
USACE / NAVFAC / AFCEC / NASA UFGS-31 41 16 (August 2009)

Preparing Activity: USACE Superseding
UFGS-31 41 16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2014

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08/09

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SECTION 31 41 16

METAL SHEET PILING 08/09

NOTE: This guide specification covers the requirements for metal sheet piling. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: Permanent earth retaining structures made with steel sheet piling such as caissons, quaywalls, and retaining walls are covered by this section. Temporary structures such as shoring and sheeting are the responsibility of the Contractor and unless required by conditions of the project, are not to be covered by this section. The extent and location of the work to be accomplished should be indicated on the project drawings.

The following information must also be shown on the project drawings:

1. Location of piles.

2. Soil data, where required.
3. Pile shape.
4. Pile size and weight.
5. Length or tip and cut-off elevations.

1.1 UNIT PRICES

NOTE: If Section 01 22 00.00 10 MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 22 00.00 10.

1.1.1 Steel Sheet Piling, Type [____], Grade [____]

1.1.1.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.1.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.1.1.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.2 Steel Fabricated Sections, Type[s] [____], Grade [____]

1.1.2.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.2.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling

installed below the point of cut-off.

1.1.2.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.3 Steel Sheet Piling - Government Furnished

1.1.3.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.3.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.1.3.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.4 Aluminum Sheet Piling, Type [_____]

1.1.4.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.4.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.1.4.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.5 Aluminum Fabricated Sections, Type[s] [_____]

1.1.5.1 Payment

Payment for sheet piling quantities will be made at the applicable contract

price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.5.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.1.5.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.6 Aluminum Sheet Piling - Government Furnished

1.1.6.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.1.6.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.1.6.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.7 Cut-Offs

1.1.7.1 Payment

When pilings which have not been driven to penetration depths shown are directed to be cut off, except for cut-offs due to excessive battering, a lump sum payment will be made for cutting off each piling.

1.1.7.2 Measurement

An additional sum will be paid for each linear meter foot of the portion cut off and measured for payment. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off at the rate of 50 percent of the

applicable contract unit price. [No payment will be made for cut-off portions of Government furnished pilings.]

1.1.7.3 Unit of Measure

Unit of measure: each.

1.1.8 Splices

1.1.8.1 Payment

Payment will be made for each piling spliced at the direction of the Contracting Officer to drive the piling to a depth greater than shown and extend it up to the required top elevation. An additional sum will be paid for each linear meter foot of the piling extension at the applicable contract unit price.

1.1.8.2 Measurement

Splices will be measured for payment for each piling spliced.

1.1.8.3 Unit of Measure

Unit of measure: each.

1.1.9 Pulled Pilings

1.1.9.1 Payment

The Contractor furnished pilings which have been installed and are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for furnishing and installing the pilings in their initial position plus an equal amount for the cost of pulling.

1.1.9.2 Measurement

When such pulled pilings are redriven, an additional amount equal to 50 percent of the applicable contract unit price for furnishing and driving the pilings will be paid for redriving the pilings. This additional price constitutes payment for redriving only. The cost of furnishing, initial driving, and pulling the pilings is to be paid for as specified.

- a. Government furnished pilings which are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for installing the pilings in their initial position plus an equal amount for the cost of pulling. Such piling when redriven will be paid for at the applicable contract unit cost for installing the pilings.
- b. When pilings are pulled and found to be damaged no payment will be made for the initial furnishing and driving or for the pulling of such pilings. Pilings replacing damaged pilings will be paid for at the applicable contract unit prices.

1.1.9.3 Unit of Measure

Unit of measure: each.

1.1.10 Removal of Sheet Pilings

1.1.10.1 Payment

Payment will be made for costs associated with removal of sheet pilings. Payment will cover cost of pulling, cleaning the interlock, sorting, inventorying and storing.

1.1.10.2 Measurement

Removal of sheet piling will be made at the applicable contract price per linear meter foot for the removal of sheet pilings.

1.1.10.3 Unit of Measure

Unit of measure: linear meter foot.

