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USACE / NAVFAC / AFCEC / NASA **UFGS-31 41 16 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 41 16 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 41 16

METAL SHEET PILING

11/20

PART 1 GENERAL

1.1 DESCRIPTION
1.2 REFERENCES
1.3 BASIS OF BID
1.3.1 Contractor's Geotechnical Consultant
1.3.2 Lump Sum Payment
1.3.3 Unit Prices
1.3.3.1 Steel Sheet Piling, Type [_____], Grade [_____]
1.3.3.1.1 Payment
1.3.3.1.2 Measurement
1.3.3.1.3 Unit of Measure
1.3.3.2 Steel Fabricated Sections, Type[s] [_____], Grade [_____]
1.3.3.2.1 Payment
1.3.3.2.2 Measurement
1.3.3.2.3 Unit of Measure
1.3.3.3 Steel Sheet Piling - Government Furnished
1.3.3.3.1 Payment
1.3.3.3.2 Measurement
1.3.3.3.3 Unit of Measure
1.3.3.4 Aluminum Sheet Piling, Type [_____]
1.3.3.4.1 Payment
1.3.3.4.2 Measurement
1.3.3.4.3 Unit of Measure
1.3.3.5 Aluminum Fabricated Sections, Type[s] [_____]
1.3.3.5.1 Payment
1.3.3.5.2 Measurement
1.3.3.5.3 Unit of Measure
1.3.3.6 Aluminum Sheet Piling - Government Furnished
1.3.3.6.1 Payment
1.3.3.6.2 Measurement
1.3.3.6.3 Unit of Measure
1.3.3.7 Cut-Offs
1.3.3.7.1 Payment
1.3.3.7.2 Measurement
1.3.3.7.3 Unit of Measure

1.3.3.8 Splices
1.3.3.8.1 Payment
1.3.3.8.2 Measurement
1.3.3.8.3 Unit of Measure
1.3.3.9 Pulled Pilings
1.3.3.9.1 Payment
1.3.3.9.2 Measurement
1.3.3.9.3 Unit of Measure
1.3.3.10 Removal of Sheet Pilings
1.3.3.10.1 Payment
1.3.3.10.2 Measurement
1.3.3.10.3 Unit of Measure
1.4 NAVY PROJECT PRICE AND PAYMENT PROCEDURES
1.4.1 Basis of Bids
1.4.2 Measurement and Payment
1.4.2.1 NAVFAC PAC Projects
1.4.2.2 NAVFAC LANT Projects
1.5 ESTIMATED QUANTITIES
1.6 SUBMITTALS
1.7 DELIVERY, STORAGE, AND HANDLING
1.7.1 Delivery and Storage
1.7.2 Handling
1.7.3 Damaged Piles
1.8 MATERIAL CERTIFICATES
1.9 INTERLOCKED JOINT TENSION TEST

PART 2 PRODUCTS

2.1 METAL SHEET PILING
2.1.1 Interlocks
2.1.2 General Requirements
2.2 APPURTENANT METAL MATERIALS
2.3 TESTS, INSPECTIONS, AND VERIFICATIONS
2.3.1 Materials Tests
2.3.2 Interlocked Joint Strength in Tension Test
2.4 PILE DRIVING EQUIPMENT
2.4.1 Driving Hammers
2.4.2 Jetting Equipment

PART 3 EXECUTION

3.1 PRELIMINARY WORK
3.1.1 Pile Length Markings
3.2 EARTHWORK
3.3 INSTALLATION
3.3.1 Placing and Driving
3.3.1.1 Placing
3.3.1.2 Driving
3.3.2 Cutting-Off and Splicing
3.3.3 Inspection of Driven Piling
3.3.4 Pulling and Redriving
3.3.5 Testing Agency Qualifications
3.3.6 Survey Data
3.4 DRAINAGE
3.5 ANCHORS
3.6 REMOVAL
3.6.1 Pulling
3.6.2 Sorting, Cleaning, Inventorying and Storing
3.7 INSTALLATION RECORDS

3.8 VIBRATION CONTROL
3.9 NOISE CONTROL
3.10 PRECONSTRUCTION CONDITION SURVEY
3.11 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

-- End of Section Table of Contents --

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SECTION 31 41 16

METAL SHEET PILING
11/20

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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 item(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, quay walls, 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 DESCRIPTION

Design, furnish, install and test metal sheet piles at the locations indicated on the drawings and specified herein. [Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.]

