UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 31 - EARTHWORK

SECTION 31 62 16.16

STEEL H-PILES

11/20, CHG 2: 02/24

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USACE / NAVFAC / AFCEC	**UFGS-31 62 16.16 (November 2020)** **Change 2 - 02/24** **----------**
Preparing Activity: NAVFAC	**Superseding** **UFGS-31 62 16.16 (November 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 31 62 16.16

STEEL H-PILES
11/20, CHG 2: 02/24

****
NOTE: This guide specification covers the requirements for furnishing all equipment, labor, and materials (except materials specified to be furnished by the Government) and performing all operations in connection with the furnishing, installing and testing of steel H-piles in accordance with these specifications and applicable drawings.

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).
****

****
NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
****

****
NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
****

****
NOTE: Show the following information on the project drawings:

1. Location, size, and cutoff elevation of project piles.

2. Location, size, cutoff elevation, and identification of test piles.

3. Subsurface soil data logs. Other subsurface data is design information and is not a part of the contract. Make data available for examination by the bidders at appropriate locations.

4. Staging area.
****

PART 1 GENERAL

****
NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.
****

1.1 DESCRIPTION

Design, furnish, install and test 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; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A690/A690M	(2024) 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 D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E94/E94M	(2022) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E164	(2024) Standard Practice for Contact Ultrasonic Testing of Weldments
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

[1.3 SUBSURFACE DATA

****
NOTE: Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.
****

Subsurface soil data logs are[indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report samples of material taken from subsurface investigations may be examined at [_____].]

]1.4 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).
****

1.4.1 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN kips. Drive piles to[minimum tip elevation][a minimum depth of [_____] m feet below cut-off

elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at end of drive or restrike] [static load tests] [wave equation analysis].

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$$R = \frac{2WH}{S \text{ plus } 0.1}$$ For single acting hammers

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips (, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

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

Table 1

[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, 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 capacity 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].

][1.4.3 Unit Price

****
NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.
****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****
NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.
****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization,[jetting][predrilling][probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,]and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles]at the bid unit price for the length of pile, from tip to final cut-off, actually provided,

excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

][1.5 PAYMENT

****
NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PAYMENT) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.
****

1.5.1 Furnishing and Delivering Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent steel H piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering steel H piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Driving Steel H Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving steel H piles, which includes costs of handling, driving,[and splicing of piles,][performing dynamic testing, interpreting data and submitting reports,] measuring heave, redriving heaved piles, removal of[build-ups] driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.5.2.2 Measurement

Steel H piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth (tenth) of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled Steel H Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Steel H Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Steel H Piles" and "Driving Steel H Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING PILES. Pulling steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. Redriving pulled undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING PILES and DRIVING STEEL H PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Pile Driving Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles, [including [pile driving points][and][splices];]conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.5.4.2 Measurement

Pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles, [including [pile driving points][and][splices];]backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

Piles piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

Pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3 Unit of Measure

Each.

][1.5.7 Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with pile static tensile load

tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.5.7.2 Measurement

Pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.7.3 Unit of Measure

Each.

][1.5.8 Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.5.8.2 Measurement

Pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.8.3 Unit of Measure

Each.

][1.5.9 Pulled Load Test Piles

1.5.9.1 Payment

Payment will be made for costs associated with load test piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Steel H Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Piles for Load Tests".

1.5.9.2 Measurement

Pulled undamaged load test piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PILES FOR LOAD TESTS. Pulling undamaged load test piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. Redriving pulled undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. New load test piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PILES FOR LOAD TESTS.

1.5.9.3 Unit of Measure

As specified in paragraph PAYMENT, subparagraphs DRIVING STEEL H PILES and PILES FOR LOAD TESTS, respectfully.

][1.5.10 Pile Driving Shoes and Points

1.5.10.1 Payment

Payment will be made for costs associated with pile driving shoes, pile driving points, including furnishing, delivering, and installing.

1.5.10.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Pile Splices

1.5.11.1 Payment

Payment will be made for costs associated with pile splices, including all plant, labor, and material required to make the splice.

1.5.11.2 Measurement

Pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.11.3 Unit of Measure

Each.

][1.5.12 Vibration Monitoring

1.5.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.12.3 Unit of Measure

Each.

][1.5.13 Sound Monitoring

1.5.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.13.3 Unit of Measure

Each.

][1.5.14 Preconstruction Condition Survey

1.5.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.14.3 Unit of Measure

Each.

][1.5.15 Construction Instrumentation and Monitoring

1.5.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.15.3 Unit of Measure

One.

]]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 and Air Force 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.

****

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. Submittals not having a "G" or "S" classification are 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; G, [_____]

Testing Agency Qualification; G, [_____]

[Wave Equation Analysis; G, [_____]

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

] SD-02 Shop Drawings

Pile splices; G, [_____]

Pile placement; G, [_____]

[Pile Reinforcing Tips or Steel Points

][Pile Encasements

][Pile Load Test Frame

] SD-03 Product Data

Pile Driving Equipment; G, [_____]

Pile Driving Records; G, [_____]

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

SD-05 Design Data

[Wave Equation Analysis

] Quantities List; G, [_____]

Procedure for Insufficient Pile Length; G, [_____]

SD-06 Test Reports

[Test Pile; G, [_____]

][Load Test; G, [_____]

][Dynamic Pile Analysis; G, [_____]

] Pile Performance Report

SD-07 Certificates

Pile Material Certificates of Compliance; G, [_____]

Pile Splices; G, [_____]

Pile Shoes; G, [_____]

SD-11 Closeout Submittals

Pile Driving Records

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 calendar days prior to delivery of piles to the job site.

1.7.1 Delivery and Storage

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 3 m 10 feet or less along its length (ends inclusive) to prevent exceeding the maximum camber or sweep. Do not stack piles more than 1.5 m 5 feet high.

1.7.2 Handling

Lift piles using a cradle or multiple points pick-up to ensure that the maximum permissible camber or sweep is not exceeded due to insufficient support for lifting piles that are not extremely long into the driving

leads. One pick up point can be used for short piles. Point pick-up devices must be of the type that clamp to both pile flanges at each pick-up point. Holes may be burned in the flanges or webs of piles above the cutoff length for lifting piles into the leads. Do not damage piles when dragging piles across the ground.

1.7.3 Excessive Camber, Sweep, and Damage

Inspect piles for excessive camber and sweep and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Camber, curvature in the pile in the direction normal to the pile flanges, must be measured with the pile flange base laying on a flat surface and is the distance between the flange base at the mid-length of the pile and the flat surface. Sweep, curvature in the pile in the direction parallel to the pile flanges, must be measured with the pile flange tips laying on a flat surface and is the distance between the flange tips at the mid-length of the pile and the flat surface. The maximum permissible camber [and][or] sweep is 50 mm 2 inches over the length of the pile. Piles having excessive camber or sweep will be rejected.

1.7.4 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 low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

1.7.5 Pile Butt Location and Elevation

A pile driven below the specified butt elevation 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.

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.

[1.7.6 Pile Sweep

Limit sweep to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep will be rejected.

]1.8 QUALITY CONTROL

1.8.1 Piles

Prepare and submit shop drawings. Indicate placement of piles. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up.

1.8.2 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. Submit Contractor's geotechnical consultant qualifications at least 30 calendar days before pile installation.

Provide instructions and procedures on how the Contractor will assist the Government in the processes of[Dynamic Pile Testing,] Inspection and Monitoring of piles during installation and testing.

1.8.3 Pile Manufacturer's Quality Control Procedures

Submit the pile manufacturer's quality control procedures.

1.8.4 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories. Submit pile driving equipment information at least 30 calendar days prior to commencement of work.

[b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures.[Submit wave equation analysis for each pile location.] The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

(1) Complete Pile and Driving Equipment Data Form, (which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables) for each proposed pile hammer and pile type combination.

(2) Copies of computer input and output sheets and graphs showing

soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis must be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

][1.8.5 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]PART 2 PRODUCTS

2.1 PILE REQUIREMENTS

****

NOTE: Delete sentence in brackets when test piles are not required. Government requires the Contractor to employ a Geotechnical Consultant to determine the calculated tip elevation and provide oversight of piling installation and testing.

****

[Order test piles [3] [_____] meters [10] [_____] feet longer in length than production piles.[Drive the additional test pile length only when based upon the recommendation of the Contractor's Geotechnical Consultant and approved by the Contracting Officer.] Submit test pile and load test reports. The[Contractor's Geotechnical Consultant][Contracting Officer] will use test pile data to determine "calculated" pile tip elevation and necessary driving resistance. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the[Contractor's Geotechnical Consultant][Contracting Officer].][Provide test piles [1.5] [_____] meter [5] [_____] feet longer than the bid length.]

2.2 MATERIALS

****

NOTE: Base selection of material on a comprehensive study of strength, cost, and corrosion resistance requirements.

ASTM A36/A36M and ASTM A572/A572M steels have the same corrosion resistance; ASTM A572/A572M can be obtained in yield strengths of 350 MPa through 448 MPa 42 ksi through 65 ksi; however, 350 MPa 50 ksi is the most available grade. ASTM A588/A588M has twice the atmospheric resistance of ASTM A36/A36M steel with 20 percent copper added.

1. Marine environment: Evaluate steel section piles exposed to seawater on the basis of application, location, degree of exposure, type of structure, and required service life. Where

additional service life in the splash zone is required over that provided by conventional steel grades, ASTM A690/A690M or ASTM A588/A588M may be considered. ASTM A690/A690M steel 350 MPa 50 ksi (yield strength) has two to three times greater resistance to seawater splash zone corrosion than ordinary ASTM A36/A36M steel.

2. Seawater protection: To obtain reasonably long life for a structure immersed in seawater, provide steel piles with coatings, cathodic protection, or concrete encasement. Choice of protection is ultimately based on economics; usually, more than one type of protection will be used on a structure for most economical, adequate protection. The following criteria applies:

a. The use of coating systems for protection, such as coal tar epoxy, is usually low in initial cost but may require relatively frequent maintenance; also, it is extremely difficult to renew in the tidal zone between mean tide and low tide.

b. Cathodic protection is low in initial cost and low in maintenance. It can be of value only where the piles are continually wet, as in the submerged zone.

c. Concrete encasement or metal jacketing is relatively expensive in initial cost but requires no maintenance if properly constructed. When concrete encasement is to be continuously submerged in water with low resistivity, it must (1) extend below the mudline, or (2) be coated to electrochemically insulate the concrete from the steel.

Use high-strength steel only when design analyses show that the use is the most economical solution or to increase the design life if approved by the Contractor's Geotechnical Consultant.

ASTM A27/A27M cast steel is used for some commercially available pile points.
****

2.2.1 H-Piles

****
NOTE: Base selection of material on a comprehensive study of strength, cost, and corrosion resistance requirements.

ASTM A36/A36M and ASTM A572/A572M steels have the same corrosion resistance; ASTM A572/A572M can be obtained in yield strengths of 350 MPa through 448 MPa 42 ksi through 65 ksi; however, 350 MPa 50 ksi is the most available grade. ASTM A588/A588M has twice the atmospheric resistance of ASTM A36/A36M

steel with 20 percent copper added.

1. Marine environment: Evaluate steel section piles exposed to seawater on the basis of application, location, degree of exposure, type of structure, and required service life. Where additional service life in the splash zone is required over that provided by conventional steel grades, ASTM A690/A690M or ASTM A588/A588M may be considered. ASTM A690/A690M steel 350 MPa 50 ksi (yield strength) has two to three times greater resistance to seawater splash zone corrosion than ordinary ASTM A36/A36M steel.