1.2 NAVY PROJECT PRICE AND PAYMENT PROCEDURES

NOTE: Select the applicable paragraph(s) from the following.

1.2.1 Basis of Bids

NOTE: Use this option for fixed-price contracts.

Base bids on pile sections and lengths as indicated. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment in the contract price and time for completion will be made. No additional payment will be made for withdrawn, damaged, rejected, or misplaced piles; for any portion of a pile remaining above the cut-off elevation; for backdriving; for cutting off piles, or for any cut off length of piles.

1.2.2 Measurement and Payment

1.2.2.1 NAVFAC PAC Projects

NOTE: Edit applicable attachments from Document 00 41 00 for inclusion in Standard Form 1442, "Solicitation, Offer and Award," and "Schedule of Bid Items." Select first bracketed text.

For unit price bid, see [SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."] [Section 00 41 00 BID SCHEDULES.]

1.2.2.2 NAVFAC LANT Projects

Payment will be at the contract unit price per length, multiplied by the total length of acceptable piles actually installed. Base bids on the number of piles with pile length from tip to cutoff, as indicated, and on the total length of piling from tip to cutoff as specified in the document titled "Instructions to Bidders." Include in bid a unit price per unit

length piling based on the quantity stated in the document titled "Instructions to Bidders." If the Contracting Officer requires an increase or a decrease in length of piles furnished and installed, the contract price will be adjusted in accordance with the Contract Clauses of the contract. The unit price bid will be used for upward or downward adjustment of the quantity subject to provisions of "FAR 52.211-18, Variations in Estimated Quantities."

1.3 ESTIMATED QUANTITIES

The estimated quantities of sheet piling listed in the unit price schedule of the contract, as to be furnished by the Contractor, are given for bidding purposes only. Sheet piling quantities for payment will consist of the linear **meters feet** of piling acceptably installed [and removed]. Installed quantities will consist of all piling including fabricated sections driven between the required top and bottom elevations of pilings plus any additions thereto resulting from changes in design or alignment as provided in paragraph DRIVING. [Removed quantities will consist of the lengths of piling pulled from below the ground level.]

1.4 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2010; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A328/A328M (2013a) Standard Specification for Steel Sheet Piling

ASTM A572/A572M (2013a) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium

Structural Steel

ASTM A6/A6M	(2013a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A690/A690M	(2013a) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM A857/A857M	(2007; R 2013) Standard Specification for Steel Sheet Piling, Cold-Formed, Light Gage
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B308/B308M	(2010) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

1.5 SYSTEM DESCRIPTION

Submit [to the Contracting Officer for approval] descriptions of pile driving equipment to be employed in the work . Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, templates, and jetting equipment.

1.6 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Sheet Piling[; G][; G, [_____]]

SD-03 Product Data

Driving

Pile Driving Equipment[; G][; G, [_____]]

Pulling and Redriving[; G][; G, [_____]]

Interlocked Joint Strength in Tension Test[; G][; G, [_____]]

SD-06 Test Reports

Materials Tests

Interlocked Joint Strength in Tension Test[; G][; G, [_____]]

SD-11 Closeout Submittals

Pile Driving Record

1.7 QUALITY ASSURANCE

1.7.1 Material Certificates

For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

[1.7.2 Interlocked Joint Tension Test

NOTE: Include this paragraph only when the design requires high interlock joint strength, such as a cellular cofferdam. Typically, heavy gauge hot-rolled steel sheet piling is required.

Submit, for approval, the procedure for testing the tension strength of piling interlocks prior to testing sheet piling.

]1.8 DELIVERY, STORAGE, AND HANDLING

Materials delivered to the site shall be new and undamaged and shall be accompanied by certified test reports. Provide the manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 3 m 10 feet apart and not more than 0.60 m 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion prior to installation. [Handle sheet piling over 25 m 80 feet in length using a minimum of two pickup points.]

PART 2 PRODUCTS

2.1 METAL SHEET PILING

NOTE: ASTM A328/A328M covers one grade of steel sheet piling for general use. ASTM A572/A572M covers three grades (yield strengths of 290, 345, 414 MPa (42, 50 and 60 ksi)) of steel available for high strength steel sheet piling. ASTM A690/A690M covers one grade of steel available for high strength steel sheet piling for use where greater resistance to marine splash zone conditions is required. Each of the ASTM Specifications contains "Supplementary Requirements" for use when desired by the purchaser. Some of these are provided for and described in the individual ASTM specification; others are standardized, and are indicated only by number and title, with their description found in ASTM A6/A6M.

Hot-rolled steel sheet piling sections are suitable for applications where interlocked joint strength in tension or section stability is a primary design requirement. Section stability (Biaxial Stress) is a consideration in highly stressed applications only.

Cold-formed, light-duty or light gauge steel sheet piling sections are suitable for applications with a required minimum sheeting thickness of 6.35 mm (0.250 inch) or less, low bending and corrosion resistances, and minimal required interlocked joint strength in tension. The corrosion resistance of light gauge sheet piling can be increased by applying a protective coating.

Cold formed sheet piling will not be used in I-walls that act as a flood barrier. This is due to the much greater permeability of the lapped connections between the sheets compared to the ball-and-socket interlock connections in hot rolled sheet piling. In addition, the interlock connections between hot rolled sheets provide much greater strength than cold formed connections. Greater interlock strength improves integrity during driving and allows forces

to be redistributed laterally along the wall at changes in wall alignment, in weak soil zones or when the I-wall undergoes wave loadings that vary along the length of the wall. The additional strength also provides some redundancy to sections that must bridge across localized weak zones in the foundation material.

For applications in salt or brackish water use the most economical of a ASTM A690/A690M steel sheet piling which offers greater corrosion resistance or a ASTM A328/A328M steel sheet piling with a protective coating in the splash zone. A protective coating should be applied to a ASTM A690/A690M sheet piling in the splash zone of waterway bulkheads located in salt or brackish water.

Corrosion protection should be provided where piling is exposed to an adverse environment. Choose system(s) based on economics and potential hazards due to sheet piling system failure; more than one system may be necessary depending on conditions above and below the splash zone. While ASTM A690/A690M is suggested for marine environments, its use alone without protective measures may not be effective.

Consideration should be given in design to the use of a ASTM A572/A572M high-strength steel sheet piling where economical. In floodwall applications the allowable working stress should not exceed 0.5 of the yield strength of the steel. In other applications the allowable working stress should not exceed 0.6 of the yield strength of the steel.

Aluminum sheet piling sections are suitable for use in applications requiring moderate bending resistance and minimal design interlocked joint strength in tension. Non-draining, clay-muck soils and soils and water with a pH outside the range of 4.5 to 8.5 and containing chlorides, sulfates or heavy metals (copper, lead, tin, mercury and cobalt) are corrosive to aluminum and should be avoided. Protective coatings or cathodic protection can be used to provide longer service life to aluminum piling in corrosive environments.

Submit detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

- a. Include in the drawings details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

- b. Metal sheet piling shall be [hot-rolled steel sections conforming to [ASTM A328/A328M] [ASTM A572/A572M, Grade [____], [Type [____]] [, interlocked joint strength in tension as shown]] [ASTM A690/A690M [, interlocked joint strength in tension as shown]] [hot-rolled, light-duty steel sections conforming to ASTM A572/A572M, Grade 50.]] [cold-formed steel sections formed from hot-rolled steel meeting the chemical and mechanical requirements of [ASTM A328/A328M] [ASTM A572/A572M, Grade [____], Type [____]] [ASTM A690/A690M]] [cold-formed, light gauge steel sections conforming to ASTM A857/A857M, Grade [____]] [extruded aluminum sections fabricated from aluminum conforming to [ASTM B221M ASTM B221,] [ASTM B308/B308M,] Alloy 6061, Temper T6.]
- c. For protection of sheet piling, coat it in accordance with Section [09 97 13.26 COATING OF STEEL WATERFRONT STRUCTURES] [09 97 02 PAINTING: HYDRAULIC STRUCTURES] [and] [provide cathodic protection in accordance with Section [26 42 13.00 20 CATHODIC PROTECTION BY GALVANIC ANODES] [or] [26 42 19.00 20 CATHODIC PROTECTION BY IMPRESSED CURRENT] [26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)] [____]].

