appropriate for distinguishing between long-term and short-term exposure.

The allowable slopes given for long-term exposure in this Appendix (in proposed *Table B–1*), coupled with the allowable configurations (given in proposed *Figures B–1.1 through B–1.5*), should provide a greater level of protection to employees than is now required by the existing standard. The existing standard does not require that the "time of exposure" be taken into account when determining required slopes.

The allowable slopes given for short-term exposure, coupled with the allowable configurations (given in the proposed *Figures B–1.1 through B–1.5*), should provide a level of protection that is equivalent to the level of protection that is required by the existing standard.

There is no scientific basis for the suggested length of time used to delineate short-term exposure. Various lengths of time from two hours to 10 days have been suggested and discussed. Some professionals in construction have suggested that the required slope not be related to time of exposure at all (Ex. 8, pp. 304–308).

OSHA believes this issue merits further discussion. Therefore, OSHA requests that careful consideration be given to the issue of "time" as it relates to the determination of maximum allowable slopes. OSHA requests that specific comment directed to this issue be submitted during the comment period for this proposal. (See also the *Issues* section of this Preamble for information related to this issue.)

Paragraph (c) of this Appendix states the requirements for sloping and benching. Primarily, it is required that soil types be determined in accordance with Appendix A; that the maximum allowable slopes be in accordance with

Table B–1 of this Appendix B; and that the configurations of the sloping and benching systems be in accordance with the illustrations in *Figures B–1.1 thru B–1.5.* Other requirements state when slopes less than the maximum allowable slope must be used.

This Appendix is intended to replace *Table P–1* found in the existing standard. The difficulties associated with the use of *Table P–1,* such as a lack of definitions of terms, are a major reason for replacing the table. Another reason for replacing the table is to provide a new set of provisions that are correlated with the soil classification system described in Appendix A. The reasons for providing a new soil classification system have been addressed earlier in this Preamble.

This new system is broader than the current standard in that more parameters must be considered when determining allowable slopes, and in that various allowable configurations of sloping and benching are illustrated. The system is based primarily on the recommendations made to OSHA by NBS (Ex. 6).

OSHA believes that this Appendix will provide employers with a realistic and flexible approach to sloping and benching. In OSHA's opinion, the maximum allowable slopes will provide a safe work area for employees in excavations when the soils are properly classified and the slopes properly made.

Appendix C—Timber Shoring for Trenches

Appendix C contains information that can be used to provide timber shoring in trenches. Timber shoring is one of several methods that can be used to provide protection for employees against cave-in hazards.

Employers are not required in every instance to use the Appendix. Therefore, in this respect, it is not mandatory. This Appendix is provided as one option that employers can use to provide cave-in protection. The option to use this Appendix is stated in § 1926.652(c)(1). When this option is chosen by the employer, *the Appendix becomes mandatory.*

The Appendix is structured as follows:

Paragraph (a) discusses the scope of the Appendix and its interrelationship with the requirements for protective systems in § 1926.652(b) or § 1926.652(c).

Paragraph (b) notes that the provisions of Appendix A to Subpart P must be followed for the purposes of soil classification. The configurations of timber shoring that can be selected using this Appendix are directly tied to the soil classifications described in Appendix A.

Paragraph (c) describes what information is contained within the Appendix.

Paragraph (d) indicates the basis and the limitations of the data in the Appendix.

Paragraph (e) is a description of how to use the tables.

Paragraph (f) contains examples to illustrate use of the tables.

Paragraph (g) contains notes that apply when using the tables.

Paragraph (g) is followed by three tables of data. There is one table for each of the three soil types. Stable rock is exempt from shoring requirements.

This Appendix is intended to replace *Table P–2,* "Trench Shoring—Minimum Requirements," which is found in existing Subpart P. This approach is being proposed primarily to address the problems detailed earlier in this Preamble concerning soil classification. This new approach provides a system that is correlated with the new proposed soil classification system detailed in Appendix A. This Appendix, however, also provides a greater degree of flexibility than the current standard in that the tables can be used to select a greater number of configurations than is currently possible with *Table P–2.*

The tables in this Appendix have primarily been developed based on recommendations and data provided to OSHA from NBS (Ex. 6). Data in the tables not specifically recommended by NBS (Ex. 6). Data in the tables not specifically recommended by NBS are provided based on traditional practice. NBS could find no evidence that traditional timber practice, if properly executed, is unsafe [Ex. 6, p. 65]

IV. References (Exhibits)

1. Salomone, Lawrence A. and Yokel, Felix Y., *Proceedings, Federal Workshop on Excavation Safety, September 19 and 20, 1978,* National Bureau of Standards, Report No. NBSIR 79–1935, Washington, DC, December 1979.

2. Salomone, Lawrence A. and Yokel, Felix Y., *An Analysis of the Responses from an Associated General Contractors of America (AGC) Survey of Trenching and Shoring Practices,* National Bureau of Standards, Report No. NBSIR 79–1936, Washington, DC, July 1979.

3. Hinze, Jimmie and Carino, Nicholas J., *A Study of Work Practices Employed to Protect Workers in Trenches, National Bureau of Standards, Report No. NBSIR 80–1988, Washington, DC, March 1980.*

4. Knab, Lawrence, Yokel, Felix Y., et al., *A Study of Lumber Used for Bracing Trenches in the United States, National Bureau of Standards, Report No. BSS–122, Washington, DC, March 1980.*

5. Yokel, Felix Y., Tucker, Richard L., and Resse, Lymon C., *Soil Classification for Construction Practice in Shallow Trenching,* National Bureau of Standards, Report No. BSS–121, Washington, DC, March 1980.

6. Yokel, Felix Y., *Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations,* National Bureau of Standards, Report No. BSS–127, Washington, DC, June 1980.

7. Yokel, Felix Y., *Working Draft of Suggested Revision in Subpart P of the Safety and Health Regulations for Construction Based on Building Science Series Report BSS–127,* National Bureau of Standards, Washington, DC, February 20, 1981, Unpublished.

8. Advisory Committee on Construction Safety and Health, *Transcripts of Meeting Held on October 13 and 14, 1982.*

9. "Work Injuries in Sewer, Pipeline, and Other Trench Construction." *Work Injuries in California, Quarterly,* State of California, Department of Industrial Relations, Division of Labor Statistics and Research, IAQ–28, San Francisco, California (1968), pp. 2–9.

10. "Work Fatalities Resulting From Cave-In of Ditch, Trench, or Excavations." *Work Injuries in California, Quarterly,* State of California, Department of Industrial Relations, Division of Labor Statistics and Research, IAQ–35. San Francisco, (June 1974), pp. 2–6.

11. *Excavations, Trenching and Shoring: The Responsibility for Design and Safety.* Thompson and Tanenbaum. Texas A & M University, Project No. RF 3177, College Station, Texas, September 1975.

12. U.S. Department of Labor, Occupational Safety and Health Administration, *Impacts of Occupational Safety (and Health) Inspections: A Retrospective Look at OSHA's Special Emphasis Program (SEP) on Trenching and Excavation,* Study by Arthur D. Little, Inc., July 1979, Unpublished.

13. *California Work Injuries and Illnesses, 1975,* State of California, Department of Industrial Relations, Division of Labor Statistics and Research, San Francisco: 1977.

14. *California Work Injuries and Illnesses, 1976,* State of California Department of Industrial Relations, Division of Labor Statistics and Research, San Francisco: 1978.

15. *California Work Injuries and Illnesses, 1977,* State of California, Department of Industrial Relations, Division of Labor Statistics and Research, San Francisco: 1980.

16. "Man Killed When Trench Collapses," The Ephraim, Utah, *Enterprise,* April 9, 1981.

17. "Precast Girder Collapse Kills Two," *Engineering News Record,* Vol. 174, May 13, 1965.

18. "Excavation Cave-In Buries Three," *Engineering News Record,* Vol. 180, May 2, 1968.

19. "OSHA First Report of Serious Accident," March 6, 1981, Unpublished.

20. "OSHA First Report of Serious Accident," December 16, 1980, Unpublished.

21. "OSHA First Report of Serious Accident," November 21, 1980, Unpublished.

22. "OSHA First Report of Serious Accident," October 8,

1980, Unpublished.
23. "Infection Caused Worker's Death, Autopsy Shows." *The Ephrata Review*, August 6, 1981.
24. U.S. Department of Health and Human Services, Public Health Service Centers for Disease Control, NIOSH, "*Request for Assistance in Preventing Deaths and Injuries from Excavation Cave-ins,*" July, 1985.
25. "Pipelaying on Land is an Underwater Job," *Construction Methods and Equipment*. Aug., 1974.
26. Yokel, Felix Y. and Stanevich, Ronald L., *Development of Draft Construction Safety Standards For Excavations—Volumes I and II*, National Bureau of Standards and National Institute for Occupational Safety and Health, NBS Report No. NBS1R 83-2693 and DHHS (NIOSH) Publication No. 83103, May 1983.
27. The American Society for Testing and Materials, Designation: D653-69 (Reapproved 1973)—"Standard Definitions of Terms and Symbols relating to SOIL AND ROCK MECHANICS."
28. The American Society for Testing and Materials, Designation: D2487-69—"Standard Methods for CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES."
29. The American Society for Testing and Materials, Designation: D2488-69—"Standard Recommended for DESCRIPTION OF SOILS (VISUAL—MANUAL PROCEDURE)."
30. U.S. Department of Labor. Occupational Safety and Health Administration. Office of Management Data Systems. Management Information Systems Data for OSHA Fatality Reports and Associated Inspections for 1977-1981.
31. U.S. Department of Labor. Occupational Safety and Health Administration. Office of Data Analysis. "*Selected Occupational Reports of OSHA Fatality/Catastrophe Investigations.*" Washington, DC, July 1985. 157 pp.
32. "Case Studies Excavating, Trenching and Shoring" done for U.S. Department of Labor, OSHA, Contract #41 USC 252C3, August 9, 1983, Washington, DC.

V. Preliminary Regulatory Impact, Regulatory Flexibility and Environmental Impact Assessments

Introduction

The Occupational Safety and Health Administration (OSHA) has prepared this Preliminary Impact Assessment (PRIA) in compliance with Executive Order 12291 and the Regulatory Flexibility Act of 1980 (Pub. L. 96-353, 94 Stat. 1164 [5 U.S.C. 60 et seq.]). In this assessment, OSHA has estimated the economic impact of the proposed amendments to the trenching and excavation standard (29 CFR Part 1926 Subpart P).