2. Seawater protection: To obtain reasonably long life for a structure immersed in seawater, provide steel piles with coatings, cathodic protection, or concrete encasement. Choice of protection is ultimately based on economics; usually, more than one type of protection will be used on a structure for most economical, adequate protection. The following criteria applies:

a. The use of coating systems for protection, such as coal tar epoxy, is usually low in initial cost but may require relatively frequent maintenance; also, it is extremely difficult to renew in the tidal zone between mean tide and low tide.

b. Cathodic protection is low in initial cost and low in maintenance. It can be of value only where the piles are continually wet, as in the submerged zone.

c. Concrete encasement or metal jacketing is relatively expensive in initial cost but requires no maintenance if properly constructed. When concrete encasement is to be continuously submerged in water with low resistivity, it must (1) extend below the mudline, or (2) be coated to electrochemically insulate the concrete from the steel.

Use high-strength steel only when design analyses show that the use is the most economical solution.

ASTM A27/A27M cast steel is used for some commercially available pile points.

****

[ASTM A36/A36M][ASTM A572/A572M, Grade [_____]][ASTM A588/A588M][ASTM A690/A690M].[Provide test piles identical to those used elsewhere in the project.][Provide square and blunt pile tips, as received from the mill.][Provide pile tip reinforcements or cast steel points.][Provide piles with concrete encasements in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.] Provide H-piles of the shape and sections shown. Submit pile material certificates of compliance certifying that materials meet the requirements specified herein. Determine lengths of piles as specified in paragraph INSTALLATION, subparagraph LENGTHS OF PRODUCTION PILES[and paragraph FIELD QUALITY CONTROL, subparagraph TEST

PILES].[Submit pile load test plan at least 30 days prior to installing any test piles. Approval of the plan does not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.]

[2.2.2 Pile Splices

[[ASTM A36/A36M][ASTM A572/A572M, Grade [_____]][ASTM A588/A588M] for splice plates.][Materials for pile splices must be as specified.] Submit detail drawings of pile splices prior to fabrication. Submit Pile Splice Welder Qualifications.

][2.2.3 Pile Points

****
NOTE: Pile points may be required when driving piles in dense sand strata, gravel strata and cobble-boulder zones, and when driving piles to refusal on a hard layer or bedrock.
****

[ASTM A148/A148M for cast steel points.][[ASTM A36/A36M][ASTM A572/A572M, Grade [_____] for pile tip reinforcements.]] Pile points must[be the type][conform to details] shown[and be provided on all piles].

][2.2.4 Pile Caps

[ASTM A36/A36M.][ASTM A572/A572M, Grade [_____].][ASTM A588/A588M.] Pile caps must conform to details shown.

][2.2.5 Pile Tension Anchors

[ASTM A36/A36M.][ASTM A572/A572M, Grade [_____].][ASTM A588/A588M.] Pile tension anchors must conform to details shown.

][2.2.6 Fabrication

Fabrication must conform to the requirements shown and as specified herein and in[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

[2.2.6.1 Pile Splices

****
NOTE: Splices are generally not permitted where required lengths are available in one piece or the pile is designed for a moment connection. Where splices are permitted, show details of the splice.
****

Fabricate pile splices as shown. Submit detail drawings of splices in accordance with paragraph SUBMITTALS. Perform all welding in accordance with the requirements for shield metal arc welding of AWS D1.1/D1.1M. Submit welding procedure for shop splices and verification of welder qualifications. Make no more than [one] [_____] field splice per [25] [_____] m [80] [_____] feet of pile, unless directed by the Contracting Officer. Fabrication drawings must show all shop splices.

