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USACE / NAVFAC / AFCEC / NASA | UFGS-31 62 19 (November 2020)
Change 1 - 05/22

Preparing Activity: NAVFAC | Superseding
UFGS-31 62 19 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

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SECTION 31 62 19

TIMBER PILES

11/20, CHG 1: 05/22

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SECTION 31 62 19

TIMBER PILES
11/20, CHG 1: 05/22

****
NOTE: This guide specification covers the requirements for procurement, installation, and testing of land and fresh water construction timber piles.

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).
****

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NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
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NOTE: Add requirements for materials and procedures for special or unusual design as necessary to fit specific projects. Specify marine piling for waterfront and other marine (salt water) type structures in another section of the project specification. Marine and Highway construction use of round piles requires the review of AWPA use categories 5A, 5B and 5C subject to geographical location.

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NOTE: Show, as a minimum, the following information on the project drawings:

Subsurface data: Subsurface-soil-data logs.

The subsoil investigation report and samples of material taken from subsurface investigations may be examined in the office where bids are received, the office of the Resident Officer in Charge of Construction, and the Architect/Engineer's office.

Pile location plan with GPS coordinates.

Test Pile Locations

****

PART 1 GENERAL

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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 timber 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.

****

NOTE: The American Wood Protection Association (AWPA) has recently adopted many new Standards (2006 Book of Standards) as well as establishing the new USE CATEGORY SYSTEM: User Specification for Treated Wood. Specifiers are advised to familiarize themselves with the latest standards and their relationship to the specific project requirements and environmental considerations. Specifiers should refer to Section 3 of U1 and review the following use categories prior to editing this guideline specification:

"4C" for wood foundation piles used for building construction completely embedded in soil (ground contact).

"4C" for round piles used for highway construction (ground contact or fresh water.

"4B" for sawn piles supporting residential /business structures.

"4C" for sawn piles supporting residential/business structures, critical.

Specifier should also refer to Section 3 of AWPA U1.

The existence of the AWPA Standards for treated products does not imply that all other regulatory bodies recognize or permit the use of the particular combination of preservatives, processes, and wood species listed in the AWPA Standards.

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AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA A1	(2015) Standard Methods for Analysis of Creosote and Oil-Type Preservatives
AWPA A2	(2015) Standard Methods for Analysis of Waterborne Preservatives and Fire-Retardant Formulations
AWPA M1	(2021) Standard for the Purchase of Treated Wood Products
AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M3	(2016) Standard for the Quality Control of Preservative Treated Products for Industrial Use
AWPA M4	(2023) Standard for the Care of

	Preservative-Treated Wood Products
AWPA M6	(2013) Brands Used on Preservative Treated Materials
AWPA P1/P13	(2019) Standard for Creosote Preservative
AWPA P2	(2019) Standard for Creosote Solutions
AWPA P3	(2019) Standard for Creosote - Petroleum Oil Solution
AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA T1	(2023) Use Category System: Processing and Treatment Standard
AWPA U1	(2023) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D25	(2012; R 2017) Standard Specification for Round Timber Piles
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 E329	(2021) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

U.S. DEPARTMENT OF DEFENSE (DOD)

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

1.3 SUBSURFACE DATA

Subsurface soil data logs are [indicated] [appended to the special contract requirements] [provided on the project drawings].[The subsoil

investigation report may be examined at [_____].]

1.4 BASIS OF BID

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

Base bids on the number, circumference of piles at the butt and tip, and length of piles from tip to cutoff as indicated. 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].[Test piles that meet performance requirements may be included into the permanent work.]

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:

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

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

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.

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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 (UNIT PRICES) 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 Timber Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent timber 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 permanent timber 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 Timber Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving permanent timber 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

Permanent timber 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 Timber 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 Timber Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Timber Piles". The cost of pulling undamaged piles will be paid

for at twice the applicable contract unit price for payment item "Driving Timber 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 Timber 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 Timber Piles" and "Driving Timber Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent timber piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph FURNISHING AND DELIVERING TIMBER PILES. Pulling undamaged timber piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph DRIVING TIMBER PILES. Redriving pulled undamaged timber piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph DRIVING TIMBER PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraphs FURNISHING AND DELIVERING TIMBER PILES and DRIVING TIMBER PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Timber 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

Timber 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 Timber 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

Timber 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 Timber Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with timber 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

Timber 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 Timber Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with timber 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

Timber 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 Timber Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with timber 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

Timber 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 Timber Piles

1.5.9.1 Payment

Payment will be made for costs associated with load test timber 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 "Timber 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 Timber Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Timber 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 "Timber Piles for Load Tests".