2.1.1 Interlocks

The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

2.1.2 General Requirements

NOTE: The following tables list section properties of sheet piling that may be commercially available. Designers should contact suppliers to verify current availabilities and lead times. Based upon the design requirements for each piling section select the most suitable corresponding section from these tables or other commercial sources and place the pertinent section properties of this section on the drawings as minimum requirements.

HOT-ROLLED STEEL SECTIONS								
Section	Nominal Web Thick's (inch)	Nominal Width (inch)	Section Mdoulus per Linear Foot of Wall (cu in)	Weight per Sq Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)	Minimum Interlocked Joint Strength in Tension (lbs per linear inch)		
						A328	A572, GR50, A690	GR60, A572
PZ22	0.375	22.00	18.1	22.0	40.3			
PZC13	0.375	27.88	24.2	21.7	50.4			
PZC14	0.420	27.88	26.0	23.7	55.0			
PZ27	0.375	18.00	30.2	27.0	40.5			

HOT-ROLLED STEEL SECTIONS								
Section	Nominal Web Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall (cu in)	Weight per Sq Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)	Minimum Interlocked Joint Strength in Tension (lbs per linear inch)		
						A328	A572, GR50, A690	GR60, A572
PZC18	0.375	25.00	33.5	24.2	50.4			
PZC19	0.420	25.00	36.1	26.4	55.0			
PZC25	0.485	27.88	45.7	29.9	69.4			
PZC26	0.525	27.88	48.4	31.8	73.9			
PZ35	0.500	22.64	48.5	35.0	66.0			
PZC28	0.570	27.88	51.3	34.0	79.0			
PZ40	0.500	19.69	60.7	40.0	65.6			
PS27.5	0.400	19.69	1.9	27.5	45.1	16,000	20,000	
PS31	0.500	19.69	1.9	31.0	50.9	16,000	20,000	24,000
COLD-FORMED STEEL SECTIONS								
Section	Nominal Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)			
CZ-67	0.217	21.65	10.70	13.72	24.76			
CZ-72	0.236	21.65	11.68	14.83	26.70			
CZ-84	0.276	21.65	13.62	17.21	31.05			
CZ-95RD	0.307	21.65	15.16	19.00	34.28			
CZ-95	0.315	21.65	15.53	19.46	35.15			
CZ-101	0.335	21.65	16.50	20.70	37.37			
CZ-113	0.375	21.65	18.79	23.10	41.70			
CZ-114RD	0.315	24.02	29.76	21.88	43.80			
CZ-114	0.335	24.02	31.62	21.88	43.83			
CZ-128	0.375	24.02	35.34	26.22	52.28			

COLD-FORMED STEEL SECTIONS					
Section	Nominal Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
CZ-141	0.413	24.02	39.06	28.88	57.92
CZ-148	0.433	24.02	40.92	30.31	60.68
SZ-222	0.312	22.00	26.7	22.1	40.4
SZ-24	0.340	22.00	29.0	24.1	44.1
SZ-25	0.350	22.00	29.7	24.8	45.3
SZ-27	0.375	22.00	32.0	26.6	48.6
SZ-14.5	0.250	26.75	13.0	14.5	32.4
SZ-18	0.312	26.75	16.2	18.1	40.4
SZ-20	0.340	26.75	17.5	19.8	44.1
SZ-21	0.350	26.75	18.1	20.3	45.3
SZ-22	0.375	26.75	19.3	21.8	48.6
COLD-FORMED, LIGHT-DUTY STEEL SECTIONS					
Section	Nominal Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
CL-42	0.157	21.65	2.55	8.60	15.52
CL-47	0.177	21.65	2.88	9.63	17.39
CL-57	0.217	21.65	3.53	11.67	21.07
CS-55	0.197	27.56	6.34	11.18	25.69
CS-60	0.217	27.56	6.98	12.29	28.22
CS-69	0.250	27.56	8.05	14.19	32.58
CS-76	0.276	27.56	8.89	15.56	36.62
SZ-10	0.164	22.00	7.3	9.4	17.2
SZ-11	0.179	22.00	7.9	10.3	18.8

