CONSTRUCTION SEQUENCE FOR TIMBER SHORING FOR TRENCHES

(a) Scope. This appendix contains information that can be used when timber shoring is provided as a method of protection from 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, shielding, 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 P of this part.

(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, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the 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 are 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. Stable rock is exempt from shoring requirements and therefore, no data are 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, and on the tables themselves.

(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 and Tables C-2.1 through C-2.3 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 in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." 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 Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under 1926.652(c)

(2), and are referred to The Corps of engineers, The Bureau of Reclamation or data from other acceptable sources.

(3) Limitation of application.

(i) 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. 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 cross braces exceed 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. The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two 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. 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 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 Tables C-1.1 through C-1.3.

(1) Example 1.

A trench dug in Type A soil is 13 feet deep and five feet wide.

From Table C-1.1, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4X4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3X8 uprights at six feet horizontally. This arrangement is

commonly called "skip shoring."

Arrangement #2

Space 4X6 crossbraces at eight feet horizontally and four feet vertically.

Space 8X8 wales at four feet vertically.

Space 2X6 uprights at four feet horizontally.

Arrangement #3

Space 6X6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8X10 wales at four feet vertically.

Space 2X6 uprights at five feet horizontally.

Arrangement #4

Space 6X6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10X10 wales at four feet vertically.

Space 3X8 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 members are listed.

Arrangement #1

Space 6X6 crossbraces at six feet horizontally and five feet vertically.

Space 8X8 wales at five feet vertically.

Space 2X6 uprights at two feet horizontally.

Arrangement #2

Space 6X8 crossbraces at eight feet horizontally and five feet vertically.

Space 10X10 wales at five feet vertically.

Space 2X6 uprights at two feet horizontally.

Arrangement #3

Space 8X8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10X12 wales at five feet vertically.

Space 2X6 uprights at two feet vertically.

(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 8X8 crossbraces at six feet horizontally and five feet vertically.

Space 10X12 wales at five feet vertically.

Position 2X6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8X10 crossbraces at eight feet horizontally and five feet vertically.

Space 12X12 wales at five feet vertically.

Position 2X6 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 8X10 crossbraces at six feet horizontally and five feet vertically.

Space 12X12 wales at five feet vertically.

Use 3X6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) Notes for all Tables.

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow 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.

OSHA Excavation Construction Standard Checklist

To ensure that existing and predictable hazards are identified at the worksite, the following checklist is provided as an outline of the OSHA Construction Standard:

a. Have "ONE CALL" notifications been made or other means used to determine what underground utilities are in the area? (811- National One Call Phone Number)

b. Is the excavation more than 5 feet in depth?

c. Is the excavation more than 20 feet in depth? (If yes, a protection system designed by a professional engineer will be required.)

d. Has a trained and qualified competent person (as defined by the OSHA standard) been designated?

e. Has the soil been categorized (stable rock, Type A, Type B, or Type C)?

f. Does the excavation require sloping, shoring, or shielding?

g. If excavation protection is required, which system will be used?

h. Is the Tabulated Data Sheets for the protection system on the job site?

i. Has a stairway, ladder, ramp, or other safe means of ingress / egress been provided and properly spaced?

j. Has the excavation been tested for a hazardous atmosphere (flammability, oxygen content, toxicity)?

k. Is the excavation a permit required confined space?

l. Has adequate protection been provided to protect employees from materials falling or rolling from the excavation face or from the surface in the vicinity of the excavation?

m. Is the spoils pile a minimum of 2' (24") from the edge of the excavation?

n. Has adequate protection been provided for water accumulation in the excavation?

n. Is emergency rescue equipment available at the jobsite? (If confined space has the local emergency response or rescue contractor been notified)?

o. Has stability of adjacent structures been considered as a result of the excavation?

p. Are daily inspections of the excavations being made?

q. Has a safe installation and removal procedure been developed to protect the employees who will be performing these tasks?

This checklist is designed only as a reminder; the details of the OSHA Construction Standard can be found in Subpart P of 29 Code of Federal Regulations Part 1926.