Regulatory History

Congress passed the Construction Safety Act of 1969 (Pub. L. 91-54), thereby amending the Contract Work Hours Standards Act (40 U.S.C. 333), by adding section 107. This section provides for occupational safety and health standards for construction employees working on federal, federally-financed, or federally-assisted projects. In 1971, pursuant to section 107, the Secretary of Labor issued safety and health regulations for construction in 29 CFR Part 1518. The Occupational Safety and Health (OSH) Act (29 U.S.C. 650 et seq.), which was passed by Congress on December 29, 1970, and became effective 4 months later, ordered the Secretary of Labor to adopt established federal standards that were issued under other statutes. In accordance with section 6(a) of the OSH Act, in May 1971, the Secretary adopted the construction standards that had been issued under the Construction Safety Act in 29 CFR Part 1518. Later in 1971, these standards were redesignated as Part 1926. As part of this process, the regulations covering trenching and excavation (Subpart P, 1926.650-1926.653) were adopted as OSHA standards.

Need for Revision

The need to revise Subpart P has been recognized since it was first incorporated as an OSHA standard. Consequently, after the Advisory Committee on Construction Safety and Health (ACCSH) reviewed the standard and following the issuance of a Notice of Proposed Rulemaking (NPRM, 36 FR 19083, September 28, 1971), several amendments were made to the standard in 1972 (37 FR 3512, February 17, 1972). After another NPRM in 1972 (37 FR 15317, July 29, 1972), the standard was further amended (37 FR 24345, November 16, 1972).

Complaints and controversy, however, continued to surround the standard. As a result, in 1976, OSHA commissioned the National Bureau of Standards (NBS) to study the standard's compatibility with actual construction practices and to recommend modifications that could improve the standard's effectiveness. The results of the NBS study were published in several reports during 1979 and 1980.

These studies, other OSHA and state data, and private sources of information clearly revealed the need to modify the standard. Surveys of firms involved in trenching and excavation indicated the widespread confusion regarding what the standard required and allowed. Many contractors were critical of the standard, claiming that it was confusing, sometimes inadequate, and often irrelevant. The tables on sloping and shoring procedures were often described as confusing and inadequate in a number of ways. Contractors were also unsure as to whether new safety techniques, such as freezing the ground rather than shoring, were allowed, and they generally believed that the standard was too rigid and was insufficiently performance oriented. Because of these problems, OSHA is proposing revisions to the current standard in order to clarify existing language and to facilitate compliance. OSHA has determined that the proposed revisions are technologically and economically feasible. OSHA has also investigated the environmental impacts of the proposed amendments and has determined that they would not be significant.

In sum, the proposed revisions would correct and clarify some of the inconsistency and inflexibility of the language in the current standard. In addition, the proposal will have no adverse effects on worker safety, relative to the current standard. OSHA assesses the cost reduction of the proposed changes at $11.4 million to $42.4 million per year. The reduced costs to industry should translate into some savings for consumers. These cost savings will arise principally from allowing firms the flexibility to select less costly methods of providing a safe workplace and therefore are consistent with the Administration's program to reduce unnecessary burdens on industry. The cumulative impact of several recent proposed revisions to 29 CFR Part 1926 are presented in Table 1. Finally, as the net effect of the Subpart P proposal is less than $100 million, this regulatory action does not constitute a "major rule."

Industry Profile

Background

Trenching and excavation projects can vary in complexity. For example, a trench may be only a few feet deep and may be dug in less than 1 hour by one person using a backhoe; a small excavation may be simply a hole scooped out by a bulldozer. The construction of a 2-foot-deep trench may be a simple project, and one that is not covered by the standard, but the construction of a 30-foot-deep trench that will not cave-in requires a knowledge of engineering, geology, and soil mechanics, or considerable field experience.

TABLE 1.—COSTS OR COST SAVINGS OF PROPOSED SAFETY REGULATIONS BY 2-DIGIT SIC CONSTRUCTION CODES [1]

[Millions of dollars]

Standard	Total construction		SIC 15		SIC 16		SIC 17	
	Incremental costs [2]	Total costs [3]	Incremental costs	Total costs	Incremental costs	Total costs	Incremental costs	Total costs
Subpart L	(7.6)	7.6	(4.0)	5.0	(0.3)	(1.0)	(3.3)	3.6
Subpart M	(27.5)	(65.8)	(17.2)	34.5	(4.2)	3.5	(14.5)	27.8
Subpart X	8.4	12.5	4.1	6.1	0.9	1.3	3.4	5.1
Subpart K	(30.6)	48.0	(2.8)	4.3	(1.8)	2.9	(26.0)	40.8
Subpart N	2.2	5.8	0.2	0.6	1.5	3.9	0.5	1.3
Subpart Q	17.5	28.7	(1.2)	4.2	(0.7)	2.3	19.4	22.2
Subpart S	2.7	3.4	.....	.....	2.7	3.4	.....	.....
Subpart P	(11.4–42.4)	.....	(1.6–5.9)	.....	(2.4–26.7)	.....	(2.6–9.8)	.....
Total [4]	(61.8)	171.8	(24.6)	54.7	(18.9)	16.3	(26.7)	100.8

Source: U.S. Department of Labor, OSHA, Office of Regulatory Analysis.

[1] Standard Industrial Classification (SIC) Codes 15: Building Construction—General Contractors and Operative Builders; SIC 16: Construction Other Than Building Construction—General Contractors; SIC 17: Construction—Special Trade Contractors (may include subcontractors working for contractors in the other two SIC categories).

[2] Costs of moving from full compliance with the existing standards to full compliance with the proposed standards.

[3] Costs of moving from current industry practice to full compliance with the proposed standards.

[4] Averages of the Subpart P savings were used to derive the total costs.

The major occupational hazards that occur in trenching and excavation work result from cave-ins, from exposure to underground utilities, and from material or equipment that may fall into the trench or the excavation. To protect against cave-ins, for example, proper precautions include bracing, sloping, benching, using shields, or freezing. Knowing when and how to use these techniques requires an understanding of the relationships among such factors as depth and width of the trench, soil type, hydraulic pressure, and other specific conditions present at the worksite. Recent advances in technology have also reduced the amount of time during which workers are physically exposed to the hazards of trenching. For example, new equipment includes trenching machines that dig and lay cable and remote-controlled equipment that compacts the soil in the trench.

Trenching is performed primarily by utility contractors who construct gas, sewer, water, and utility lines. Much of this work is performed as a result of competitive bids from state and local governments or local utilities. Surveys indicate that 70 percent of utility contractors receive about 90 percent of their business through competitive bidding. Minimizing costs, including safety-related costs, is therefore important to these contractors. Excavation work is performed for many kinds of construction, including buildings, bridges, towers, swimming pools, and port facilities.

A number of important economic and technical characteristics separate trenching from excavation work and make trenching the more hazardous activity. For example, large excavations tend to be adjacent to buildings that would collapse if the excavation were not shored. The possibility that damage suits would be initiated as a result of the collapse of these buildings provides strong incentives to shore these excavations. Thus, excavation safety is largely a byproduct of investments undertaken for other purposes. Even where other structures are not adjacent, excavations may be deep enough so that the risk of collapse of an unbraced wall, along with the concomitant economic expense of reexcavating, would give sufficient incentive to contractors to brace the walls. In contrast, such incentives are greatly diminished for trenching work. Trenches are less likely to be in close proximity to other structures, structures adjacent to trenches are less likely to collapse, and the cost of redigging a caved-in trench is far lower than reexcavating the foundation of a large building. For these reasons, an externality problem is more likely to exist for trenching than for excavation.

Industries and Economic Activity

Trenching and excavation occur chiefly in the following 13 four-digit Standard Industrial Classifications (SIC):

SIC 1521 General Contractors—Single Family Houses.

SIC 1522 General Contractors—Residential Buildings Other than Single Family Houses.

SIC 1541 General Contractors—Industrial Buildings and Warehouses.

SIC 1542 General Contractors—Non-Residential Buildings Other than Industrial Buildings and Warehouses.

SIC 1611 Highway and Street Construction Contractors.

SIC 1622 Bridge, Tunnel, and Elevated Highway Construction.

SIC 1623 Water, Sewer, Pipeline, Communication and Power Line Construction Contractors.

SIC 1629 Heavy Construction Contractors, Not Elsewhere Classified (NEC).

SIC 1711 Plumbing, Heating (Except Electrical) and Air Conditioning.

SIC 1771 Concrete Work.

SIC 1781 Water Well Drilling.

SIC 1794 Excavation and Foundation Work.

SIC 1799 Specialty Trade Contractors, NEC.

No published data exist that allow the estimation of either the total value of trenching and excavation work or the number of establishments and workers involved. Bureau of the Census data [1], however, do exist on the amount of contracted excavation work by four-digit SIC code. The data demonstrate that most of such work occurs in SIC 1794 and that most contract work in SIC 1794 is excavation work. Excavation work performed under another contract (e.g., as part of a high rise apartment) would be included in another category. Thus, although it is reasonable to assume that most contract work performed in SIC 1794 is for excavations, it cannot be assumed that most excavation work occurs in SIC 1794. Moreover, the Bureau of the Census publishes no data that specifically identify trenching as a

category of business. For these reasons, OSHA has estimated trenching and excavation activity in the followlng manner.

The Associated General Contractors of America (AGC) [2] conducted a survey of trenching contractors whose work closely corresponded to that in SIC 1623. The results of this survey were used to estimate the percentage of revenues in trenching and excavation for SIC 1623. The 96 responding firms indicated that 38 percent of their revenues were from trenching. Another survey also conducted by AGC [3] on the practices of contractors engaged in trenching and excavation found that of the 22 firms responding, an average of 36.5 percent of their revenues were derived from either trenching or excavation. The majority of these firms would probably be classified in SIC 1623, as most of their trenching work was for the construction of sewer and water lines. Based on these surveys, it seems reasonable to assume that no more than 15 percent of the revenues in SIC 1623 are derived from trenching and excavation. It becomes more difficult, however, to make a similar estimate for all other affected SIC codes. The trenching and excavation revenues for the other SICs in the construction industry are derived at a more aggregate level. For example, most of the trenching and excavation activity classified within SIC 15 involves the excavation of foundations for houses, offices, and warehouses. Foundation work for these types of structures ranges from 2 percent of the total costs for single-family houses to 12 percent for industrial buildings [4]. Because the foundation phase also includes all of the concrete costs not related to excavation, it is assumed that roughly 5 percent of the activity in SIC 15 would be affected by Subpart P. For SIC 16, the major affected activity, other than that in SIC 1623, would be highway, bridge, and other heavy construction. To estimate the trenching and excavation activities for this SIC code, a number of bids for these types of jobs were examined [5]. The excavation component of these bids was in the range of 1–5 percent of the total project costs. Based on this information, 5 percent has been used as a conservative estimate of the percent of revenues in SIC 16 that are affected by Subpart P. In SIC 17, the two main classifications affected are SIC 1711 (plumbing, heating and air conditioning) and SIC 1794 (excavation and foundation work). A best estimate of 1 percent of revenues was used for SIC 1711 based on average plumbing estimates from a construction estimation manual [6], where trenching and backfilling represented .7 percent of the total time required for the job . For SIC 1794, it was assumed that 45 percent of revenues are affected by Subpart P. This was based on the assumption that although SIC 1794 almost exclusively represents firms doing excavations and foundation work, the actual excavation activity affected by Subpart P is one phase, and once the walls are supported, laying the foundation, stripping, etc. become the other major cost factors of the job. This results in a total industry revenue estimate of § 12.42 billion for trenching and excavation work (see Table 2).