][2.2.6.2 [Pile Caps,] [Pile Points,] [Pile Tension Anchors,] [Pile Shoes]

[Attach [pile caps,] [pile points,] [piles shoes,] [and] [pile tension anchors] as shown.][Ground the top of piles sufficiently smooth to provide a good welding surface for structural-shape pile caps.] Submit Certificates of compliance certifying that materials meet the requirements specified herein.

]]2.3 PILE DRIVING EQUIPMENT

Select the proposed pile driving equipment, including hammers and other required items, and submit complete descriptions of the proposed equipment in accordance with paragraph SUBMITTALS. Final approval of the proposed equipment is subject to the satisfactory completion and approval of pile tests. Changes in the selected pile driving equipment will not be allowed after the equipment has been approved except as directed. No additional contract time will be allowed for Contractor proposed changes in the equipment.

2.3.1 Pile Driving Hammers

****

NOTE: When specifying the minimum driving energy, make an allowance for reduced penetration caused by shock absorption of pile helmets. Enter the appropriate minimum allowable driving energy for the project. Minimum allowable driving energy must be not less than the following:

Design Bearing Pile Capacity for Single Pile (Kilonewton) (Kips)	Minimum Rated Hammer Driving Energy (Joules) (Foot-Pounds)
Up to 534 120	20,350 15,000
Over 534 120	25,750 19,000

The minimum and maximum hammer energies required may be determined from experience on other jobs or by a series of wave equation analyses.

****

Provide impact or vibratory type pile driving hammers.

2.3.1.1 Impact Hammers

Provide air, hydraulic or diesel-powered impact pile hammers of the single-acting, double-acting, or differential-acting type.[The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass (weight) and the character of the soil formation to be penetrated.][The rated driving energy of hammers is limited to a minimum of [20,350] [25,750] joules [15,000] [19,000] foot-pounds.][Hammers must be capable of[, and so demonstrated during the development of refusal criteria,] hard driving in excess of 20 blows per 25 mm inch.] Provide boiler, compressor, or engine capacity sufficient to operate hammers continuously at the full rated speed. Hammers must have a gage to monitor

hammer bounce chamber pressure for diesel hammers or pressure at the hammer for air hammers. This gage must be operational during the driving of piles and be mounted in an accessible location for monitoring by the Contractor and the Contracting Officer.[Provide two spare operational bounce chamber read out units on site.][Provide bounce chamber pressure gage correction tables and charts for the type and length of hose to be used with the pressure gage to the Contracting Officer.][Hydraulic hammers must be equipped with a system for measurement of ram energy. The system must be in good working order and the results must be easily and immediately available to the Engineer. Install an energy monitor on the hydraulic hammers and record readings every 300 mm 12 inches of pile installation.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. Position a pile cap or drive cap between the pile and hammer. Place hammer cushion or cap block between ram and the pile cap or drive cap. Hammer cushion or cap block must have consistent elastic properties, minimize energy absorption, and transmit hammer energy uniformly and consistently during the entire driving period.[Do not use a pile cushion block.] In accordance with paragraph SUBMITTALS, submit the following information for each impact hammer proposed:

a. Make and model.

b. Ram mass (kilograms) weight (pounds).

c. Anvil mass (kilograms) weight (pounds).

d. Rated stroke (millimeters) (inches).

e. Rated energy range (joules) (foot-pounds).

f. Rated speed (blows per minute).

g. Air pressure, hammer, and boiler [and] [or] compressor (MPa)(psi).

[h. Rated bounce chamber pressure curves or charts, including pressure correction chart for type and length of hose used with pressure gage (bar) (pounds per square inch).

] i. Pile driving cap, make, and mass (kilograms) weight (pounds).

j. Cushion block dimensions and material type.

k. Power pack description.

[2.3.1.2 Vibratory Hammers

[The use of vibratory hammers is dependent upon satisfactory driving and load testing of piles.][Final approval of the proposed hammer and other driving equipment is subject to the satisfactory completion and approval of the pile tests.][The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass weight and the character of the soil formation to be penetrated.] The hammer must provide for maintaining a rigid connection between the hammer and the pile. In accordance with paragraph SUBMITTALS, submit the following information for each vibratory hammer proposed:

a. Make and model.

b. Eccentric moment (newton-meters) (inch-pounds).

c. Dynamic force (kilonewtons) (tons).

d. Steady state frequency or frequency range (cycles per minute).

e. Vibrating mass (kilonewtons) weight (pounds).

f. Amplitude (millimeters) (inches).

g. Maximum pull capacity (metric tons) (tons).

h. Non-vibrating mass (kilonewtons) weight (pounds).

i. Power pack description.

]2.3.2 Pile Driving Leads

****
NOTE: Suspended leads should not be used on jobs where accurate pile placement and alignment are required.

Vibratory hammers are typically operated free hanging without leads unless accurate placement and alignment of the piles are required.
****

Support and guide hammers with fixed extended leads or fixed underhung leads.[For driving battered piles, support and guide impact hammers with three-axis, fixed-extended leads capable of 1 H and 2-1/2 V before and after batter and 1 H on 6 V side batter, with 30 degree rotation each side of an axis running along the center line of rotation of the crane through the center line of the leads.] Provide two intermediate supports for the pile in the leads to reduce the unbraced length of the pile during driving and pulling.

2.3.3 Pile Extractors

Pile extractors may be vibratory or impact pile driving hammers. Impact hammers are required for pulling piles not extractable with vibratory hammers.

[2.3.4 Jetting Equipment

****
NOTE: Do not use jetting on piles carrying significant tension loads, lateral loads, or compression loads developed predominantly from skin friction.
****

Provide jetting equipment with 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 immediately under and adjacent to piles without resulting in pile drift. Submit jetting equipment including plant description, volume of water and pressure, and size and length of hoses and pipes in accordance with paragraph SUBMITTALS.

]PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity. Provide instructions and procedures on how the Contractor will perform [Dynamic Pile Testing,] Inspection and Monitoring of piles during installation and testing

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Steel Piles

Compression - 0.9 fy
Tension - 0.9 fy

Where fy is yield strength of steel

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

3.1.2 Order List

Submit to the Contracting Officer for approval, an itemized quantities list for piles prior to placing the order with the supplier. Indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile in the list.[Complete load testing and refined wave equation analysis and submit to Government for review and approval prior to submission of an order list.]

3.2 INSTALLATION

Inspect piles when delivered and when in the leads immediately before driving. Cut piles at cutoff grade by an approved method. Where cutoff is below existing ground or mudline elevation, complete excavation, sheeting, and dewatering before driving pile to cutoff elevation.

3.2.1 Lengths of Production Piles

The estimated quantities of piles are given for bidding purposes only. Drive piles to [or below "calculated"] [indicated] tip elevation [to reach a driving resistance established by the wave equation analyses (WEAP) in accordance with the schedule which the Contractor's Geotechnical Consultant will prepare from the test-pile driving data].

3.2.2 Pile Driving Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Submit the proposed form for compiling pile driving records 30 calendar days prior to commencement of work.

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations,[batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings during pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Submit[to the Contracting Officer] complete and accurate[test and] job pile driving records as specified in paragraph PILE RECORDS of this

section, within [15][_____] calendar days after completion of driving. Make pile driving records available to the Contracting Officer at the job site, within 24 hours after each day of pile driving.

3.2.3 Pile Placement and Tolerances in Driving

Develop and submit a pile placement plan which shows the installation sequence and the methods proposed for controlling the location and alignment of piles. Submit pile placement plan at least 30 calendar days prior to delivery of piles to the job site. Complete all foundation preparation in the area prior to the placement of piles for driving. Accurately place piles in the correct location and alignments, both laterally and longitudinally, and to the vertical or batter lines indicated. Establish a permanent base line to provide for inspection of pile placement by the Contracting Officer during pile driving operations prior to driving production piles and maintain during the installation of the production piles.

A final lateral deviation from the correct location at the cutoff elevation of not more than 76 mm 3 inches will be permitted for vertical and battered piles. Manipulation of piles will not be permitted. A variation of not more than 6 mm per 300 mm 0.25 inch per foot of pile length from the vertical for vertical piles nor more than 12 mm per 300 mm 0.50 inch per foot of pile length from the required angle for batter piles will be permitted. In addition to complying with the tolerances stated herein, the clear distance between the heads of piles and the edges of caps must be not less than 150 mm 6 inches. Redesign of pile caps or additional work required due to improper location of piles is the responsibility of the Contractor. A vertical deviation of not more than 25 mm one inch from the correct cutoff elevations shown is permitted. Inspect piles for heave. Redrive heaved piles to the required pile driving criteria. Maintain the correct relative position of all piles by the use of templates or by other approved means. Piles damaged or not located properly or exceeding the maximum limits for lateral and vertical deviation, or variation in alignment must be pulled and new piles redriven, or provide additional piles, at a location directed at no additional cost to the Government.

3.2.3.1 Survey Data

After the driving of each pile group is complete, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed 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 [_____].

3.2.4 Pile Penetration Criteria

The controlling driving resistance for production piles will be determined by the Contractor's Geotechnical Consultant. The required initial driving criteria and restrike will be established subsequent to the analysis of pile tests as specified in paragraph TEST PILES.

3.2.5 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 300 mm one foot

intervals. Mark the interval number on pile every 1.5 m 5 feet from pile tip.

3.2.6 Pile Driving

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.

****

Notify Contracting Officer 10 days prior to driving of[test] piles[and load test].[Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.][The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].] Drive piles to[the terminal driving criteria][or below "calculated"][indicated tip elevation][to reach a driving resistance established by the[dynamic pile driving tests at the end of drive or restrike][static load tests][wave equation analyses (WEAP)] in accordance with the schedule which the[Contractor's Geotechnical Consultant][Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil[or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach["calculated"][indicated] tip elevation,[or if a pile reaches["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.7 Protection of Piles

****

NOTE: Delete references to batter piles when not applicable to the project.

****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through

the reinforcement, by using a special driving head.

3.2.8 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.8.1 Obstructions

If a pile encounters an underground obstruction within 1.5 meters 5 feet of the ground surface of such size as to prevent driving the pile to the required driving criteria, the pile must be pulled or cut off at no cost to the Government. If such an obstruction is encountered more than 5 feet below the ground surface, the pile must be cut off and paid for as if a completed pile. In either event, a replacement pile must be installed at a location indicated by the Contracting Officer and paid for as a completed pile.

3.2.8.2 Splicing Piles

****
NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).
****

[Splicing of piles is not permitted.][Make splices as indicated. Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending. Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval.][Provide a detailed procedure for insufficient pile length where recovering of pile length is required.]

3.2.9 Jetting of Piles

****
NOTE: Jetting should generally not be permitted for piles:

1. 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. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.
****

Water jets will [not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment must be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.10 Predrilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. 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. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven [will [not] be permitted] [will be provided].[The diameter of the hole must not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the[calculated][indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.10.1 Heaved Piles

When driving piles in clusters or under conditions of relatively close spacing, perform observations to detect heave of adjacent piles. Backdrive heaved piles to original to the required[depth of penetration][tip elevation][refusal blow count] as directed by the Contractor's Geotechnical Consultant, after reviewing the heave data, without additional cost to the Government.

3.2.10.2 Pulled Piles

Pull and replace piles damaged or impaired for use during driving with new piles, or cut off and abandon and drive new piles as directed without additional cost to the Government. The Contracting Officer may require that any pile be pulled for inspection. Redrive piles pulled as directed

and found to be in suitable condition at another location as directed. Replace piles pulled as directed and found to be damaged with new piles at the Contractor's expense.