COLD-FORMED, LIGHT-DUTY STEEL SECTIONS					
Section	Nominal Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
SZ-12	0.209	22.00	9.2	12.0	21.9
SZ-14	0.239	22.00	10.4	13.5	24.6
SZ-15	0.250	22.00	10.9	14.0	25.6
LZ-8	0.164	24.00	3.6	8.3	17.2
LZ-7	0.179	24.00	3.9	9.1	18.8
LZ-5	0.209	24.00	4.6	10.6	21.9
LZ-3	0.239	24.00	5.2	11.0	24.6
LZ-250	0.250	24.00	5.4	12.3	25.6
COLD-FORMED, LIGHT GAUGE STEEL SECTIONS					
Gauge	Nominal Thickness (inch)	Laying Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
12	0.1046	21.67	1.76	5.80	10.40
12	0.1046	19.67	1.80	5.90	9.50
10	0.1345	18.00	2.20	7.20	10.80
10	0.1345	21.67	2.25	7.40	13.40
10	0.1345	19.67	2.36	7.60	12.20
8	0.1644	18.00	2.62	8.80	13.20
8	0.1644	21.67	2.75	9.10	16.40
8	0.1644	19.67	2.86	9.30	14.90
7	0.1793	18.00	2.80	9.60	14.40
7	0.1793	21.67	2.99	6.90	17.90
7	0.1793	19.67	3.10	10.10	16.34
6	0.1943	18.00	3.00	10.50	15.80

COLD-FORMED, LIGHT GAUGE STEEL SECTIONS					
Gauge	Nominal Thickness (inch)	Laying Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
5	0.2092	18.00	3.40	11.30	16.90
5	0.2092	21.67	3.48	11.70	21.10
ALUMINUM SECTIONS					
Section	Nominal Thickness (inch)	Nominal Width (inch)	Section Modulus per Linear Foot of Wall	Weight per Square Foot of Wall (lbs)	Weight per Linear Foot of Piling (lbs)
AWL-3	0.100	12.00	1.258	-----	-----
AWL-8	0.125	12.00	1.542	-----	-----
AWL-11	0.135	12.00	1.714	-----	-----
AWM-3	0.100	12.00	2.200	-----	-----
AWM-8	0.125	12.00	2.967	-----	-----
PZMA-16	0.145/0.160	12.00	3.710	-----	-----
PZM-19	0.175/0.188	12.00	4.29	-----	-----
PZH--1	0.150	12.00	6.309	-----	-----
PZH-3	0.188	12.00	7.633	-----	-----
PZH-7	0.250	12.00	9.783	-----	-----
PZH-153	0.188	15.00	13.49	-----	-----
PZH-159	0.225/0.275	15.00	18.00	-----	-----

Z-Sections develop a maximum resistance to bending per unit weight and are particularly adapted to cantilever and anchored type retaining walls.

Straight-Web (S) sections have their interlocks designed for maximum flexibility and tensile strength and are particularly adapted to cellular retaining walls and cellular cofferdam construction.

Sheet piling [including special fabricated sections] shall be [full-length] sections of the dimensions shown. [Provide fabricated sections conforming to the requirement and the piling manufacturer's recommendations for fabricated sections.] [Fabricated sections connecting cofferdam cells and

adjacent arcs composed of pilings from different manufacturers shall be Y-sections fabricated from the respective manufacturer's pilings.] [Fabricated tees, wyes and cross pieces shall be fabricated of piling sections with a minimum web thickness of 13 mm 1/2 inch.] [Sheet piling to be placed in a circular cell or a connecting arc shall be of the same manufacture.] Provide sheet piling with standard pulling holes. Metalwork fabrication for sheet piling shall be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer's standards and to the requirements specified in the respective sheet piling standards and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance shall be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.3.1 Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials. Material test reports shall meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials shall be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties shall be performed after the completion of all rolling and forming operations. Testing of sheet piling shall meet the requirements of ASTM A6/A6M.