The Proposed Revisions to the Standard

Introduction

This section discusses the proposed revisions to OSHA's current trenching and excavation standard. The proposed revisions are intended to clarify the requirements of the standard and how these requirements may be satisfied as well as to eliminate discrepancies between requirements and current practices where there is no evidence that current practices pose a hazard to workers.

TABLE 2.—ESTIMATES OF TRENCHING AND EXCAVATION REVENUES BY INDUSTRY, 1982

Industry	Net revenues (In billions of dollars)	Proportion Subpart P related	Trenching and excavation revenues (In billions of dollars)
SIC 15 (except 1531)....	48.5	.05	2.43
SIC 16 (except 1623)....	44.2	.05	2.21
SIC 1623..	10.5	.40	4.20
SIC 1711..	28.8	.01	.29
SIC 1794..	7.3	.45	3.29
			12.42

Source: U.S. Department of Labor, OSHA, Office of Regulatory Analysis.

The following paragraphs describe only those changes that appear to have significant economic impacts.

Changes in Format

The current standard consists of four main sections: General Protection Requirements, Specific Excavation Requirements, Specific Trenching Requirements, and Definitions. The General Protection Requirements also apply to each section of the standard. The use and application of these provisions, however, are not clearly identified in the current standard and some users did not understand their intent [2, Appendix D]. Consequently, the presentation and format of the standard have been revised in order to clarify the language and requirements of Subpart P. The proposed amended standard includes a section on Scope, Application and Definitions, followed by General Requirements, and then the Specific Requirements for Protective Systems. The existing standard contains two tables on sloping and shoring, whereas the revised standard contains three nonmandatory appendices that provide a soil classification system, describe tests for determining soil type, and provide designs for sloping, benching, and timber shoring. OSHA expects that this reorganization will clarify the standard and the applicability of the various provisions and appendices.

Changes in Provisions

Numerous changes have been made to specific provisions of the standard. In the following discussion, the changes are presented in broad groupings according to their expected effects, and important examples of these groupings are then examined.

Specific Changes

The first group of changes are called *specific* changes because, individually, they affect specific requirements of the standard. A number of these specific changes are designed to bring the requirements of the standard into conformity with current industry practices when doing so would not compromise safe work practices. Some of the specific changes are simply definitional in nature. For example, the existing standard defines "belled excavations," and the proposed standard defines and refers to "belled-bottom pier holes." Because belled excavations are actually called belled-bottom pier holes, the change simply brings the terminology of the standard into conformity with current usage.

The specific changes, however, involve more than just a change in wording; many change the actual requirements of the standard. For example, one such change alters the definition of a trench shield and states that it must protect employees from the hazards of cave-ins, but need not: protect against the occurrence of cave-ins. In addition, the existing definition specifies that shields must be composed of steel plates and braces, but the

proposed standard would allow homemade shields to be made of wood or other materials.

Many of the specific changes that OSHA is proposing are likely to lower costs but not increase worker risk. One is the change in the existing requirement that work must discontinue in trenches or excavations where water has accumulated. The proposed revision would allow work to continue under those circumstances where the proper precautions have been taken to protect employees. Another example of a cost-savings results from the modification of the provision for the use of emergency rescue equipment where adverse atmospheric conditions exist. The existing standard requires such equipment where hazardous atmospheres "may exist," and requires the equipment to be physically "attended" by a worker. The proposed standard would modify this requirement to apply only where such conditions "exist or may reasonably be expected to develop," and would remove the requirement for an attendant.

General Changes

The *general* changes affect several provisions of the standard. Perhaps the most important general changes are those specifying alternative acceptable ways for contractors to comply with the existing requirements for protective systems. Although most of the existing standard's provisions allow the use of alternative means of protection, the availability of these options or alternatives was not generally appreciated. For example, in one survey [2] of utility contractors, a number of respondents said that they complied with Tables P–1 and P–2 of the existing standard in order to prevent citations, indicating that they were unaware that alternatives were acceptable. In addition, there is some confusion about the minimum standards contractors must meet in order to be in compliance. The proposed revisions to the requirements for protective systems would also clarify such requirements.

Contractors who choose to use a support system, such as shoring, must follow one of four basic options: (1) They may use OSHA's Appendices A and C for soil classification and timber shoring, (2) they can use supports, shields, or other systems prepared in accordance with manufacturers', or other, tabulated data, (3) they can use other tabulated data such as that found in some state plans, or tabulated data prepared by or under the guidance of a qualified person, and (4) they can have the system designed by a qualified person or a qualified engineer, or under the direction of a qualified engineer.

These requirements represent a substantial change to the existing standard. The existing standard does not clearly specify the function of Table P–1 on sloping and Table P–2 on timber shoring or who may design sloping or support systems. For example, Table P–1 is required as "a guide" for trenches, which appears to imply that it is nonmandatory. Elsewhere, the standard states that trench banks are required to be "laid back to a stable slope," while excavations, which are defined to include trenches, are to be dug to the "angle of repose." These requirements are exceedingly vague. The existing Table P–2 on timber shoring is described as containing "minimum requirements," but it is unclear whether such requirements are to be interpreted as minimum performance requirements or whether contractors must follow the exact specifications of the table. Similarly, although the standard defines a trench as a form of excavation, the section on "Specific Excavation Requirements" contains the statement that support systems must be designed by a qualified person according to accepted engineering practices. However, it is unclear if these requirements would allow a qualified person to design a different timber shoring system than that contained in Table P–2.

Changes in Tables

The final type of amendment that distinguishes the proposed standard from the existing standard is intended to clarify and broaden the applicability of the material contained in Tables P–1 and P–2 of the current standard. The set of tables in the existing standard not only are confusing (as noted above), but also lead to inflexibility in application. For example, they contain no information about benching, or the combined use of sloping and benching practices. Table P–1 on sloping contains the note that "clays, silts, loams or nonhomogeneous soils require shoring or bracing," thus apparently implying that sloping is inappropriate in such situations. In addition, although Table P–1 notes the importance of both soil type and environmental conditions in determining proper sloping, it contains no method for determining either soil type or environmental conditions. Finally, Table P–2 on timber shoring for trenches contains only one set of specifications for a given soil type and depth. The specifications in Table P–2 could be cost-effective only inadvertently because the relative prices of types and grades of lumber can vary sharply both over time and by geographic region.

In contrast, the proposed appendices are designed to eliminate these problems. For example, the proposed standard's Appendix A on soil and environmental classification is intended for field use. As proposed, Appendix B on sloping clearly applies to all excavations including trenches, and sloping is allowed for clays, silts, and other soils. In the current standard these applications were not clearly identified. Benching and the combined use of sloping and benching are also discussed in this appendix. Appendix C on timber shoring is also more flexible than the requirements shown in Table P–2 of the current standard. This appendix contains as many as four sets of timber shoring procedures for a given soil classification and trench depth. Finally, in the revised standard, the use of these appendices would be nonmandatory.

OSHA believes that, overall, these changes would significantly increase the ease with which firms may comply with the regulation by increasing the flexibility, clarity, and usefulness of the standard.

Worker Risk

The element of risk involved in construction work was recognized by Congress in the Construction Safety Act (Pub. L. 91–54, 1969). This Act mandated the promulgation of safety and health standards for construction employees at federal or federally-financed/assisted projects. These regulations, based on existing standards, were published as 29 CFR Part 1518. When the OSH Act was enacted by Congress in 1970 it authorized the Secretary of Labor to adopt established federal standards. Hence, the then existing Construction Safety Act standards, including Subpart P, were incorporated into the new OSHA standards. Thus, the industry itself, as evidenced by the development of consensus standards, as well as Congress and the Secretary of Labor, have all determined that the construction industry, in general, and trenching and excavation work, in particular, present an undue risk to the workers involved.

The hazardous nature of construction work, especially that related to trenching and excavating (particularly trenching), has been documented. The fatality rate in SIC 1623, which is dominated by trenching, was estimated by OSHA at 42.7 deaths per 100,000 workers per year for 1977–1981, whereas for construction work generally, it was estimated at 29.0 deaths per 100,000 employees per year. Similarly, trenching

and excavation fatalities were estimated at 97 deaths per year, and injury rates were comparably high [7, 8, 9]. The incidence rate for injury among construction workers, including those doing trenching and excavation work, is about two times the all industry average (i.e., 14.8 injuries per 100 workers in construction compared with 7.6 injuries per 100 workers in all industries [10]). Since the injury rate for trenching and excavation is not readily available, OSHA solicits additional information on injuries and fatalities for use in the final analysis.

Moreover, data from OSHA's Fatality/Catastrophe Abstracts indicate that 74.8 percent of all fatalities in trenching and excavating came from cave-ins. It is generally accepted by the construction industry, by labor, and by insurance companies that shoring, shielding, and sloping to a sufficient angle eliminate or substantially diminish the risk of cave-in or fatality from cave-ins. The main provision of Subpart P that relates to trenching is the requirement of providing protection against death or injuries resulting from cave-ins by using methods that are now in use in the industry and that were prompted by the original consensus standards.

The proposed amendment to Subpart P has been compared to the current Subpart P to determine whether it would be less effective in reducing risk than the unamended, current Subpart P. Based on a review of the OSHA Fatality/Catastrophe Abstracts for 1974–1981, including 283 accidents and 223 fatalities in trenching and excavation, there is no evidence that the proposed amended standard would have been any less effective than the existing standard [11]. Rather, the primary purpose and effect of the proposed revisions are to clarify requirements and to add flexibility so that firms can tailor their protective measures to their particular situations. OSHA would appreciate receiving information on any differences in employee protection as a result of the proposal or any other methods of reducing the risk of trenching fatalities including the number of injuries and fatalities that would be avoided under these alternatives.