1.2 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 Reference Identifier (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	(2020) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2017a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A328/A328M	(2013; R 2018) Standard Specification for Steel Sheet Piling
ASTM A572/A572M	(2018) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A690/A690M	(2013a; R 2018) 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	(2014) 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; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM E329	(2020) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E548	(1994; E 1995) Standard Guide for General Criteria Used for Evaluating Laboratory Competence

1.3 BASIS OF BID

****
NOTE: Select one of the following options.
****

****
NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter (foot) of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep

Foundations (ASTM D4945).

Whenever sheet piling section properties greater than required by design are acceptable, "(Min.)" should be indicated after the applicable value shown in this specification or on the drawings.

****

1.3.1 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest.

[1.3.2 Lump Sum Payment

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1							
[Location]	Number	Section	[Section Modulus]*	[Moment of Inertia]**	Length (tip to cut-off)	[_____]	[_____]

*Section properties should be detailed per foot of wall, in^3 per ft.
**Section properties should be detailed per foot of wall, in^4 per ft.]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, pullout, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the requirements specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys.]

]1.3.3 Unit Prices

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES 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 20 00.
****

1.3.3.1 Steel Sheet Piling, Type [_____], Grade [_____]

1.3.3.1.1 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.

1.3.3.1.2 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.

1.3.3.1.3 Unit of Measure

Linear meter foot.

1.3.3.2 Steel Fabricated Sections, Type[s] [_____], Grade [_____]

1.3.3.2.1 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].

1.3.3.2.2 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.

1.3.3.2.3 Unit of Measure

Linear meter foot.

1.3.3.3 Steel Sheet Piling - Government Furnished

1.3.3.3.1 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].

1.3.3.3.2 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.

1.3.3.3.3 Unit of Measure

Linear meter foot.

1.3.3.4 Aluminum Sheet Piling, Type [_____]

1.3.3.4.1 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].

1.3.3.4.2 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.

1.3.3.4.3 Unit of Measure

Linear meter foot.

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

1.3.3.5.1 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].

1.3.3.5.2 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.

1.3.3.5.3 Unit of Measure

Linear meter foot.

1.3.3.6 Aluminum Sheet Piling - Government Furnished

1.3.3.6.1 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].

1.3.3.6.2 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.

1.3.3.6.3 Unit of Measure

Linear meter foot.

1.3.3.7 Cut-Offs

1.3.3.7.1 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.

1.3.3.7.2 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.]

1.3.3.7.3 Unit of Measure

Each.

1.3.3.8 Splices

1.3.3.8.1 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.

1.3.3.8.2 Measurement

Splices will be measured for payment for each piling spliced.

1.3.3.8.3 Unit of Measure

Each.

1.3.3.9 Pulled Pilings

1.3.3.9.1 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 the applicable contract unit price for the cost of pulling.

1.3.3.9.2 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.

1.3.3.9.3 Unit of Measure

Each.

1.3.3.10 Removal of Sheet Pilings

1.3.3.10.1 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.

1.3.3.10.2 Measurement

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

1.3.3.10.3 Unit of Measure

Linear meter foot.

1.4 NAVY PROJECT PRICE AND PAYMENT PROCEDURES

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

1.4.1 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.

1.4.2 Measurement and Payment

1.4.2.1 NAVFAC PAC Projects

****
NOTE: Edit applicable attachments from Document 00 22 13.00 20 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 22 13.00 20 SUPPLEMENTARY INSTRUCTIONS TO OFFERORS.]

1.4.2.2 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, Variation in Estimated Quantities.

1.5 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.]

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

Interlock joint tension strength requirements should be deleted except for flat, or straight web, pilings used in radial or transverse tension applications.
****

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

SD-01 Preconstruction Submittals

Installation Procedures; G[, [_____]]

[Contractor's Geotechnical Consultant Documentation; G[, [_____]]

] Testing Agency Qualifications; G[, [_____]]

[Instrumentation and Monitoring Program Report; G[, [_____]]

] SD-02 Shop Drawings

Metal Sheet Piling; G[, [_____]]

Pile Splicing; G[, [_____]]

Pile Placement; G[, [_____]]

As-Driven Survey; G[, [_____]]

Pile Shoe; G[, [_____]]

SD-03 Product Data

Driving

Pile Driving Equipment; G[, [_____]]

Delivery, Storage, and Handling; G[, [_____]]

Pulling and Redriving; G[, [_____]]

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

] SD-05 Design Data

Procedure for Insufficient Pile Length; G[, [_____]]

SD-06 Test Reports

Materials Tests

[Interlocked Joint Strength in Tension Test

] SD-07 Certificates

Pile Shoe; G[, [_____]]

Welding Certifications; G[, [_____]]

Steel Plant Certificate; G[, [_____]]

SD-11 Closeout Submittals

Pile Driving Record; G[, [_____]]

1.7 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein. Develop and submit plans for the delivery, storage, and handling of piles. Submit delivery, storage, and handling plans for piles at least 30 days prior to delivery of piles to the job site.