1.5.9.2 Measurement

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

1.5.9.3 Unit of Measure

As specified in paragraph UNIT PRICES, subparagraphs DRIVING TIMBER PILES and TIMBER PILES FOR LOAD TESTS, respectfully.

][1.5.10 Pile Driving Shoes

1.5.10.1 Payment

Payment will be made for costs associated with pile driving shoes, 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 Timber Pile Splices

1.5.11.1 Payment

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

1.5.11.2 Measurement

Timber 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, Air Force, and NASA projects.

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

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

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

SD-01 Preconstruction Submittals

Testing Agency Qualifications; G[, [_____]]

SD-02 Shop Drawings

Installation Drawings; G[, [_____]]

SD-03 Product Data

Driving Equipment; G[, [_____]]

Helmets and Cushion Blocks; G[, [_____]]

Pile Shoes; G[, [_____]]

SD-04 Samples

Test Piles; G[, [_____]]

SD-06 Test Reports

[Pile Driving Test Data; G[, [_____]]

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

][Dynamic Testing Of Piles

] Test Piles; G[, [_____]]

Load Tests; G[, [_____]]

SD-07 Certificates

Timber Piles; G[, [_____]]

SD-11 Closeout Submittals

Pile Driving Records; G[, [_____]]

1.7 DELIVERY, STORAGE, AND HANDLING

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 3 meters 10 feet or less along its length (ends inclusive). Do not stack piles more than 1.5 meters 5 feet high. Use methods for handling and storage of piles such that the piles are not subjected to excessive bending stress.

Load, unload or transfer treated wood products using procedures specified in AWPA M4. Use slings, padding, or any method to prevent or minimize damage to treated wood products. Treat any damage sustained during handling as specified above.

Untreated piles to be stored for an extended period of time must be inspected periodically, as well as shortly before driving, to detect damage due to fungus and insect attack. If treated piles are to be stored in a horizontal position for an extended period of time, they must be inspected periodically to ensure that the treatment does not seep to the lower half of the pile to the extent that the upper half does not contain a sufficient amount of treatment. Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Maximum permissible curvature is 50 mm 2 inches over the length of the pile. Piles having excessive curvature will be rejected.

1.7.1 Damaged Piles

Inspect each pile for soundness, splits, knots and holes before transporting them to the project site and immediately prior to placement in the driving leads. Bring any unusual pile conditions 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 integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

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

a. The pile is spliced (if approved).

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

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

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

b. As directed by the structural engineer.

1.7.2 Pile Sweep

****
NOTE: Sweep and camber typically apply to steel piles. In special cases, this paragraph may apply to precast/pre-stressed concrete piles or timber piles.
****

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 ASSURANCE

The producer must brand each treated pile, in accordance with AWPA M1, AWPA M2, AWPA M6, AWPA T1 and AWPA U1. Submit the inspection report of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA Standards, and that the plant conforms to AWPA M3.

1.9 PLANT INSPECTION

The Government, at its discretion, reserves the right to inspect the treating process. Notify the Contracting Officer at least 3 weeks prior to beginning the treatment, stating where preservative treatment will be done. Allow Government inspector access to all parts of the plant. Allow inspection of all facets of the treating process.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Piles

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

****
NOTE: The option below covers piles pressure treated with a preservative for land or fresh water. Specify or indicate on the drawings the minimum butt or tip circumference of the pile. Use butt circumference for a friction pile and tip circumference for an end-bearing pile.

****

****

NOTE: For NAVFAC LANT projects only, the following minimum circumferences normally apply:

Capacity (metric tons)	Minimum Butt Circumference for Friction Piles (Use Table 1. ASTM D25) (mm)	Minimum Tip Circumference for End-Bearing Piles (Use Table 2. ASTM D25) (mm)
(18)	(965 mm)	(483 mm)
(23)	(965 or 1041 mm)*	(559 mm)
(27)	(1041 mm)	(635 mm)
*Depends on specific soil conditions encountered at the site.		

Capacity (tons)	Minimum Butt Circumference for Friction Piles (Use Table 1. ASTM D25) (inches)	Minimum Tip Circumference for End-Bearing Piles (Use Table 2. ASTM D25) (inches)
(200	(38 inches)	(19 inches)
(25)	(38 or 41 inches)*	(22 inches)
(30)	(41 inches)	(25 inches)
*Depends on specific soil conditions encountered at the site.		

****

[Provide pressure treated Douglas fir or southern pine clean-peeled piles conforming to ASTM D25. Minimum [butt circumference measured at 900 mm 3 feet from the butt] [tip circumference] must be [[_____] mm inches] [as indicated]. Piles must be in one piece. Splicing is [not] permitted.] Submit the inspection report of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA Standards. Identify treatment on each piece by the quality mark of an agency accredited by the Board of Review of the America Lumber Standard Committee.

****

NOTE: The option below covers piles for use in construction where preservative treatment is not required. Specify or indicate on the drawings the minimum butt or tip circumference of the pile. Use butt circumference for friction piles and tip circumference for an end-bearing pile.

Numerous species of high density wood (Walaba, Purple Heart, etc.) are available for applications of untreated piles where environmental conditions prohibit the use of preservatives. Insert selected species in the blank provided below.

****

[Provide untreated [Douglas fir or southern pine] [_____] [clean-peeled] [rough-peeled] [unpeeled] piles conforming to ASTM D25, AWPA T1, and AWPA U1. Minimum [butt circumference measured at 900 mm 3 feet from the butt] [tip circumference] must be [[_____] mm inches] [as indicated]. Piles must be in one piece.[Splices are not permitted.][Splices are permitted.]] A straight line drawn from the center of the butt to the center of the tip must lie entirely within the body of the pile per ASTM D25.[Ensure a continuous taper from the point of butt measurement to the tip.]

2.1.2 Preservative Treatment

****

NOTE: This paragraph covers preservative and preservative treatment for land or fresh water piling. Compliance with treatment standards must be confirmed, by an inspection report from an approved independent inspection agency, on each pile. Select appropriate treatment for intended use. Do not use CCA, ACA, or ACZA treatment for round timber piles when significant bending or impact loads are expected.

****

Provide [round] piles[conforming to ASTM D25 and AWPA T1] treated with [creosote per AWPA A1, AWPA P1/P13, and AWPA P2], [or] [creosote-coal tar solution conforming to AWPA A1, AWPA P1/P13, and AWPA P3] [waterborne preservative either, Ammoniacal Copper Arsenate (ACA), Ammoniacal Copper Zinc Arsenate (ACZA), or Chromated Copper Arsenate (CCA) in accordance with AWPA A2 and AWPA P5] for Land and Fresh Water Piles, confirmed by the report of an approved independent inspection agency.

[Treat cut, bored, dappled, and damaged surfaces as specified in AWPA M4[project requirements].]

2.2 PILE DRIVING EQUIPMENT

Provide Pile Driving Equipment as mentioned in this section.

2.2.1 Pile Hammers

Provide a hammer capable of developing the indicated ultimate pile capacity at blow count less than 100 per 300 mm foot considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered.[Use the same pile hammer, operating at the same rate and in the same manner, as that used for driving test piles.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. At final driving, operate pile hammer in accordance with manufacturer's recommendation. Provide the plant and equipment for air hammers that have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The hose connecting the compressor with the hammer must be at least the minimum size recommended by the Manufacturer. Evaluate hammer performance at the end of driving by measuring blows per minute and comparing with the manufacturer's recommendations. Measure impact velocity of open-end (single acting) diesel hammers at all times during pile driving operations with a device for this purpose. If such a

device is not available, obtain the stroke by measuring the speed of operation either manually or with a device that makes the measurement automatically. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge in good working order, mounted near ground level so as to be easily read by the Contracting Officer. Provide a correlation chart of bounce chamber pressure and potential energy. Equip hydraulic hammers 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.

2.2.2 Driving Helmets and Cushion Blocks

2.2.2.1 Driving Helmets or Pile Cushions

Use a steel driving helmet or pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet.[During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function.] Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Select the pile cushion thickness placed on the pile head prior to driving by wave equation analysis so that the limiting driving stresses are not exceeded. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, and pile cushions. Submit 2 weeks prior to [test] pile installation.