3.2.10.3 Long Piles

Provide pile driving rig with rigid supports so that leads remain accurately aligned. Where a high degree of accuracy is required, erect templates or guide frames at or close to the ground or water surface.

3.2.10.4 Welding

AWS D1.1/D1.1M. 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.

[3.2.11 Protection of Existing Structures

****
NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.
****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document][_____].

]3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

****
NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.
****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters [_____] feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's

Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria. Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

3.3.1.1 Dynamic Pile Analysis

Submit a performance report summarizing dynamic test results for [test] piles within [7] [_____] calendar days of completing field work.[For production piles, submit a performance report within one day of testing. Submit a typed report summarizing the results of dynamic testing of production piles on a monthly basis.]

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the[test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing must also be performed on [_____] production piles as chosen by the Contracting Officer. Use[test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive[test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

3.3.1.2 Pile Analyzing

[_____] working days prior to driving the [test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and must prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer must be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] blows per mm blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.1.3 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring must determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

a. Blow number.

b. Blow rate per minute and stroke.

c. Input and reflected values of force and velocity.

d. Value of upward and downward traveling force wave with time.

e. Maximum and final transferred energy to pile, hammer system efficiency.

f. Maximum compressive stress, velocity, acceleration and displacement.

g. Maximum tensile stress in pile.

h. Pile structural integrity, damage detection, extent and location.

i. Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.1.4 CAPWAP

Signal matching analysis by CAPWAP software of the dynamic pile testing data must be performed on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of[test] pile driving, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as

directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the[test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant) are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.1.5 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. The report for the Dynamic Pile Analysis must contain the following information:

(1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

(2) Maximum and final transferred energy, hammer system efficiency during pile installation.

(3) Maximum compressive stress, velocity, acceleration and displacement.

(4) Maximum tensile stress in pile.

(5) Pile structural integrity, damage detection, extent and location.

(6) Blows per minute and blow number.

(7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

(8) Pile skin friction and toe resistance distribution.

(9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and must include the effects of load transfer to the soil above the foundation stratum.

Use either a Model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, must be furnished by the Contractor's Geotechnical Consultant. The equipment must conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

3.3.2 Static Load Tests

****
NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure kN kips corresponding to 200 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.
****

Submit details and procedures for Pile load test frame.

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours] [_____ days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips for compressive load tests. Consider load test satisfactory when[after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,][slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,][net settlement after removal of test load does not exceed 19 mm 3/4 inch]. Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.2.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

3.3.3 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Additional signal matching analysis must be performed as determined by the Engineer.

3.3.4 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M. Lateral load tests must consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.5 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

****

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NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations,[batter alignment,] number of blows required for each 300 mm

foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof[as required] for the "calculated"[driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions,[jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings every 300 mm 12 inches of pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

[3.3.6 Testing Agency Qualification

Engage an independent testing agency to observe the production piles installation. The testing agency must be qualified according to ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

]3.3.7 Welding Inspection

Employ a testing agency to perform the welding inspections as specified in the statement of special inspection.

3.3.8 Weld Testing

In addition to visual inspection, welds must be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.[Test [10] [_____] percent of pile splices, the steel pile cap splice connections and the steel pile insert connection.]

a. Liquid Penetrant Inspection: ASTM E165/E165M.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Radiographic Inspection: ASTM E94/E94M, minimum quality level "2-2T."

d. Ultrasonic Inspection: ASTM E164.

3.4 TOUCHUP PAINTING

Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC PA 1. Use same paint and apply same number of coats as specified. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

[3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.6 VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary for 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 [5] [_____] 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 [2.0] [_____] 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.

][3.7 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria or requirements as necessary for 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, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] 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.

][3.8 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria or requirements as necessary for 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.

][3.9 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. Submit interim and final instrumentation and monitoring program reports.

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 --