TABLE C-1.1
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*
SOIL TYPE A P(a) = 25 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (Actual) and Spacing of Members **						
	Wales		Uprights				
	Size (Inches)	Vertical Spacing (Feet)	Maximum Allowable Horizontal Spacing (Feet)				
			Close	4	5	6	8
5 to 10	Not Req'd	NA				2x6	
	Not Req'd	NA					2x8
	8x8	4			2x6		
	8x8	4				2x6	
10 to 15	Not Req'd	NA				3x8	
	8x8	4		2x6			
	8x10	4			2x6		
	10x10	4				3x8	
15 to 20	6x8	4	3x6				
	8x8	4	3x6				
	8x10	4	3x6				
	10x10	4	3x6				
Over 20	**See Note 1**						

*Mixed oak or equivalent with a bending strength of not less than 850 psi.

**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE C-1.2
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*
SOIL TYPE B P(a) = 45 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (Actual) and Spacing of Members**				
	Wales		Uprights		
			Maximum Allowable Horizontal		
	Size (Inches)	Vertical Spacing (Feet)	Close	2	3
5 to 10	6x8	5			2x6
	8x10	5			2x6
	10x10	5			2x6
10 to 15	8x8	5		2x6	
	10x10	5		2x6	
	10x12	5		2x6	
15 to 20	8x10	5	3x6		
	10x12	5	3x6		
	12x12	5	3x6		
Over 20	**See Note 1**				

*Mixed oak or equivalent with a bending strength of not less than 850 psi.

**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE C-1.3
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*
SOIL TYPE C P(a) = 80 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (Actual) and Spacing of Members**				
	Wales		Uprights		
	Size (Inches)	Vertical Spacing (Feet)	Maximum Allowable Horizontal Spacing (Feet)		
			Close		
5 to 10	8x10	5	2x6		
	10x12	5	2x6		
	12x12	5	2x6		
10 to 15	10x12	5	2x6		
	12x12	5	2x6		
15 to 20	12x12	5	3x6		
Over 20	**See Note 1**				

*Mixed oak or equivalent with a bending strength of not less than 850 psi.
**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE C-2.1
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*
SOIL TYPE A P(a) = 25 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (S4S) and Spacing of Members**						
	Wales		Uprights				
			Maximum Allowable Horizontal Spacing (Feet)				
	Size (Inches)	Vertical Spacing (Feet)	Close	4	5	6	8
5 to 10	Not Req'd	Not Req'd				4x6	
	Not Req'd	Not Req'd					4x8
	8x8	4			4x6		
	8x8	4				4x6	
10 to 15	Not Req'd	Not Req'd				4x10	
	6x8	4		4x6			
	8x8	4			4x8		
	8x10	4		4x6		4x10	
15 to 20	6x8	4	3x6				
	8x8	4	3x6	4x12			
	8x10	4	3x6				
	8x12	4	3x6	4x12			
Over 20	**See Note 1**						

*Douglas fir or equivalent with a bending strength of not less than 1500 psi.

**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE C-2.2

TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

SOIL TYPE B P(a) = 45 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (S4S) and Spacing of Members**						
	Wales		Uprights				
	Size (Inches)	Vertical Spacing (Feet)	Maximum Allowable Horizontal Spacing (Feet)				
			Close	2	3		
5 to 10	6x8	5			3x12 4x8		4x12
	8x8	5		3x8		4x8	
	8x10	5			4x8		
10 to 15	8x8	5	3x6	4x10			
	10x10	5	3x6	4x10			
	10x12	5	3x6	4x10			
15 to 20	8x10	5	4x6				
	10x12	5	4x6				
	12x12	5	4x6				
Over 20	**See Note 1**						

*Douglas fir or equivalent with a bending strength of not less than 1500 psi.

**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE C-2.3
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*
SOIL TYPE C P(a) = 80 x H + 72 psf (2ft Surcharge)

Depth of Trench (Feet)	Size (S4S) and Spacing of Members**				
	Wales		Uprights		
	Size (Inches)	Vertical Spacing (Feet)	Maximum Allowable Horizontal Spacing (Feet)		
			Close		
5 to 10	8x8	5	3x6		
	10x10	5	3x6		
	10x12	5	3x6		
10 to 15	10x10	5	4x6		
	12x12	5	4x6		
15 to 20	10x12	5	4x6		
Over 20	**See Note 1**				

*Douglas fir or equivalent with a bending strength of not less than 1500 psi.

**Manufactured members of equivalent strength may be substituted for wood.

Notes:

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "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 (e.g., tongue and groove) 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 and to prevent the loss of backfill material. 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. Mudsills are wales that are installed at the tow of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

TABLE D-1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
SOIL TYPE A

Depth of Trench (Feet)	Hydraulic Cylinders				
	Maximum Horiz. Spacing (Feet)	Width of Trench (Feet)			Maximum Vert. Spacing (Feet)
		Up to 8	Over 8 Up to 12	Over 12 Up to 15	
Over 5 Up to 10	8	2 Inch Diameter	2 Inch Diameter **Note (2)**	3 Inch Diameter	4
Over 10 Up to 15	8				
Over 15 up to 20	7				
Over 20	**See Note 1**				

Notes:

(1) For applications other than those listed in the tables, refer to 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to 1926.652(c)(2) and 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) Basis and limitations of the data.

(a) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(b) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(c) Limitation of application.

(i) It is not intended that the aluminum hydraulic 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 otherwise 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. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with 1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) 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.

TABLE D-1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
SOIL TYPE B

Depth of Trench (Feet)	Hydraulic Cylinders				
	Maximum Horiz. Spacing (Feet)	Width of Trench (Feet)			Maximum Vert. Spacing (Feet)
		Up to 8	Over 8 Up to 12	Over 12 Up to 15	
Over 5 Up to 10	8	2 Inch Diameter	2 Inch Diameter **Note (2)**	3 Inch Diameter	4
Over 10 Up to 15	6.5				
Over 15 up to 20	5.5				
Over 20	**See Note 1**				

Notes:

(1) For applications other than those listed in the tables, refer to 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to 1926.652(c)(2) and 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) Basis and limitations of the data.

(a) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(b) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(c) Limitation of application.

(i) It is not intended that the aluminum hydraulic 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 otherwise 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. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with 1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) 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.

TABLE D-1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
SOIL TYPE B

Depth of Trench (Feet)	Wales		Hydraulic Cylinders		Timber Uprights		
			Width of Trench		Maximum Horizontal Spacing (On Center)		
			Over 12 Up to 15				
	Vertical Spacing (Feet)	Section Modulus* (In (3))	Horizontal Spacing	Cylinder Diameter	Solid Sheet	2 Feet	3 Feet
Over 5 Up to 10	4	3.5	8.0	3 IN	NA	NA	3x12
		7.0	9.0	3 IN			
		14.0	12.0	3 IN			
Over 10 Up to 15	4	3.5	6.0	3 IN	NA	3x12	NA
		7.0	8.0	3 IN			
		14.0	10.0	3 IN			
Over 15 up to 20	4	3.5	5.5	3 IN	3x12	NA	NA
		7.0	6.0	3 IN			
		14.0	9.0	3 IN			
Over 20	**See Note 1**						

*** Consult product manufacturer and/or qualified engineer for Section Modulus of**

Notes:

(1) For applications other than those listed in the tables, refer to 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to 1926.652(c)(2) and 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) Basis and limitations of the data.

(a) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent

(b) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as

(c) Limitation of application.

(i) It is not intended that the aluminum hydraulic 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

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000

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.

TABLE D-1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
SOIL TYPE C

Depth of Trench (Feet)	Wales		Hydraulic Cylinders		Timber Uprights		
			Width of Trench		Maximum Horizontal Spacing (On Center)		
			Over 12 Up to 15				
	Vertical Spacing (Feet)	Section Modulus* (In (3))	Horizontal Spacing	Cylinder Diameter	Solid Sheet	2 Feet	3 Feet
Over 5 Up to 10	4	3.5	6.0	3 IN	3x12	NA	NA
		7.0	6.5	3 IN			
		14.0	10.0	3 IN			
Over 10 Up to 15	4	3.5	4.0	3 IN	3x12	NA	NA
		7.0	5.5	3 IN			
		14.0	8.0	3 IN			
Over 15 up to 20	4	3.5	3.5	3 IN	3x12	NA	NA
		7.0	5.0	3 IN			
		14.0	6.0	3 IN			
Over 20	**See Note 1**						

*** Consult product manufacturer and/or qualified engineer for Section Modulus of available Wales.**

Notes:

(1) For applications other than those listed in the tables, refer to 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to 1926.652(c)(2) and 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) Basis and limitations of the data.

(a) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent

(b) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as

(c) Limitation of application.

(i) It is not intended that the aluminum hydraulic 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

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000

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.