Incremental Costs

Methodology

The current Subpart P is an OSHA regulation by order of an Act of Congress. Any economic analysis attempting to discuss whether an Act of Congress is reasonable, feasible, or cost effective would be legally superfluous. Operating on the basis of the legal reasonableness, feasibility, and/or cost-effectiveness of current Subpart P, this economic analysis focuses only on the incremental effects of the amendments to Subpart P. The changes proposed to the current Subpart P represent numerous clarifications and amendments that in most cases increase the flexibility of and reduce the regulatory burden on private enterprise; the proposed amendments are expected to reduce the cost of regulation without impairing worker protection. OSHA estimates the economic effects of the proposed amendments to Subpart P, to be on the order of a $11.4 million to $42.4 million savings to the industry.

The discrete costs of providing the safety requirements under the existing or proposed standards are virtually impossible to isolate for a number of reasons. The costs of meeting individual requirements can be estimated, and from these, the costs related to Subpart P can be derived for a particular trenching or excavation job. The extension of this methodology beyond any given job, however, stretches the assumptions to implausible lengths in its application to the entire universe of trenching and excavation activities. This is primarily due to the broad diversity of these types of construction jobs and to the unknown number of miles of trench of various depths that are dug each year. In many other OSHA construction regulations, it has been reasonable to develop some model construction jobs, estimate OSHA costs, weigh these jobs in some manner, and then extrapolate to the entire country. In this case, even to consider the most major variations in trench depth and width, soil type, weather conditions, site locations, and protective systems necessitates the development of a complicated model based on tenuous assumptions at each level. This, in fact, was attempted by a firm under contract to OSHA. Because of the complexity of these technical issues, the contracted effort failed to produce reliable cost estimates.

On average, the proposal is expected to result in a net reduction in costs, however particular provisions may result in cost increases for some firms. Therefore, OSHA requests data on the cost of different alternatives for use in the final analysis.

Given the paucity of published data on the safety costs related to trenching and excavation, it was decided to rely upon the judgement of people in the business of digging trenches who would be in the best position to know the costs imposed by an OSHA regulation. They clearly have no incentive to underestimate such costs. This basic question was posed to the Associated General Contractors (AGC), which in turn queried a sample of its members (about two dozen contractors). No one was able to estimate precisely either the costs of particular Subpart P requirements or even to relate them as a percentage of all revenues. Similarly, a number of representatives of firms were contacted directly by OSHA and asked if they could estimate what percent of their costs of trenching or excavating stemmed directly from OSHA requirements, or conversely, how their costs would be affected were this particular regulation to disappear tomorrow. Once again, no one could provide precise estimates, owing in part to the variety of jobs and circumstances. Only after further probing did industry representatives indicate that only under the most extreme circumstances would Subpart P requirements account for even 5 percent of their total job costs.

In a further attempt to isolate these costs, all of the major publishers of construction industry cost indexes, as found in Engineering News Record [12], were contacted in an attempt to determine if either Subpart P or safety costs generally were calculated separately in the compilation of their costs. Of the 15 firms contacted, all stated that the labor and materials costs were considered individually, but that all safety costs were absorbed within overhead costs and could not be separately identified. In addition, bids on major construction projects that had been published over several years in Engineering News Record [5] were examined to determine whether safety costs were a line item in the specifications or itemized costs. None were found. If safety were a major cost factor, it would be expected that it would be an individual cost component in the bids. Based upon the above information, then, it can be assumed that all safety costs cannot exceed that portion of the costs represented by overhead. The costs associated with Subpart P are only one factor contributing to the total safety costs of a trenching or excavation job. In addition, items such as offsite wages, fringe benefits, financing costs, inventory, other administrative expenses, and profit are included in overhead costs.

The most recent Bureau of Labor Statistics (BLS) studies [13] of the distribution of construction contract costs for various types of construction projects found that for sewer line construction, overhead and profit accounted for 23.8 percent of the total contract costs. Before-tax profit alone

accounts for over 10 percent of the total; all other overhead items account for the remaining 13 plus percent. From this remainder it is assumed that no more than 5 percent of the total project cost can be attributed to all safety items, only a portion of which is a direct result of complying with Subpart P requirements. This, of course, may vary for individual jobs but should be fairly accurate for the industry as a whole. An additional study on the costs of constructing power plants [14] tends to support this estimate. The study found that for both nuclear and coal-fired plants the combined costs for both safety and environmental protection accounted for 8 percent of the total costs of construction. Given that in this industry environmental requirements tend to be significant, the cost for safety factors must be a relatively small part of the total project and certainly less than 5 percent ot the total.

An estimate of the amount of construction revenues affected by Subpart P and the incremental impact of the proposed amendments were made by the Office of Regulatory Analysis. The estimate of $12.42 billion of annual trenching and excavating revenues derived earlier was used as the basis of this cost assessment. It has been assumed that the 5 percent of the total construction job costs, as discussed earlier, can be used as an *upper bound* of the current costs imposed by the existing standard. Thus, the current cost of the existing standard is estimated at $621 million annually. Based on discussions with contractors and their representatives, OSHA estimates that the proposed amendments will save between 2 percent and 7 percent of the current cost of Subpart P. Thus, the savings arising from the proposed amendments range between $12.42 million and $43.47 million to the economy as a whole.

Recordkeeping Costs

It is necessary to estimate separately the cost of additional paperwork required by the proposed admendments. Contractors who choose to rely on engineering designs, tabulated data, or manufacturers' specifications for sloping, support, or other systems would be required to keep copies of the designs or specifications for as long as the job is in progress and to make them available to OSHA inspectors on request. OSHA assumes that all engineer-designed projects would already have the specifications and drawings necessary to comply with this requirement, and therefore, the proposed standard would generate no additional costs. Tabulated data from other sources, including manufacturers' specifications, might not be routinely kept on file; thus, the proposed standard could generate additional costs in these cases.

OSHA assumes that all affected contractors would comply with this requirement by making copies of the tabulated data or manufacturers' specifications that are used on projects and by putting these copies in binders that would be taken routinely to jobsites along with other necessary equipment. The costs of the standard would then be the costs of copying the relevant specifications and filing them in a binder. OSHA assumes that this would be a one-time effort for each affected jobsite and that it would require half an hour of clerical time at $7.64 * per hour, plus an additional $.75 to cover the cost of paper, copying, and other miscellaneous supplies.

OSHA has estimated the number of jobsites that would be affected by this recordkeeping requirement, based on building permit data [15]. There were 482,315 permits issued in 1984, excluding residential garages. There were 1,021,911 permits for residential buildings issued in 1984. Assuming 10 buildings per development, or with similar excavation designs at a site, this would result in 102,191 sites with excavation activity.

It was assumed that public construction would add an additional 10 percent to private sector projects that require some trenching and excavation work. This results in an estimate of 642,956 potentially affected projects each year. Under the proposed new rules only contractors who opt for trenching and excavation systems based on tabulated data (that is, standardized or existing plans or designs and not plans uniquely developed for a particular project) will be affected by new recordkeeping requirements. Based on estimates of the expected frequency of use of tabulated data, it was assumed that approximately 35 percent of the affected projects, or 225,035 jobsites, would be affected. Thus, the annual incremental recordkeeping costs would be $1,028,410 [225,035×(($7.64×½)+$.75)].

Total Costs

Based on the assumptions described in the previous sections of this chapter, OSHA estimates that the proposed standard would reduce annual trenching and excavation costs attributable to Subpart P by between $12.42 million and $43.47 million. Recordkeeping costs associated with all trenching and excavation activities would increase $1.03 million; thus, the total savings under the proposal would be between $11.4 million and $42.4 million for the economy as a whole.

OSHA believes that the proposed revisions will be less costly than the existing standard and that this conclusion accurately reflects the true relative costs of the current and revised standards. OSHA solicits additional cost and impact data for use in the analysis of a final standard.

Other Economic Effects

Environmental Impacts

The proposed revisions to Subpart P have been reviewed in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4231 et seq.), the Regulations of the Council on Environmental Quality (CEQ) (40 CFR Part 1500), and OSHA's DOL NEPA Procedures (29 CFR Part 11). As a result of this review, the Assistant Secretary for OSHA has determined that the proposed standard would have no significant environmental impact.

Although safety standards rarely influence air, water, or soil quality, plant or animal life, or the use of land or other aspects of the environment, it is appropriate to examine whether the proposed revisions to the OSHA standard on trenching and excavation (29 CFR Part 1926, Subpart P) will alter the environment external to the workplace. Both trenching and excavation can have significant effects upon local environments. For example, erosion, runoff, and similar actions can result in environmental degradation. These potential impacts can be more or less severe depending upon how and where the trench or excavation is dug, how long it is left open, the disposition of the earth that is removed, etc. OSHA has determined, however, that the proposed revisions to Subpart P consist primarily of clarifications in work practices and procedures and are unlikely to have significant impacts on any of these activities; therefore, these revisions will have no significant environmental effects.

Regulatory Flexibility Certification

Pursuant to the Regulatory Flexibility Act of 1980 (Pub. L. 95–353, 94 Stat. 1164 [5 U.S.C. 60 et seq.]), OSHA has assessed the impact of the proposed revisions and concludes that they would not adversely affect a significant number of small entities.

* Derived from the 1979 construction industry file clerk mean annual earnings reported in the 1980 Census [16] and adjusted to 1985 by using the employment cost index for white collar clerical workers [17] plus 30 percent for fringe benefits.

As is generally known, the burden of most regulation, especially the legal and paperwork burdens, can fall disproportionately on small enterprises. This occurs primarily because larger firms often have the legal and clerical support in place to handle the burdens imposed by government regulation.

Similarly, it may be true that the larger trenching and excavating firms are less affected by the requirements of Subpart P than their smaller rivals because the very size of the larger firms may have prompted the adoption of companywide construction practices that meet or exceed the minimum requirements in Subpart P.

It is therefore apparent that the amendments to Subpart P, which serve principally to reduce the cost of compliance by increasing the flexibility of the regulations and clarifying their intent, will also benefit smaller firms. Thus, clarifying Subpart P and explicitly stating the flexibility and choice available to firms will proportionately reduce compliance costs to small firms. OSHA solicits information on any disproportional impacts that small firms may experience as a result of the alternatives allowed under the proposal.