2.3.2 Interlocked Joint Strength in Tension Test

Submit the procedure for testing sheet piling interlocked joint strength in tension, prior to testing piling. [The interlocked joint strength in tension test shall conform to the piling manufacturer's standard test, include testing at least two 75 mm 3 inch long coupons taken randomly from different as-produced pilings of each heat and shall t be approved.] Submit a certified report showing results based on approved testing procedures.

PART 3 EXECUTION

3.1 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Pre-excavation [will] [will not] [be permitted.] [permitted to a maximum depth [of [_____] meters feet below [_____] [as indicated]]. Backfill as indicated.

3.2 INSTALLATION

3.2.1 Pile Driving Equipment

Submit complete descriptions of sheet piling driving equipment including

hammers, [jetting equipment,] extractors, protection caps and other installation appurtenances, prior to commencement of work. Provide pile driving equipment conforming to the following requirements.

3.2.1.1 Driving Hammers

NOTE: Insert desired energy ratings in this paragraph. Hammers with energy ratings between 11,860 and 21,700 J (8,750 and 16,000 foot pounds) are recommended.

Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting [, or vibratory] type. The driving energy of the hammers shall be between [_____] and [_____] J foot-pounds as recommended by the manufacturer for the piling weights and subsurface materials to be encountered. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

3.2.1.2 Jetting Equipment

Jetting [may be used at no additional cost to the Government] [will not be permitted]. [Jetting equipment shall have not less than two removable or fixed jets of the water or combination air-water type. Water jets shall be designed so that the discharge volume and pressure are sufficient to freely erode the material under and adjacent to the piling.]

3.2.2 Placing and Driving

3.2.2.1 Placing

NOTE: When long piles are being driven, templates are of value. Long piles are very flexible and damage easily. Use templates to keep piles vertical.

Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

- [a. Pilings to be placed in cofferdam cells and connecting arcs shall be picked up and completely threaded to demonstrate that they slide freely in interlock.]

[a.] [b.] Pilings shall be carefully located as [indicated] [or] [directed.] Pilings shall be placed plumb with out-of-plumbness not exceeding [10] [22] mm per meter [1/8] [1/4] inch per foot of length and true to line. Place the pile so the face will not be more than 150 mm 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off shall be within 13 mm 1/2 inch horizontally and 50 mm 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Redrive all heaved piles to the required tip elevation.

[b.][c.] Provide temporary wales, templates, [master pilings] [current deflectors] or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved. Use two templates, at least, when placing each piling [at third points] [not less than 6 m 20 feet apart]. Templates shall not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means shall be used to keep the sheet pile vertical along its leading edge.

[[c.][d.] Master pilings shall be used to maintain plumbness and proper configuration in placing cofferdam cells over 27 m 90 feet in height in water flowing at a velocity of more than 1.2 m/s 4 feet per second.]

3.2.2.2 Driving

NOTE: When hard driving or driving through rocky soil or debris is anticipated, require addition of tip protection to prevent damage to sheet piling.

Jetting should generally not be permitted for:

1. Piles dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.
2. Piles subject to uplift.
3. Piles adjacent to existing structures.
4. Piles in closely spaced clusters unless the load capacity is confirmed by tests and unless all jetting is done before final driving of any pile in the cluster.

Pre-augering or spudding should generally not be permitted for piles dependent on side friction in fine-grained, low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. [The format for driving records shall be as directed.] [Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line shall indicate the profile of the

bottom elevation of installed pilings and potential problem areas can be identified by abrupt changes in its elevation.] Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