1.7.1 Delivery and Storage

Materials delivered to the site must be new and undamaged and must 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 protection prior to installation.

1.7.2 Handling

Lift piles to ensure that the maximum permissible curvature is not exceeded. Holes may be burned above the cutoff length for lifting piles into the leads. If there is evidence of pile damage during driving due to the holes, Contracting Officer may forbid the burning of holes. Do not damage piles when dragging piles across the ground or barge deck.

Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Straightness of the sections of piles must conform to AWS D1.5M/D1.5, Section 3.5.1.1. Piles having excessive curvature will be rejected.

1.7.3 Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the
Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for

the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and/or low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

1.8 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.

[1.9 INTERLOCKED JOINT TENSION TEST

****
NOTE: Include this paragraph only when the design utilizes straight web metal sheet piles, such as a cellular cofferdam. This should not be included for Z-type sheet piles.
****

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

]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, 55, 60 and 65 ksi) of steel available for high strength steel sheet piling, with ASTM A572/572M grade 345MPa 50ksi being the most common. 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. Availability of sheet piling sizes and grades should always be verified as part of the design. 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 straight web 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 straight web steel sheet piles should not be used.

Hot-rolled z-type steel sheet pile sections have tighter interlocks and are suitable for applications where reduced permeability through the wall is a primary design requirement.

Cold-formed steel sheet pile sections are suitable for applications where the permeability through the wall is not a primary design requirement. Cold-formed sheet piles typically have a hook and grip interlock which typically has the highest permeability rates. 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.

Higher section modulus and stiffness (moment of inertia) of a z-type steel sheet pile 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 enough.

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 must 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 (for flat web sheet piles)]] [hot-rolled, light-duty steel sections conforming to ASTM A572/A572M, Grade [42,][55,][60,][or 65].]] [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 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, ZERO VOC, (SZC) SPLASH ZONE COATING] [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 must 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: 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 manufacturer's product specification tables or other commercial sources and place the pertinent section properties of this section on the drawings as minimum requirements.

Z-type sheet pile 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.

Take consideration of which section properties are crucial to the design of the wall. Properties such as section modulus, moment of inertia, and minimum thickness can be listed.

Interlock types for z-type sheet piles, such as larssen or ball and socket, can also be specified if it is crucial to the performance of the design of the wall. Cold formed sheet piles generally have the highest permeability rates with their hook and grip interlocks.

****

Provide sheet piles with minimum section modulus, moment of inertia, shape, and size as specified in the [drawings] [plans] [contract document][design]. Sheet piling [including special fabricated sections] must 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 must be Y-sections fabricated from the respective manufacturer's pilings.] [Fabricated tees, wyes and cross pieces must be fabricated of piling sections with a minimum web thickness of 13 mm 1/2 inch.] [Straight web sheet piling to be placed in a circular cell or a connecting arc must be of the same manufacture.] Provide sheet piling with standard lifting holes. Metalwork fabrication for sheet piling must 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 must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide manufacturer's steel plant certificate for Government review and approval.

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 must meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials must 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 must be performed after the completion of all rolling and forming operations. Testing of sheet piling must meet the requirements of ASTM A6/A6M.

2.3.2 Interlocked Joint Strength in Tension Test

****
NOTE: This is for straight web sheet pile only.
This is not be included for z-type sheet pile.
****

Submit the procedure for testing sheet piling interlocked joint strength in tension, prior to testing piling. [The interlocked joint strength in tension test must 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 must be approved.] Submit a certified report showing results based on approved testing procedures.

2.4 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. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements. Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work.

2.4.1 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 must be steam, air, or diesel drop, single-acting, double-acting, differential-acting[, or vibratory][or press-in] type. The driving energy

of the hammers must 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.

2.4.2 Jetting Equipment

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

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.52 m 5 feet from pile tip.

3.2 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.