Simply put, the amendments to Subpart P will benefit large and small firms, and smaller firms will likely reap the larger proportional gains. Some portion of these savings will pass through to consumers or to state and local governments that often are the buyers in the trenching and excavation market. As the total, economy-wide savings from the proposed amendments are estimated to be from $11.4 million to $42.4 million, the overall effect on prices, output, and employment in the U.S. economy will be quite small, but favorable.

For these reasons, OSHA concludes that the proposed standard is unlikely to have an adverse impact on a significant number of small trenching and excavation companies. OSHA welcomes any additional information, data, or opinions regarding the effects of these revisions on small entities.

References

1. U.S. Department of Commerce. Bureau of the Census. 1982 Census of Construction Industries, U.S. Summary. Washington, DC: Government Printing Office, December 1984.

2. Hinze, Jimmie and Carino, Nicholas. A Study of Work Practices Employed to Protect Workers in Trenches. Publication No. NBSIR 80–1988, National Bureau of Standards. Washington, DC: U.S. Department of Commerce, March 1980.

3. Salomone, Lawrence, and Yokel, Felix. An Analysis of the Responses from an Associated General Contractors of America (AGC) Survey of Trenching and Shoring Practices. Publication No. NBSIR 79–1936. Washington, DC: U.S. Department of Commerce, July 1979.

4. Cassimatis, P.J. Economics of the Construction Industry. New York: National Industrial Conference Board, Inc., 1969.

5. Eng News Record: 40, March 8, 1984; 35, May 3, 1984; 40, August 16, 1984; 40, September 6, 1984; 55, November 8, 1984; 39, January 3, 1985; 14, January 10, 1985; 111, January 24, 1985; 40, January 31, 1985; 50, March 7, 1985; 51, March 14, 1985; 44, March 28, 1985; 45, April 4, 1985; 47, April 25, 1985; 39, May 2, 1985; 37, May 9, 1985; 87, May 31, 1985; 57, June 27, 1985; 73–74, July 4, 1985.

6. Pulver, Harvey E. Construction Estimates and Costs. 4th ed. New York, 1969.

7. U.S. Department of Labor. Occupational Safety and Health Administration. Office of Management Data Systems. Management Information Systems Data for OSHA fatality reports and associated inspections for 1977–1981.

8. Abramo, Vincent J. "Case Studies Excavating Trenching and Shoring." Performed for U.S. Department of Labor, Occupational Safety and Health Administration, under contract No. 41USC252C3. Washington, DC, August 9, 1983. (Unpublished).

9. U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. National Institute for Occupational Safety and Health. Request for Assistance in Preventing Deaths and Injuries from Excavation Cave-ins. Cincinnati, Ohio: NIOSH, July 1985.

10. U.S. Department of Labor. Bureau of Labor Statistics. Occupational Injuries and Illnesses in the United States by Industry, 1983. Bulletin 2236. Washington, DC: Government Printing Office, 1985. Table 1. P. 2.

11. U.S. Department of Labor. Occupational Safety and Health Administration. Office of Data Analysis. "Selected Occupational Fatalities Related to Trenching and Excavation as Found in Reports of OSHA Fatality/Catastrophe Investigations." Washington, DC, July 1985. 157 Pp.

12. Building costs remain moderate. Eng News Record 214(12):92–95, March 21, 1985; and Cost indexes point to rising materials. Eng News Record 202(12):86–87, March 22, 1979.

13. U.S. Department of Labor. Labor Management Services Administration. Office of Construction Industry Services. Annual Construction Industry Report. Washington, DC: Government Printing Office, April 1980. P. 106.

14. Lange, Julian E., and Mills, Daniel Quinn, eds. The Construction Industry-Balance Wheel of the Economy. Lexington, Massachusetts: Lexington Books, 1979. pp. 186–187.

15. U.S. Department of Commerce. International Trade Administration Construction Review. Washington, DC: Government Printing Office, November–December 1985. Pp. 31; 39.

16. U.S. Department of Commerce. Bureau of the Census. 1980 Census of Population. Washington, DC: Government Printing Office, May 1984. Table 2. Pp. 182; 185.

17. Employment Cost Index. Monthly Labor Rev 108(8):92, August 1985; and 402(12):December 1979.

VI. Recordkeeping

The proposed standard contains "collection of information" (recordkeeping) requirements pertaining to design of protective systems (§ 1926.652(b) and § 1926.652(c)). In accordance with 5 CFR Part 1320 (Controlling Paperwork Burdens on the Public), OSHA has submitted the proposed recordkeeping requirements to the Office of Management and Budget (OMB) for review under section 3504(h) of the Paperwork Reduction Act. Comments regarding the proposed recordkeeping requirements may be directed to the Office of Information and Regulatory Affairs, OMB, Attention: Desk Officer for the Occupational Safety and Health Administration, Washington, DC 20503.

List of Subjects in 29 CFR Part 1926

Construction safety, Construction industry, Excavations, Occupational safety and health, Protective equipment, Safety.

VII. Public Participation

Interested persons are invited to submit written data, views, and arguments with respect to this proposal and all issues involved therein. The comments must be postmarked on or before June 15, 1987, and submitted in quadruplicate to the Docket Officer, Docket No. S–204, U.S. Department of Labor, 200 Constitution Avenue, NW., Room N–3670, Washington, DC 20210. Written submissions must clearly identify the provisions of the proposal which are addressed and the position taken with respect to each issue.

The data, views, and arguments that are submitted will be available for public inspection and copying at the above address. All timely written submissions received will be made a part of the record of this proceeding.

Additionally, under section 6(b)(3) of the OSH Act (29 U.S.C. 657), section 107 of the Construction Safety Act (41 U.S.C. 333), and 29 CFR 1911.11, interested persons may file objections to the proposal and request an informal public hearing. The objections and hearing request should be submitted in quadruplicate to the Docket Officer at the address above and must comply with the following conditions:

1. The objections must include the name and address of the objector;

2. The objections must be postmarked on or before June 15, 1987, and

submitted to the Docket Office at the aforementioned address;

3. The objections must specify with particularity the provisions(s) of the proposed rule to which objection is taken, and must state the grounds therefore;

4. Each objection must be separately stated and numbered; and

5. The objections must be accompanied by a detailed summary of the evidence proposed to be adduced at the requested hearing.

If objection and request for a hearing are timely filed, a hearing will be scheduled pursuant to section 6(b)(3) of the Occupational Safety and Health Act of 1970.

OSHA recognizes that there may be interested persons who, through their knowledge of safety or their experience in the operations involved, would wish to endorse or support certain provisions in the standard. OSHA welcomes such supportive comments, including any pertinent accident data or cost information which may be available, in order that the record of this rulemaking will present a balanced picture of the public response on the issues involved.

VIII. State Plan Standards

The 25 States with their own OSHA-approved occupational safety and health plans must adopt a comparable standard within six months of the publication date of the final rule or show OSHA why there is no need for action, e.g. because an existing standard covering this area is already "at least as effective" as the revised federal standard. These States are: Alaska, Arizona, California, Connecticut (for State and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York (for State and local government employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, and Wyoming.

IX. Authority

This document was prepared under the direction of John A. Pendergrass, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210.

Accordingly, pursuant to sections 4, 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657), section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333), Secretary of Labor's Order No. 9–83 (48 FR 35736), and 29 CFR Part 1911, it is proposed to amend Part 1926 of Title 29 of the Code of Federal Regulations as set forth below.

Signed at Washington, DC, this 7th day of April 1987.

John A. Pendergrass,

Assistant Secretary of Labor.

PART 1926—[AMENDED]

Part 1926 of 29 CFR would be amended as follows:

1. The authority citation for Subpart M of Part 1926, continues to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable.

2. By revising the authority citation for Subpart P of Part 1926, to read as follows:

Authority: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable.

§§ 1926.500 and 1926.501 [Amended]

3. By redesignating paragraphs (t) and (w) of § 1926.651 as paragraphs (h) and (i) of § 1926.500, respectively.

4. By revising Subpart P to read as follows:

Subpart P—Excavations

Sec.

Subpart P—Excavations

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This Subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.* (1) "Accepted engineering practices" means those requirements or practices which are compatible with standards of practice required by a registered professional engineer, or other duly licensed or recognized authority.

(2) "Bell-bottom pier hole" means a type of shaft or footing excavation, a portion of which is made larger than the cross section above to form a belled shape.

(3) "Benching" (Benching system) means a method of protecting employees against cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

(4) "Cave-in" means the separation of a mass of soil or rock material from the side of an excavation and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

(5) "Competent person" means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. (**Note:** the competent person can act as the employer's designee for the purpose of choosing a protective system from the options provided in § 1926.652 (b) and (c) of this section; but cannot take on original design responsibility allowed by § 1926.652 (b)(3), (c)(3) or (c)(4), unless otherwise qualified.)

(6) "Cross braces" means the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

(7) "Excavation" means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal and producing unsupported earth conditions (sides, faces).

(8) "Faces" or "Sides" means the vertical or inclined earth surfaces formed as a result of excavation work.

(9) "Failure" means the breakage, displacement, or permanent deformation of a structural member or connection so as to affect its supportive capabilities.

(10) "Hazardous atmosphere" means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

(11) "Kickout" means the accidental release or failure of a cross brace.

(12) "Protective system" means any method of protecting employees against cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

(13) "Qualified engineer" means a person who has attained (through

engineering education and experience) a special knowledge of mathematical, physical, and engineering sciences and the principles and methods of engineering analysis and design; and who, therefore, is qualified to practice engineering, i.e., apply the principles and methods of engineering analysis and design to solve specific problems.

(14) "Qualified person" means one who, by possession of a recognized degree, certificate, or professional standing or who by extensive knowledge, training, and experience has successfully demonstrated his ability to solve or resolve problems related to the subject matter, or the project.

(15) "Ramp" means an inclined walking or working surface used to gain access to one point from another, and that is constructed from earth or from structural materials such as steel or wood.

(16) "Sheeting" means the members of a shoring system such as dimensional lumber uprights, plywood or other materials that are driven or placed in contact with the earth, usually in a vertical position, for the purpose of retaining the earth in position and in turn being supported by other members of the shoring system.

(17) "Shield" (Shield system) means a structure that normally will not prevent a cave-in, but is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job built. Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

(18) "Shoring" (Shoring system) means a structure such as a mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

(19) "Sides." See "Faces."

(20) "Sloping" (Sloping system) means a method of protecting employees against cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

(21) "Stable rock" means rock that can be excavated with vertical sides and will remain intact while exposed. (Note: Unstable rock is considered equivalent to stable rock when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or another system that has been designed by a qualified engineer or a qualified person).

(22) "Structural Ramp" means a ramp built of material other than soil or rock.

(23) "Support system" means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

(24) "Tabulated data" means tables and charts prepared in accordance with accepted engineering practice by a qualified person, a qualified engineer or a person under the direction of a qualified engineer, and used to design and construct a protective system. Manufacturers' tables, or charts, or State regulations promulgated under an approved State plan and determined by OSHA to be "as effective as" Federal regulations, are other examples of acceptable tabulated data.

(25) "Trench" (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). (Note: If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.)

(26) "Trench box." See "Shield."

(27) "Trench shield." See "Shield."

(28) "Uprights" means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. (Note: Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting.")

(29) "Wales" means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 General requirements.

(a) *Surface encumbrances.* Trees, boulders, and other surface encumbrances that are located so as to create a hazard to employees shall be made safe or removed.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, or water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by acceptable means, such as probing with hand-held tools.

(4) While the excavation is open, underground installations shall be removed, protected, or supported as necessary to safeguard employees.

(c) *Access and egress.* (1) *Structural ramps.* (i) Structural ramps that are used by employees or equipment as a means of access to or egress from excavations shall be designed by a qualified person, a qualified engineer or a person under the direction of a qualified engineer, in accordance with accepted engineering practices, and constructed in accordance with their design.

(ii) Ramps and runways constructed of two or more planks shall have the planks securely connected together to prevent displacement.

(iii) Planks used for ramps and runways shall be of uniform thickness.

(iv) Cleats used to connect runway planks together shall be attached to the bottom of the runway or be beveled to prevent tripping.

(v) Ramps used in lieu of steps shall be provided with beveled cleats on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are four feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees. (Note: A negotiable slope may be used as a means of egress unless climatic conditions (rain, snow, ice) create a hazard to the user.)

(d) *Exposure to vehicular traffic.* Employees exposed to vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling material. (Note: Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped to provide adequate protection for the operator during loading and unloading operations.)

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilied such as barricades, hand or mechanical signals, or stop logs. (**Note:** If possible, the grade should be away from the excavation.)

(g) *Hazardous atmospheres.* (1) *Testing and controls.* In addition to the requirements set forth in Subparts D and E of this Part to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) The atmosphere in the excavation shall be tested before employees enter excavations greater than four feet (1.22 m) in depth where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby.

(ii) Adequate precautions shall be taken, such as providing proper respiratory protection or ventilation in accordance with Subparts D and E of this Part respectively, to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen.

(iii) Adequate precautions, shall be taken such as providing ventilation to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation.

(ii) Employees entering bell-bottom pier holes, or other substantially similar footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection against water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless these conditions have been anticipated and adequate precautions have been taken to protect employees against the hazards posed by water accumulation. (**Note:** The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect against cave-ins, water removal to control the level of accumulating water, and use of a safety harness and lifeline.)

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. (**Note:** Excavations subject to runoff from neavy rains will require an inspection by a competent person and compliance with (h)(1) and (h)(2) above.)

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall shall not be permitted except when:

(i) A support system, such as underpinning is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A qualified person, a qualified engineer or a person under the direction of a qualified engineer determines, based on accepted engineering practice, that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) A qualified person, a qualified engineer, or a person under the direction of a qualified engineer, determines, based on accepted engineering practice, that such work will not pose a hazard to employees.

(3) Sidewalks and pavements shall not be undermined unless a support system is provided or another method of protection to protect employees from the possible collapse of such structures.

(j) *Protection of employees in excavations.* (1) Employees snall be protected from cave-ins in excavations by the installation or use of an adequate protective system which meets the requirements of § 1926.652. However, the installation or use of a protective system is not required when:

(i) Excavations are made in stable rock; or

(ii) Excavations are less than five feet (1.52 m) in depth and examination of the ground by a competent person provides no indication that a cave-in should be expected.

(2) In addition to the protection against cave-ins required in paragraph (j)(1), adequate protection shall be provided to protect employees against loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(3) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least two feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent material or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

§ 1926.652 Requirements for protective systems.

(a) *Capacity of protective systems.* Protective systems shall be designed in accordance with the requirements of paragraphs (b) and (c) of this section and shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.* The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3) as follows:

(1) *Option (1)—Allowable configuration and slopes.* (i) Excavations that are open 72 hours or less shall be sloped at an angle not greater than one and one-half horizontal to one vertical (34 degrees measured from the horizontal).

(ii) Excavations that are open longer than 72 hours shall be sloped at an angle not greater than two horizontal to one vertical (27 degrees measured from the horizontal).

(iii) Slopes specified in paragraph (b)(1) (i) and (ii) of this section, shall be excavated to form configurations that are in accordance with *Figures B–1 through B–1.5* of Appendix B to this Subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in Appendices A and B to this Subpart.

(3) *Option (3)—Design by a qualified person or a qualified engineer.* (i) Sloping and benching systems not utilizing Option 1 or Option 2 above shall be designed in accordance with accepted engineering practice by a qualified person, a qualified engineer, or a person under the direction of a qualified engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) An indication of the magnitude of the slopes that were determined to be safe for the particular project; and

(B) An indication of the configurations that were detemined to be safe for the particular project; and

(C) The identity of the person responsible for the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be on the jobsite, but, as long as the excavation is open a copy shall be made readily available to the Secretary upon request. (Note: Readily available means provided during an inspection.)

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using Appendices A and C.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in Appendices A and C to this Subpart.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Designs of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed when the manufacturer issues specific written approval.

(iii) Manufacturers' specifications, recommendations, and limitations; and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite, during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made readily available to the Secretary upon request as long as the excavation is open. (Note: Readily available means provided during an inspection.)

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall have been prepared in accordance with accepted engineering practice by a qualified person, a qualified engineer, or a person under the direction of a qualified engineer, for the purpose of using the tabulated data to design and construct protective systems.

(iii) The tabulated data shall be in written form and include at least all of following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data;

(D) The identity of the person who prepared or directed the preparation of the data (unless using Nationally recognized tabulated data or tabulated data promulgated under an approved State plan).

(iv) At least one copy of the tabulated data shall be maintained at the jobsite, during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made readily available to the Secretary upon request. (Note: Readily available means provided during an inspection.)

(4) *Option (4)—Design by a qualified person or a qualified engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1 , Option 2, or Option 3, above shall be designed in accordance with accepted engineering practice by a qualified person, a qualified engineer or a person under the direction of a qualified engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system, and

(B) The identity of the person responsible for the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made readily available to the Secretary upon request. (Note: Readily available means provided during an inspection.)

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person determines that

the material or equipment is unable to support the intended loads or is otherwise unsuitable for safe use, then such material or equipment shall be removed from service.

(e) *Installation and removal of support systems.* (1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) When temporary removal of individual members is necessary, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) When removal of the support system is done on a member-by-member basis, removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level not greater than two feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible cave-in below the bottom of the support system.

(ii) Installation of support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems.* (1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or relocated.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than two feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of a possible cave-in below the bottom of the shield.

Appendix A to Subpart P of Part 1926

Soil Classification

(a) *Scope and application.* (1) *Scope.* This Appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The Appendix contains definitions, sets forth requirements, and describes recommended visual and manual tests for use in classifying soils.

(2) *Application.* This Appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in § 1926.652(b) as a method of protection for employees against cave-ins.

This Appendix also applies when timber shoring for trenches is designed as a method of protection against cave-ins in accordance with Appendix C to Subpart P of Part 1926. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in § 1926.652 (c)(2), and the use of the data is predicated on the use of the soil classification system set forth in this Appendix.

(b) *Definitions.* (1) "Cemented soil" means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

(2) "Cohesive soil" means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay, and organic clay.

(3) "Dry soil" means soil that does not exhibit visible signs of moisture content.

(4) "Fissured" means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

(5) "Granular soil" means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion and temporarily stand on a vertical slope, but normally cannot be excavated with vertical sideslopes. Granular soil cannot be molded when moist and crumbles easily when dry.

(6) "Layered system" means two or more distinctly different soil or rock types arranged in layers. Micaceous seams in rock are considered layered.

(7) "Moist soil" means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

(8) "Plastic" means a property of a soil which allows the soil to be deformed or molded without cracking, crumbling, or appreciable volume change.

(9) "Saturated soil" means submerged soil that is below the ground water table, and very wet soil such as soil that forms the sides of an excavation from which water can be seen seeping; soil that forms the sides of an excavation that has been flooded to more than one-half its depth and has not been drained for at least one day; and soil in which water is retained by a shoring system.

(10) "Soil classification system" means a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

(11) "Stable rock" means rock that can be excavated with vertical sides and remain intact while exposed.

(12) "Type A" means cohesive soil with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater, or cemented granular soil such as hardpan, till, or caliche, except that no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:IV) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

(13) "Type B" means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular soil that can stand on a slope of three horizontal to one vertical (3H:IV) or greater without slumping; or

(iii) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured, subject to vibration, or has previously been disturbed; and

(iv) Dry rock that is not stable; and

(v) Material that is part of a sloped, layered system where the layers dip into the

excavation on a slope less steep than four horizontal to one vertical (4H:IV), but only if the material would otherwise be classified as Type B.

(14) "Type C" means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; and

(ii) Granular soil that cannot stand on a slope of three horizontal to one vertical (3H:IV) without slumping; and

(iii) Saturated or submerged soil; and

(iv) Submerged rock that is not stable; and

(v) Soil in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:IV) or greater.

(15) "Unconfined compressive strength" means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

(16) "Wet soil" means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements.* (1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this Appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analyses. Such analyses shall be conducted by a competent person.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those recommended in paragraph (d) of this Appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Recommended visual and manual test.* (1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the opened excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained clay material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks indicate fissured material. If chunks of soil spall off a vertical side, the soil should be considered fissured.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the ability of the opened excavation to stand on a slope of three horizontal to one vertical or greater. Observe the ability of the opened excavation to stand with a vertical face. A soil may be Type A if it can stand with a vertical face for two hours or longer and there are no other disqualifying factors present.

(viii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual test.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly where doubt remains from visual analysis.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛ inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛ inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (sand or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it is a fissured clay. If the dry soil breaks into clumps which do not break up into smaller clumps, and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure.") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb, however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as the excavation face or a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. [NOTE: If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.]

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

Appendix B to Subpart P of Part 1926

Sloping and Benching

(a) *Scope and application.* This Appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this Appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) *Definitions.* (1) "Actual slope" means the slope to which an excavation face is excavated.

(2) "Distress" means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating

from the face of an excavation and trickling or rolling down into the excavation.

(3) "Long term exposure" means a period of time that an excavation is open longer than 72 hours.

(4) "Maximum allowable slope" means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

(5) "Short term exposure" means a period of time less than or equal to 72 hours that an excavation is open.

(c) *Requirements.* (1) *Soil classification.* Soil and rock deposits shall be classified in accordance with Appendix A to Subpart P of Part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from *Table B-1* of this Appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope when there are signs of distress. The slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:iV) less steep than the maximum allowable slope.

(iii) When surcharge loads from adjacent structures, stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved.

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with *Figure B-1.*

TABLE B-1.—MAXIMUM ALLOWABLE SLOPES

Soil or rock type	Maximum allowable slopes (H:V) [1]	
	Short-term exposure	Long-term exposure
Stable Rock:	Vertical (90°)	Vertical (90°)
Type A [See footnote (2)].	1/2:1 (63°)	3/4:1 (53°)
Type B	3/4:1 (53°)	1:1 (45°)
Type C	1-1/2:1 (34°)	2:1 (27°)

[1] Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

[2] A short-term maximum allowable slope of 1/2 H:IV is allowed in excavations that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4 H:IV (53°).

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FIGURE B - 1

ALLOWABLE SLOPING AND BENCHING CONFIGURATIONS

FIGURE B - 1.1

SIMPLE SLOPE

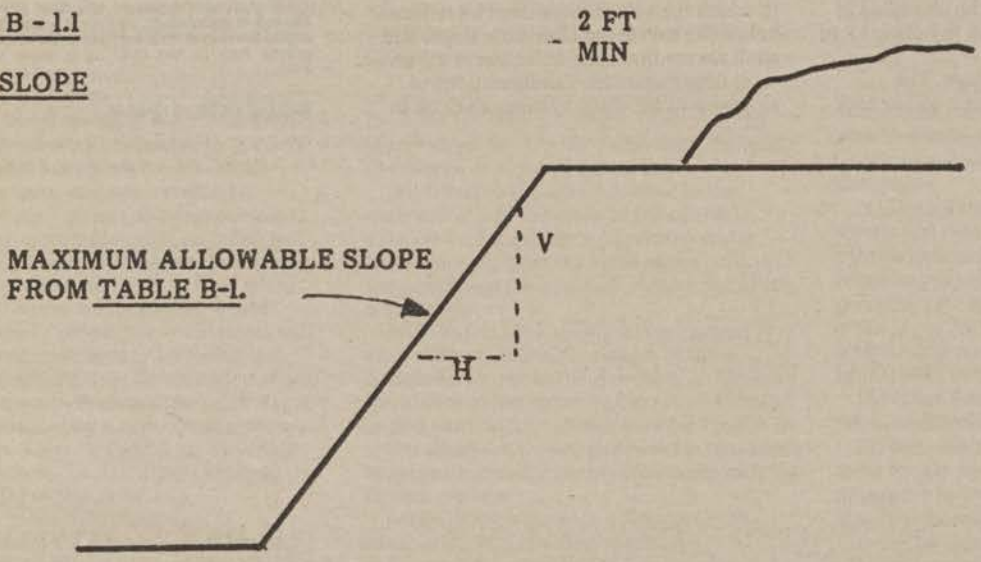
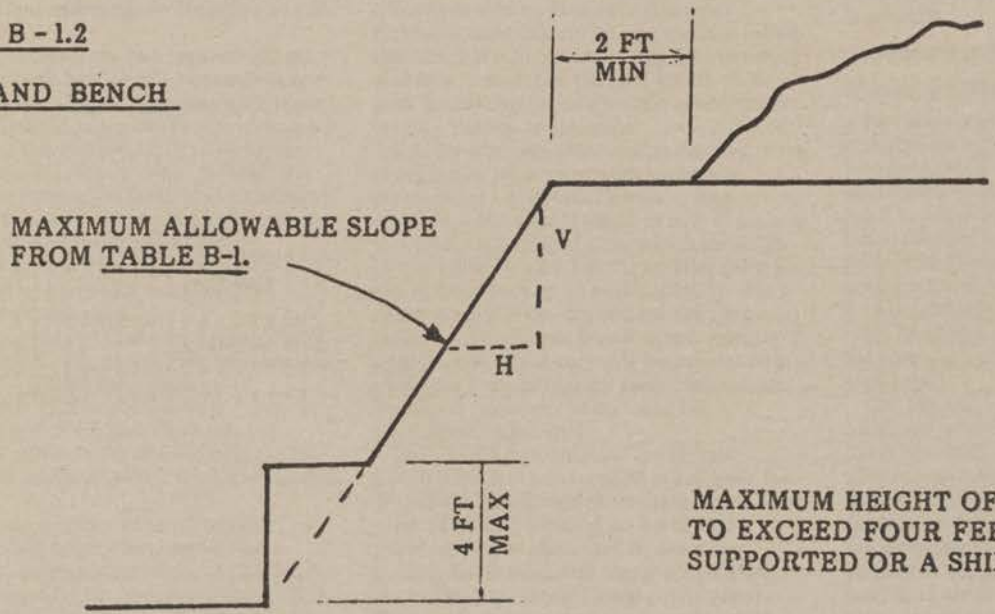


FIGURE B - 1.2

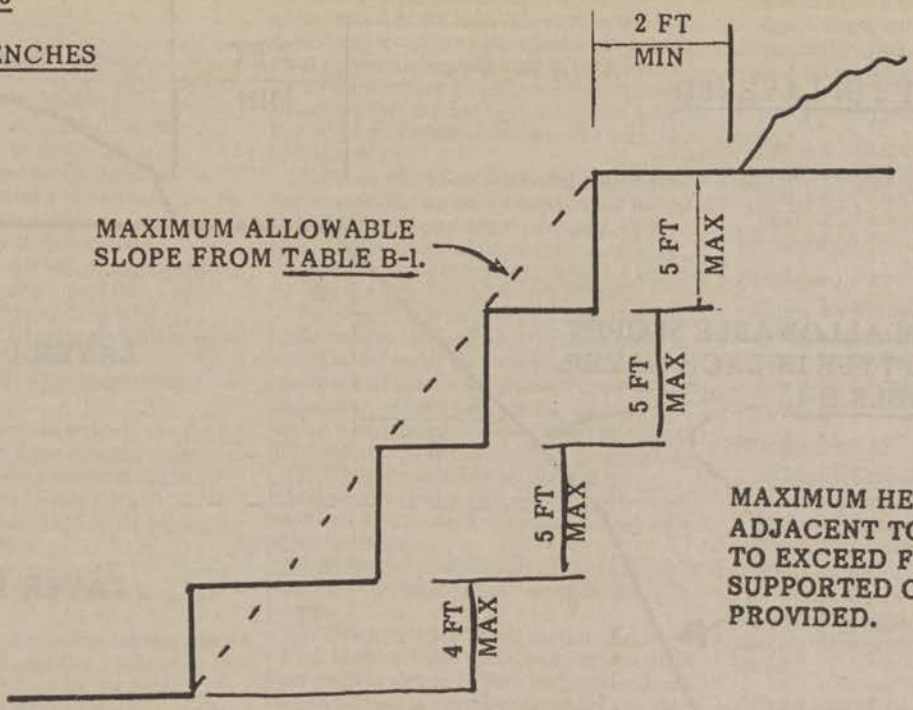
SLOPE AND BENCH



MAXIMUM HEIGHT OF BENCH NOT TO EXCEED FOUR FEET UNLESS SUPPORTED OR A SHIELD IS PROVIDED.

FIGURE B - 1.3

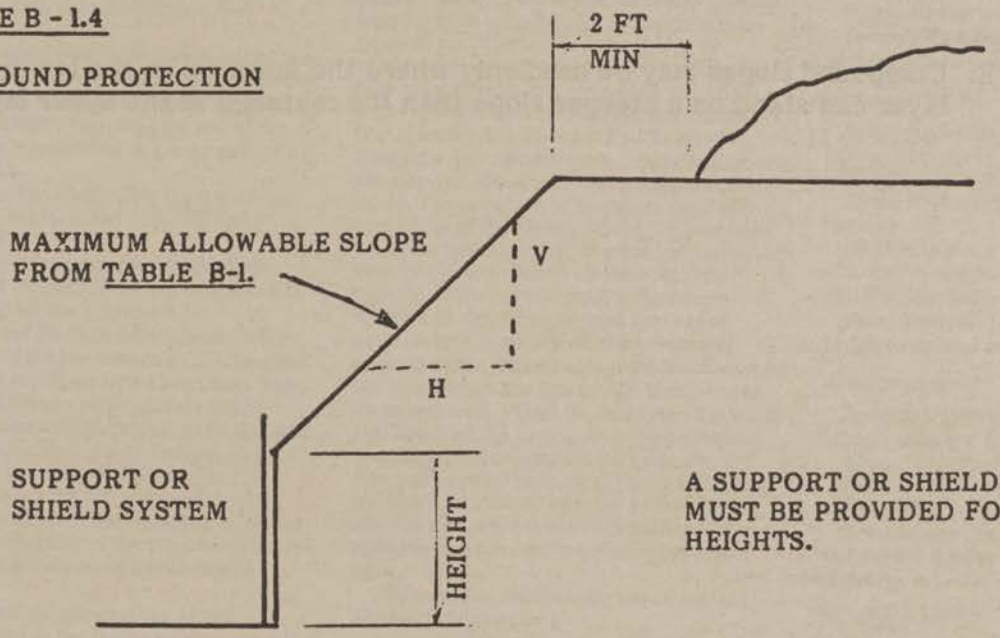
MULTIPLE BENCHES



MAXIMUM HEIGHT OF BENCH ADJACENT TO WORK AREA NOT TO EXCEED FOUR FEET UNLESS SUPPORTED OR A SHIELD IS PROVIDED.

FIGURE B - 1.4

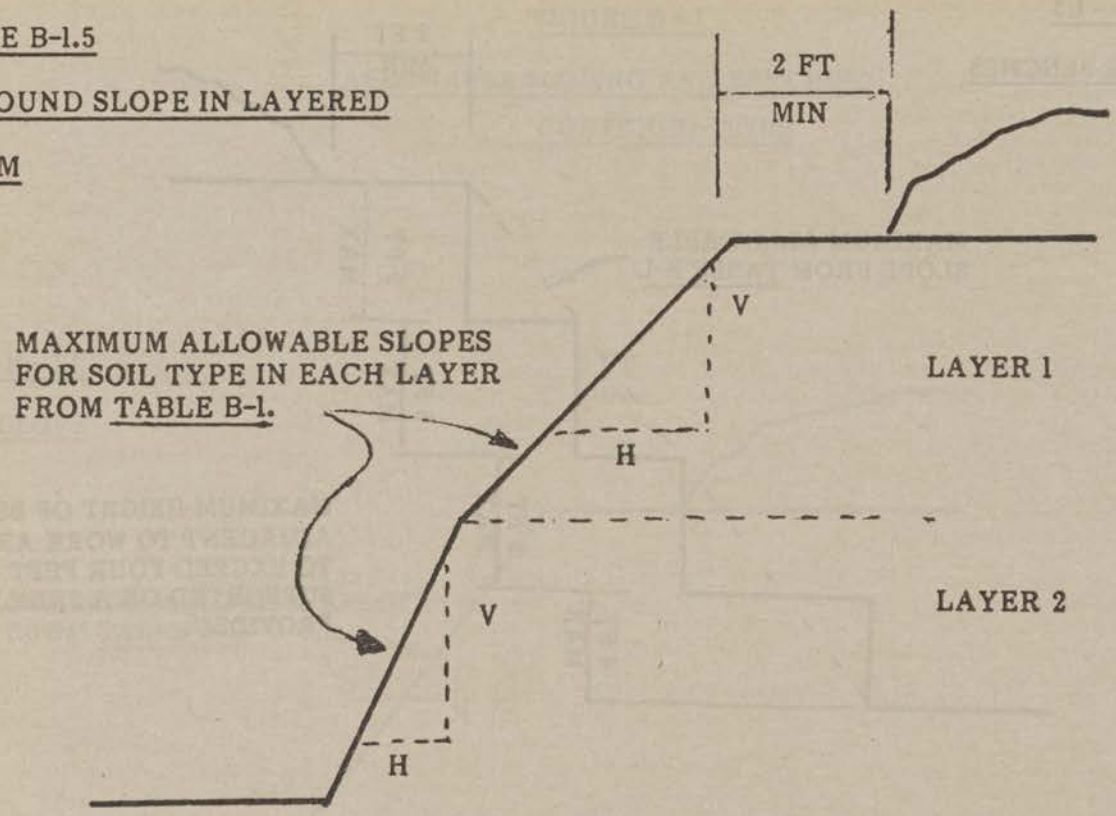
COMPOUND PROTECTION



A SUPPORT OR SHIELD SYSTEM MUST BE PROVIDED FOR ALL HEIGHTS.

FIGURE B-1.5

COMPOUND SLOPE IN LAYERED SYSTEM



NOTE: Compound slopes may be used only where the material in the lower layer can stand on a steeper slope than the material in the upper layer.

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Appendix C to Subpart P of Part 1926

Timber Shoring for Trenches

(a) *Scope.* This Appendix contains information that can be used when timber shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This Appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shield, and freezing systems must be designed in accordance with the requirements set forth in § 1926.652(b) and § 1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this Appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in Appendix A of Subpart B of Part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in *Tables C–1.1, C–1.2, and C–1.3* following paragraph (g) of this Appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data is arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. (Note: Stable rock is exempt from shoring requirements and therefore no data is presented for this condition.)

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this Appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this Appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this Appendix.

(5) Miscellaneous notations regarding *Tables C–1.1 through C–1.3* are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.* (1) *Dimensions of timber members.* (i) The sizes of the timber members listed are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice is Shoring and Sloping of Trenches and Excavation." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in the tables refer to actual dimensions and not nominal dimensions of the timber. (Note: Employees wanting to use nominal size shoring have this choice under § 1926.652(c)(3), and are referred to Corp of Engineers or Bureau of Reclamation data.)

(2) *Limitation of application.* (1) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this Appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. (Note: The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.)

(B) When vertical loads imposed on crossbraces exeed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables C–1.1, C–1.2 and C–1.3.* The members of the shoring system that are to be selected using this information are the crossbraces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are three tables of information, one for each soil type. The soil type must first be determined in accordance with the soil classification system described in Appendix A to Subpart P of Part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. In instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of the Tables:* (1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C–1.1,* four acceptable arrangements of timber can be used.

Arrangement #1.

Space 4 × 4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3 × 8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2.

Space 4 × 6 crossbraces at eight feet horizontally and four feet vertically.

Space 8 × 8 wales at four feet vertically.

Space 2 × 6 uprights at four feet horizontally.

Arrangement #3

Space 6×6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8×10 wales at four feet vertically.

Space 2×6 uprights at five feet horizontally.

Arrangement #4

Space 6×6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10×10 wales at four feet vertically.

Space 3×8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil is 13 feet deep and five feet wide. From *Table C–1.2* three acceptable arrangements of member are listed.

Arrangement #1

Space 6×6 crossbraces at six feet horizontally and five feet vertically.

Space 8×8 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #2

Space 6×8 crossbraces at eight feet horizontally and five feet vertically.

Space 10×10 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #3

Space 8×8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From *Table C–1.3* two acceptable arrangements of members can be used.

Arrangement #1

Space 8×8 crossbraces at six feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Position 2×6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8×10 crossbraces at eight feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Position 2×6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using *Table* C–1.3. Only one arrangement of members is provided.

Space 8×10 crossbraces at six feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Use 3×6 tight sheeting.

(g) *Notes for Tables C–1.1, C–1.2, and* C–1.3.

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(b), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. *Tight Sheeting* refers to the use of specially-edged timber planks at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water. *Close Sheeting* refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. (**Note:** Mudsills are wales that are installed at the toe of the trench side.)

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

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TABLE C-1.1
TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS FOR SOIL TYPE A (SEE NOTES)

ALL TIMBER SIZES ARE ACTUAL, NOT NOMINAL

DEPTH OF TRENCH (FEET)	SIZE AND SPACING OF MEMBERS													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZONTAL SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERTICAL SPACING (FEET)	SIZE (INCHES)	VERTICAL SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
OVER 5 UP TO 10	UP TO 6	4x4	4x4	4x6	6x6	6x6	4	NOT REQUIRED	--				2x6	
	UP TO 8	4x4	4x4	4x6	6x6	6x6	4	NOT REQUIRED	--					2x8
	UP TO 10	4x6	4x6	6x6	6x6	6x6	4	8x8	4			2x6		
	UP TO 12	4x6	4x6	6x6	6x6	6x6	4	8x8	4				2x6	
OVER 10 UP TO 15	UP TO 6	4x4	4x4	4x6	6x6	6x6	4	NOT REQUIRED	--				3x8	
	UP TO 8	4x6	4x6	6x6	6x6	6x6	4	8x8	4		2x6			
	UP TO 10	6x6	6x6	6x6	6x8	6x8	4	8x10	4			2x6		
	UP TO 12	6x6	6x6	6x6	6x8	6x8	4	10x10	4				3x8	
OVER 15 UP TO 20	UP TO 6	6x6	6x6	6x6	6x8	6x8	4	6x8	4	3x6				
	UP TO 8	6x6	6x6	6x6	6x8	6x8	4	8x8	4	3x6				
	UP TO 10	8x8	8x8	8x8	8x8	8x10	4	8x10	4	3x6				
	UP TO 12	8x8	8x8	8x8	8x8	8x10	4	10x10	4	3x6				
OVER 20	SEE NOTE 1.													

TABLE C-1.2

TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS FOR SOIL TYPE B (SEE NOTES)

ALL TIMBER SIZES ARE ACTUAL, NOT NOMINAL

DEPTH OF TRENCH (FEET)	SIZE AND SPACING OF MEMBERS													
	CROSS BRACES						WALES		UPRIGHTS					
	HORIZONTAL SPACING (FEET)	WIDTH OF TRENCH (FEET)				VERTICAL SPACING (FEET)	SIZE (INCHES)	VERTICAL SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15			CLOSE	2	3		
OVER 5 UP TO 10	UP TO 6	4x6	4x6	6x6	6x6	6x6	5	6x8	5			2x6		
	UP TO 8	6x6	6x6	6x6	6x8	6x8	5	8x10	5			2x6		
	UP TO 10	6x6	6x6	6x6	6x8	6x8	5	10x10	5			2x6		
	SEE NOTE 1.													
OVER 10 UP TO 15	UP TO 6	6x6	6x6	6x6	6x8	6x8	5	8x 8	5		2x6			
	UP TO 8	6x8	6x8	6x8	8x8	8x8	5	10x10	5		2x6			
	UP TO 10	8x8	8x8	8x8	8x8	8x10	5	10x12	5		2x6			
	SEE NOTE 1.													
OVER 15 UP TO 20	UP TO 6	6x8	6x8	6x8	8x8	8x 8	5	8x10	5	3x6				
	UP TO 8	8x8	8x8	8x8	8x8	8x10	5	10x12	5	3x6				
	UP TO 10	8x10	8x10	8x10	8x10	10x10	5	12x12	5	3x6				
	SEE NOTE 1.													
OVER 20	SEE NOTE 1.													

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TABLE C-1.3
TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS FOR SOIL TYPE C (SEE NOTES)
ALL TIMBER SIZES ARE ACTUAL, NOT NOMINAL

DEPTH OF TRENCH (FEET)	SIZE AND SPACING OF MEMBERS														
	CROSS BRACES							WALES		UPRIGHTS					
	HORIZONTAL SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERTICAL SPACING (FEET)	SIZE (INCHES)	VERTICAL SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (SEE NOTE 2.)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
OVER 5 UP TO 10	UP TO 6	6x8	6x8	6x8	8x8	8x8	5	8x10	5	2x6				
	UP TO 8	8x8	8x8	8x8	8x8	8x10	5	10x12	5	2x6				
	UP TO 10	8x10	8x10	8x10	8x10	10x10	5	12x12	5	2x6				
	SEE NOTE 1.													
OVER 10 UP TO 15	UP TO 6	8x8	8x8	8x8	8x8	8x10	5	10x12	5	2x6				
	UP TO 8	8x10	8x10	8x10	8x10	10x10	5	12x12	5	2x6				
	SEE NOTE 1.													
	SEE NOTE 1.													
OVER 15 UP TO 20	UP TO 6	8x10	8x10	8x10	8x10	10x10	5	12x12	5	3x6				
	SEE NOTE 1.													
	SEE NOTE 1.													
	SEE NOTE 1.													
OVER 20	SEE NOTE 1													