- a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer. [Caution shall be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages. Discontinue the use of vibratory hammers and impact hammers employed when the penetration rate due to vibratory loading is 300 mm one foot or less per minute.]
- b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. [Use cast steel shoe to prevent damage to the tip of the sheet piling.] Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense. [Store Government furnished pilings, damaged during driving, at the site as directed.]
- c. Drive pilings without the aid of a water jet [unless otherwise authorized]. [Perform authorized jetting on both sides of the pilings simultaneously; discontinue it when the pile tip is approximately 1.5 m 5 feet above the ["calculated"] [indicated] pile tip elevation and make the final 1.5 m 5 feet of penetration by driving. Before commencing the driving of the final 1.5 m 5 feet, firmly seat the pile in place by the application of a number of reduced energy hammer blows.]
- d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven shall be driven to the required depth and tapered pilings shall be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures shall be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling shall be 10 mm per meter 1/8 inch per foot of length.
- e. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile shall not be more than 1.2 m 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per 25 mm inch, the tip of any sheet pile shall not be more than 0.6 m 2 feet below any adjacent sheet pile. [For cofferdam cells the driving increments shall be such that no piling leads the adjacent piling by more than [_____] mm feet and the direction of advancing the driving hammer shall be reversed after each pass around the cell.] If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling.
- f. If obstructions restrict driving a piling to the specified penetration, the obstructions shall be removed or penetrated with a chisel beam. If

the Contractor demonstrates that removal or penetration is impractical, make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. [Piling driven to rock shall be seated individually on the rock.] A tolerance of [_____] mm inches above the indicated top elevation will be permitted. [At least the first two sheets of the connecting arcs adjacent to the main cells shall be driven in the cofferdam cells prior to filling the cells.] Pilings shall not be driven within 30 m 100 feet of concrete less than 7 days old.

- g. Pre-augering or spudding of piles [may be used at no additional cost to the Government] [will not be permitted]. [Discontinue pre-augering or spudding approximately [_____] meters feet above the [calculated] [indicated] pile tip elevation. Drive the pile the final [_____] meters feet of penetration].

3.2.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. [If directed, pilings shall be spliced as required to drive them to depths greater than shown and extend them up to the required top elevation.]

- a. Pilings adjoining spliced pilings shall be full length unless otherwise approved. [If splices are allowed in adjoining pilings, the splices shall be spaced at least [_____] m feet apart in elevation.] Splicing of pilings shall be as indicated. Ends of pilings to be spliced shall be squared before splicing to eliminate dips or camber. Pilings shall be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings shall be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices shall conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1/D1.1M.
- b. The tops of pilings excessively battered during driving shall be trimmed when directed, at no cost to the Government. Piling cut-offs [except for Government furnished pilings] shall become the property of the Contractor and shall be removed from the site.
- c. Cut holes in pilings for bolts, rods, drains or utilities in a neat and workmanlike manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling shall be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. [Bolt holes in aluminum pilings shall be drilled.] Holes other than bolt holes shall be reasonably smooth and the proper size for rods and other items to be inserted. [All holes in steel pilings on the wet side of cofferdams shall be made watertight by welding steel plates over the holes after the piling installation is completed.] Do not use explosives for cutting.

3.2.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Contracting Officer. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense. [Use divers to inspect underwater interlocked joints of cofferdam sheet piling. Government divers may also inspect the interlocked joints. The inspection of cofferdams shall be performed after driving is completed, prior to filling each cell and connecting arc, and within 48 hours after filling each cell and arc.]

3.2.5 Pulling and Redriving

Submit the proposed method of pulling sheet piling, prior to pulling any piling. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be redriven when directed. [Government furnished pilings pulled and not redriven shall be stored as directed.]

3.3 REMOVAL

The removal of sheet pilings shall consist of pulling, sorting, cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

3.3.1 Pulling

The method of pulling piling shall be approved. Provide pulling holes in pilings, as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the Government. Pull pilings one sheet at a time. Pilings fused together shall be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Contracting Officer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

3.3.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings shall be sorted, cleaned, inventoried and stored by type into groups as:

- a. Piling usable without reconditioning.
- b. Piling requiring reconditioning.
- c. Piling damaged beyond structural use.

3.4 INSTALLATION RECORDS

Maintain a **pile driving record** for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per **meter foot** for each **meter foot** of penetration, final driving resistance in blows for final **150 mm 6 inches**, pile locations, tip elevations, ground elevations, cut-off elevations, and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Contracting Officer.

-- End of Section --