2.2.2.2 Hammer Cushion

****

NOTE: Select either wood or aluminum/micarta cushion. Delete inappropriate sentences. An aluminum/micarta cushion is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a Wave Equation analysis, the type of cushion used should be the same as that used in the analysis.

****

Use a hammer cushion between driving helmet or cap and hammer ram consisting of [a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing] [aluminum and micarta (or equal) discs stacked alternately in a steel housing or a suitable polymer designed for this specific purpose as indicated by the hammer manufacturer]. Use steel plates at top and bottom of hammer cushion.[Replace hammer cushion when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner].[Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner].[Do not replace hammer cushion during final driving of any pile.] Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

If the cushion is other than that specified above, submit to the Contracting Officer at least two weeks prior to the commencement of test

pile driving, detailed drawings and records of previous successful use. Generally, follow the pile hammer manufacturer's recommendations with respect to hammer cushions.

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Installation Drawings

Submit pile installation drawings at least 28 calendar days prior to installation. Drawings must indicate individual pile numbers,sequencing, and any phasing or special installation considerations.

3.1.2 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 capblock 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.

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

Wood

Compression - 20.7 MPa 3 ksi
Tension - 20.7 MPa 3 ksi Qa Allowable static timber stress

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.

3.1.3 Pile Length Markings

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

tip.

3.2 PILE DRIVING

3.2.1 Driving Piles

****

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].[Submit pile driving test data and reports of the dynamic testing of piles within one [day] [week] after each test is completed.]

[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.] Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting.[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. Do not handle or move piles or pile sections in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.2 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.] Square top of pile to longitudinal axis of 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.

3.2.3 Pile Placement and Tolerances in Driving

****

NOTE: Omit references to batter piles when not applicable to the project. Select appropriate tolerances for type of pile. Use more stringent criteria as necessary based on the application. Confirm with the structural engineer.

****

Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 100 mm 4 inches of location indicated.[Manipulation of piles within specified tolerances [will not be permitted.] [will be permitted, to a maximum of 1-1/2 percent of their exposed length above ground surface or mudline.]] In addition to specified tolerances, maintain a location to provide a clear distance of at least 125 mm 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Piles must be monitored for heave immediately after installation and after adjacent piles are installed. If piles heave more than 13 mm 1/2 inch notify the Contracting Officer Redrive heaved piles to required point elevation. Piles damaged or driven outside the above tolerances must be replaced, or additional piles driven at locations specified by the Contracting Officer at no expense to the Government.

3.2.4 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.

3.2.5 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 which damage the concrete.] 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.]

3.2.6 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.]

3.2.7 Pile Splices

****

NOTE: Timber pile splices are difficult and undesirable. AASHTO(2010) LRFD Bridge Construction

Specifications state that timber piles should not be spliced unless specified in the contract documents and approved by the engineer.
****

[Splicing of piles is not permitted.][Make splices as indicated in the contract drawings.][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.]

3.2.8 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted. Remove cut-off sections of piles from the site and off government property upon completion of the work.

3.2.9 As-Driven Survey

After the driving of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.10 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] [_____].

3.2.11 Pile Shoes

Where indicated or directed, securely attach pile shoes of an approved design to the piles in a manner described in the detail drawings.

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.[Submit pile driving analyzer data and resport within one [day] [week] after each test is completed.]

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

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 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

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, as modified [and] in paragraph LOAD TESTS. 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 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, as modified [and] in paragraph LOAD TESTS. 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.

3.3.5 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.

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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 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: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Submit complete and accurate pile driving records of installed piles to Contracting Officer within [15] [_____] calendar days after completion of pile driving. Make pile driving records available to the Contracting Officer at the job site, within 24 hours after each day of pile driving. Preparation of the record must be by, or under the direct supervision of a registered professional engineer.

3.3.6 Testing Agency Qualifications

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

[3.4 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 3-301-01, "Structural Engineering".

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.

][3.5 VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.
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Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of 61 meters 200 feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable

to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [five] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

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

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

][3.6 NOISE CONTROL

****

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

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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 [five] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

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

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

][3.7 PRECONSTRUCTION CONDITION SURVEY

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

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

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

Add any additional criteria or requirements as necessary for the particular project.
****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and

distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

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

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

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

] -- End of Section --