3.3 INSTALLATION

3.3.1 Placing and Driving

3.3.1.1 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.
****

Submit a written description of the site specific pile installation procedures for Government review and approval. Pile placement installation drawings and details must also be provided.

Any excavation required within the area where sheet pilings are to be installed must be completed prior to placing sheet pilings. Pilings properly placed and driven must 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 must be picked up and completely threaded to demonstrate that they slide freely in interlock.]

[a.][b.] Pilings must be carefully located as [indicated] [or] [directed.] Pilings must 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 must 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. Re-drive 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 must 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 must be used to keep the sheet pile vertical along its leading edge.

[[c.][d.] Master pilings must 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.]

3.3.1.2 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.

The press-in pile driving method can be used for reduction of noise and/or vibration associated with

sheet pile driving; however, site and soil conditions will need to be considered.
****

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 must 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 must 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 must 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. Submit pile shoe installation details and material data for Government review and approval prior to use in the field.] 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 must be driven to the required depth and tapered pilings must be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures must be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling must be 10 mm per meter 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall must be driven alternately in increments of depth to the required depth or

elevation. No piling will 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 must 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 must not be more than 0.6 m 2 feet below any adjacent sheet pile. [For cofferdam cells the driving increments must be such that no piling leads the adjacent piling by more than [_____] mm feet and the direction of advancing the driving hammer must 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 must 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 must be driven to depths shown and must extend up to the elevation indicated for the top of pilings. [Piling driven to rock must 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 must be driven in the cofferdam cells prior to filling the cells.] Pilings must 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].

3.3.2 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 must 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 must be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. Submit procedure for insufficient pile length. Provide pile splicing information and details for Government review and approval prior to installation in the field. [If directed, pilings must 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 must be full length unless otherwise approved. [If splices are allowed in adjoining pilings, the splices must be spaced at least [_____] m feet apart in elevation.] Splicing of pilings must be as indicated. Ends of pilings to be spliced must be squared before splicing to eliminate dips or camber. Pilings must be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings must be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices must conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding

procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M. Submit welding certifications for all welders and welding operators for Government review and approval.

b. The tops of pilings excessively battered during driving must be trimmed when directed, at no cost to the Government. Piling cut-offs [except for Government furnished pilings] will become the property of the Contractor and must 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 must be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. [Bolt holes in aluminum pilings must be drilled.] Holes other than bolt holes must 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 must be made watertight by welding steel plates over the holes after the piling installation is completed.] Do not use explosives for cutting.

3.3.3 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 must 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 must be performed after driving is completed, prior to filling each cell and connecting arc, and within 48 hours after filling each cell and arc.]

3.3.4 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, must be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition must be redriven when directed. [Government furnished pilings pulled and not redriven must be stored as directed.]

[3.3.5 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548, and approved by the Contracting Officer.

]3.3.6 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Submit an as-driven survey showing actual location and top elevation of each [production pile] [test pile] within [7][_____] calendar days of completing the pile installation. Do not proceed with placing concrete

until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a land surveyor licensed in [_____].

[3.4 DRAINAGE

****
NOTE: Include this paragraph in cases where sheet pile walls are not designed to retain saturated soils and drainage behind the sheet pile wall is required.
****

Backfill material behind the sheet piling must be free draining and in accordance with Section 31 00 00 EARTHWORK.[Install drainage system and weep holes as shown in the [contract documents] [plans].]

][3.5 ANCHORS

****
NOTE: Include this paragraph only when tiebacks (anchors) are required to support sheet pile wall.
****

Conform to Section 31 68 13 SOIL AND ROCK ANCHORS.

]3.6 REMOVAL

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

3.6.1 Pulling

The method of pulling piling must be approved. Provide pulling holes in pilings, as required. Extractors must 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 must 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.

3.6.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings must 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.

3.7 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.

[3.8 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of 61 meters 200 feet from the pile driving activity. [Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [five] years of experience in vibration monitoring. A minimum of [28] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second] [the limits mentioned in the [contract documents]]. [Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.]During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.9 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the

particular project.
****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations. [Perform noise monitoring using [noise meters][, and][_____]]. [Engage the services of a qualified, independent noise consultant, accept able to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [five] years of experience in noise monitoring. A minimum of [28] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels. [The noise limits are mentioned in the [plan] [contract documents]]. [Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines]. During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.10 PRECONSTRUCTION CONDITION SURVEY

****
NOTE: Add any additional criteria, references or requirements as necessary to the particular project.
****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing

damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.11 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements. Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --