
USACE / NAVFAC / AFCEC / NASA UFGS-31 62 16.16 (November 2011)

Preparing Activity: NAVFAC Superseding
UFGS-31 62 16.16 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated January 2014

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 62 16.16

STEEL H-PILES

11/11

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 BASIS FOR BIDS AND PAYMENT
 - 1.2.1 Principal Sum
 - 1.2.2 Unit Price
 - 1.2.2.1 Payment and Measurement for Furnishing and Delivering Piles
 - 1.2.2.2 Payment and Measurement for Driving Piles
 - 1.2.2.3 Payment and Measurement for Pulled Piles
 - 1.2.2.4 Payment and Measurement for Driving Tests
 - 1.2.2.5 Payment and Measurement for Load Tests
 - 1.2.2.6 Payment and Measurement for Compressive Load Tests
 - 1.2.2.7 Payment and Measurement for Tensile Load Tests
 - 1.2.2.8 Payment and Measurement for Lateral Load Tests
 - 1.2.2.9 Payment and Measurement for Pulled Load Test H-Piles
 - 1.2.2.10 Payment and Measurement for Steel H-Pile Points
 - 1.2.2.11 Payment and Measurement for Steel H-Pile Caps
 - 1.2.2.12 Payment and Measurement for Steel H-Pile Splices
 - 1.2.2.13 Payment and Measurement for Steel H-Pile Tension Anchors
- 1.3 SUBMITTALS
- 1.4 DELIVERY, STORAGE, AND HANDLING
 - 1.4.1 Delivery and Storage
 - 1.4.2 Handling

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 H-Piles
 - 2.1.2 Pile Splices
 - 2.1.3 Pile Points
 - 2.1.4 Pile Caps
 - 2.1.5 Pile Tension Anchors
 - 2.1.6 FABRICATION
 - 2.1.6.1 Pile Splices
 - 2.1.6.2 [Pile Caps,] [Pile Points,] [Pile Tension Anchors]

PART 3 EXECUTION

- 3.1 PILE DRIVING EQUIPMENT
 - 3.1.1 Pile Driving Hammers
 - 3.1.1.1 Impact Hammers
 - 3.1.1.2 Vibratory Hammers
 - 3.1.2 Pile Driving Leads
 - 3.1.3 Pile Extractors
 - 3.1.4 Jetting Equipment
- 3.2 INSTALLATION
 - 3.2.1 Lengths of Job Piles
 - 3.2.2 Pile Driving Records
 - 3.2.3 Pile Placement and Tolerances in Driving
 - 3.2.3.1 Survey Data
 - 3.2.4 Pile Penetration Criteria
 - 3.2.5 Pile Driving
 - 3.2.5.1 Splicing Piles
 - 3.2.5.2 Jetting
 - 3.2.5.3 Predrilling
 - 3.2.5.4 Heaved Piles
 - 3.2.5.5 Pulled Piles
 - 3.2.5.6 Long Piles
 - 3.2.5.7 Welding
- 3.3 PILE TESTS
 - 3.3.1 Test Piles
 - 3.3.2 Pile Driving Tests
 - 3.3.3 Dynamic Testing of Piles
 - 3.3.3.1 Test Piles
 - 3.3.3.2 Job Piles
 - 3.3.3.3 Reports
 - 3.3.4 Pile Load Tests
 - 3.3.4.1 Compressive Load Test
 - 3.3.4.2 Tensile Load Test
 - 3.3.4.3 Lateral Load Test
 - 3.3.5 Safe Design Capacity
- 3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC / NASA UFGS-31 62 16.16 (November 2011)

Preparing Activity: NAVFAC Superseding
UFGS-31 62 16.16 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2014

SECTION 31 62 16.16

STEEL H-PILES

11/11

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 items(s) or insert appropriate information.

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

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

NOTE: Use Section [31 62 19](#) TIMBER PILES.
Use Section [31 62 23](#) COMPOSITE PILES.

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

1.1 REFERENCES

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

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

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

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

AMERICAN WELDING SOCIETY (AWS)

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

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M (2013) Standard Specification for Steel Castings, Carbon, for General Application

ASTM A36/A36M (2012) Standard Specification for Carbon Structural Steel

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

ASTM A588/A588M (2010) Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance

ASTM A690/A690M	(2013a) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM 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) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2012) High-Strain Dynamic Testing of Piles

1.2 BASIS FOR BIDS AND PAYMENT

NOTE: Select one of the following options:

NOTE: Use "Principal 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.

[1.2.1 Principal Sum

[Base bids on the number, size, and length of piles from tip to cutoff as indicated. Include in bids the retapping of piles to confirm pile capacity and/or redriving of heaved piles to the required tip elevation as directed by the Contracting Officer. Base bids on retapping/redriving [100] [_____] percent of the job piles. [Provide test piles [1.5] [_____] meter [5] [_____] feet longer than bid length piles.] [Base bids on the number of load tests indicated or specified.]

From the data obtained as a result of driving the test piles [and load tests] specified herein, the Government will determine and will list for the Contractor the calculated pile tip elevations, the driving resistance for piles, or both. The information will be given to the Contractor no later than [3] [_____] working days after receipt of complete test pile

data. Use this list as the basis for ordering piles. Do not order production piles prior to receipt of the above information from the Government. Should the total number of piles or number of each length vary from that specified as the basis for bidding, the contract price will be adjusted in accordance with Contract Clause entitled "Changes." Adjustment in contract price will not be made for cutting off piles, for any portion of a pile remaining above the cutoff elevation, or for damaged or rejected piles.]

NOTE: For NAVFAC LANT projects, select one of the following options for basis for bids. Use first option below for lump sum bidding of piles. Use second option for unit price bidding of piles.

Base bids on providing [] steel H-piles totaling [] linear meters [] linear feet on the assumed pile length of [] meters [] feet from tip to cutoff. Pile length provided over [] meters [] feet for ease of installation are the responsibility of the Contractor. Provide splices [in accordance with the detail indicated] [as specified]. Continuously drive piles to a minimum depth of [] meters [] feet below the cutoff elevation and to such additional depth as required to obtain a bearing capacity of not less than [] kilonewtons [] tons. Use the following formula as a guide in establishing the controlling penetration per blow which, together with the minimum depth of penetration ([] meters [] feet below cutoff elevation) serves to determine the required depth of penetration of each individual pile:

$$R=2E/(S \text{ plus } 0.1) \text{ for double acting hammers}$$

$$R=2WH/(S \text{ plus } 0.1) \text{ for single acting hammers}$$

in which R is the approximate allowable pile load in pounds, E equals the energy in foot-pounds per blow based on an acceptable certified statement from the manufacturer of the hammer, W equals the weight of the hammer or ram in pounds, H equals the fall of the hammer or ram in feet, and S equals the average inches of penetration per blow for the last three blows. If after driving a pile to [] meters [] feet tip penetration below cutoff elevation and a bearing capacity of [] kilonewtons [] tons is not achieved, notify the Contracting Officer. Take corrective action as directed by the Contracting Officer, such as splicing additional pile length and driving to greater depth. An adjustment to the contract cost will be made for Contracting Officer authorized corrective action required due to inadequate bearing capacity. No reduction in price is required for piles driven shorter than the specified tip to cutoff length when the requirements for minimum penetration and bearing capacity have been met. Include all costs incidental to providing steel H-piles in the lump sum contract price bid, including furnishing and driving piles, mobilization, cutting off piles at cutoff elevation, splices (except those as directed by the Contracting Officer as corrective action due to required bearing not being achieved), retapping of piles to confirm pile capacity, redriving of heaved piles to the required tip elevation, pile coatings, and providing driving records. Base bids on retapping/redriving [100] [] percent of the job piles.

] [1.2.2 Unit Price

NOTE: For NAVFAC PAC projects: Select the first bracketed text and edit applicable "Unit Prices Form" in Section 00 41 00 BID SCHEDULES for inclusion in Standard Form 1442, "Solicitation, Offer and Award".

[For unit price bid, see [SF 1442, SOLICITATION, OFFER AND AWARD and "Schedule of Bid Items."] [Section 00 41 00, BID SCHEDULES.]]

NOTE: For NAVFAC LANT projects, select one of the following options for basis for bids. Use first option below for lump sum bidding of piles. Use second option for unit price bidding of piles.

[Payment will be at the contract unit price per unit length, including test piles, multiplied by the total length of acceptable piles actually installed. Work includes furnishing labor, materials, tools, equipment, and incidentals required for installing piles including [test piles,] [load tests,] [jetting,] [predrilling,] pile cutoff, redriving, and removal and replacement of damaged, mislocated, or otherwise rejected piles. Include in bids the retapping of piles to confirm pile capacity and/or redriving of heaved piles to the required tip elevation as directed by the Contracting Officer. Base bids on retapping/redriving [100] [_____] percent of the job piles. Provide test piles [1.5 m] [5 feet] [_____] longer than bid length piles. Base bids on the number of piles with pile length from tip to cutoff, as indicated, and on total length of piling from tip to cutoff, including test piles, as specified [in the document titled "Supplementary Instructions to Bidders."]. Include in bid a unit price per [load test[s] and] linear foot of piling based on the quantity [indicated] [stated in document titled "Supplementary Instructions to Bidders."]. From the data obtained as a result of driving the test piles [and load tests] specified herein, the Government will determine and list for the Contractor the calculated pile tip elevations, the driving resistance for piles, or both. Information will be given to the Contractor no later than 3 working days after receipt of complete test pile data. Use this list as the basis for ordering piles. Do not order job piles prior to receipt of the above information from the Government. If the Contracting Officer requires an increase or a decrease in the length of piles furnished and installed, the contract will be adjusted in accordance with "FAR 52.211-18, Variations in Estimated Quantities." [Adjustment in contract price will also be made for each increase or decrease in number of pile load tests.]]

NOTE: For USACE (Army) projects, use and edit the appropriate following paragraph(s). Do not use for Navy projects.

NOTE: If Section 01 22 00.00 10 MEASUREMENT AND PAYMENT is included in the project specifications, delete paragraph title Unit Prices from this section and the remaining appropriately edited subparagraphs

below should be inserted into Section 01 22 00.00 10.

1.2.2.1 Payment and Measurement for Furnishing and Delivering Piles

Payment will be made for costs associated with furnishing and delivering the required lengths of job piles to the work site. No payment will be made for the lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, handling, or driving to the extent that they are determined by the Contracting Officer to be unsuitable for the work.

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

1.2.2.2 Payment and Measurement for Driving Piles

Payment will be made for costs associated with driving job piles, which includes costs of handling [,] [and] driving, [and splicing] piles, [furnishing, installing, and operating a pile driving analyzer,] measuring pile heave, redriving heaved piles, cutting off piles at the cutoff elevation and removing cutoffs 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. No payment will be made for misplaced piles or piles exceeding the maximum limits for rotation, lateral deviation, and variation in alignment. No payment will be made for piles impaired during driving to the extent that they are determined by the Contracting Officer to be unsuitable for the work.

Job piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth of a linear meter tenth of a linear foot along the axis of each pile acceptably in place below the cutoff elevation shown.

1.2.2.3 Payment and Measurement for Pulled Piles

Payment will be made for costs associated with pulling piles, as directed, 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[s] "Furnishing and Delivering Steel H-Piles" [and "Pile Points"]. The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item[s] "Driving Steel H-Piles" [and "Pile Splices"]. 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, backfilling voids, and disposing of piles[, including [pile points] [and] [pile splices,]] pulled and found to be damaged. 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".

Furnishing and delivering pulled and undamaged piles will be measured for payment as specified in paragraph "Furnishing and Delivering Steel H-Piles". Pulling undamaged piles will be measured for payment as specified in paragraph "Driving Steel H-Piles". Redriving pulled,

undamaged piles will be measured for payment as specified in paragraph "Driving Steel H-Piles". New piles replacing damaged piles will be measured for payment as specified in paragraph "Furnishing and Delivering Steel H-Piles" and "Driving Steel H-Piles".

1.2.2.4 Payment and Measurement for Driving Tests

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driving test piles[, including [pile points] [and] [pile splices]]; conducting pile driving tests; backfilling voids around piles; compiling pile driving test records [; and furnishing, installing, and operating a pile driving analyzer and reducing its data].

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

1.2.2.5 Payment and Measurement for Load Tests

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles[, including [pile points] [and] [pile 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] [; and furnishing, installing, and operating a pile driving analyzer and reducing its data]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

Steel H-piles for load tests will be measured for payment on the basis of the number of load test piles (each) required.

1.2.2.6 Payment and Measurement for Compressive Load Tests

Payment will be made for costs associated with steel H-pile compressive load tests, 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 compressive load tests.

Steel H-pile compressive load tests will be measured for payment on the basis of the number (each) of compressive load tests required.

1.2.2.7 Payment and Measurement for Tensile Load Tests

Payment will be made for costs associated with steel H-pile tensile load tests, 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 tensile load tests.

Steel H-pile tensile load tests will be measured for payment on the basis of the number (each) of tensile load tests required.

1.2.2.8 Payment and Measurement for Lateral Load Tests

Payment will be made for costs associated with steel H-pile lateral load tests, 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.

Steel H-pile lateral load tests will be measured for payment on the basis of the number (each) of lateral load tests required.

1.2.2.9 Payment and Measurement for Pulled Load Test H-Piles

Payment will be made for costs associated with load test H-piles pulled prior to load testing as directed 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 "Steel H-Piles for Load Tests". The cost of pulling undamaged load test piles the second time after re-driving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Steel H-Piles". The cost of re-driving 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 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 "Steel H-Piles for Load Tests".

Pulled undamaged load test H-piles will be measured for payment as specified in paragraph "Steel H-Piles for Load Tests". Pulling undamaged load test steel H-piles, the second time after re-driving and testing will be measured for payment as specified in paragraph "Driving Steel H-Piles". Re-driving pulled, undamaged steel H-piles will be measured for payment as specified in paragraph "Steel H-Piles for Load Tests". New load test H-piles replacing damaged piles will be measured for payment as specified in paragraph "Steel H-Piles for Load Tests".

1.2.2.10 Payment and Measurement for Steel H-Pile Points

Payment will be made for costs associated with steel H-pile points, including furnishing and delivering, pile preparation for installing pile points, and installing the pile points.

Steel H-pile points will be measured for payment on the basis of the number (each) of steel H-pile points required.

1.2.2.11 Payment and Measurement for Steel H-Pile Caps

Payment will be made for costs associated with steel H-pile caps, including furnishing and delivering, pile preparation for installing pile caps, and installing the pile caps.

Steel H-pile caps will be measured for payment on the basis of the number (each) of steel H-pile caps required.

1.2.2.12 Payment and Measurement for Steel H-Pile Splices

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

Steel H-pile splices will be measured for payment on the basis of the number of steel H-pile splices required.

1.2.2.13 Payment and Measurement for Steel H-Pile Tension Anchors

Payment will be made for costs associated with steel H-pile tension anchors, including furnishing and installing pile tension anchors.

Steel H-pile tension anchors will be measured for payment on the basis of the number of steel H-pile tension anchors required.

] 1.3 SUBMITTALS

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

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

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

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

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

SD-02 Shop Drawings

[Pile splices[; G][; G, [____]]]
[Submit detail drawings of pile splices prior to fabrication.]

Pile placement[; G][; G, [____]]
Submit pile placement plan at least 30 days prior to delivery of piles to the job site.

[Pile reinforcing tips or steel points]

[Pile encasements]

SD-03 Product Data

Pile driving equipment[; G][; G, [____]]
Submit descriptions of pile driving equipment at least 30 days prior to commencement of work.

Pile driving records[; G][; G, [____]]
Submit the proposed form for compiling pile driving records 30 days prior to commencement of work.

Delivery, storage, and handling[; G][; G, [____]]
Submit delivery, storage, and handling plans for piles at least 30 days prior to delivery of piles to the job site.

[Pile tests[; G][; G, [____]]]
[Submit pile load test plan at least 30 days prior to installing any test piles. Approval of the plan shall not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.]

SD-04 Samples

Test piles[; G][; G, [____]]

SD-05 Design Data

[Wave equation analysis]
[Submit wave equation analysis.]

SD-06 Test Reports

[Pile driving tests[; G][; G, [____]]]
[Submit pile driving test data within one (1) [day] [week] after each test is completed.]

[Pile driving analyzer[; G][; G, [____]]]
[Submit pile driving analyzer data within one (1) [day] [week] after each test is completed.]

[Pile load tests[; G][; G, [____]]]
[Submit four copies of the load test report for each pile tested within one (1) [day] [week] after the load test is completed.]

[Dynamic testing of piles]
[Submit reports of the dynamic testing of piles within one (1) [day] [week] after dynamic testing is completed.]

SD-11 Closeout Submittals

Pile driving records

Submit [to the Contracting Officer] complete and accurate [test and] job pile driving records as specified in paragraph entitled "Records" of this section, within [15] [_____] calendar days after completion of driving.

1.4 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.

1.4.1 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.

1.4.2 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, except that a one-point pick-up may be used for lifting piles that are not extremely long into the driving leads. 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 drag piles across the ground.

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.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 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.] [Coat piles in accordance with Section 09 97 13.26 COATING OF STEEL WATERFRONT STRUCTURES.] [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. Determine lengths of piles as specified in paragraph "Installation," subparagraph "Lengths of Job Piles" [and paragraph "Pile Tests," subparagraph "Test Piles"].

2.1.1.2 [Pile Splices

[[ASTM A36/A36M] [ASTM A572/A572M, Grade [____]] [ASTM A588/A588M] for splice plates.] [Materials for pile splices must be as specified.]

] [2.1.1.3 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 A27/A27M 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.]

] [2.1.1.4 Pile Caps

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

] [2.1.1.5 Pile Tension Anchors

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

] 2.1.1.6 [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].

] [2.1.1.6.1 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."

] 2.1.1.6.2 [[Pile Caps,] [Pile Points,] [Pile Tension Anchors]

[Attach [pile caps,] [pile points,] [and] [pile tension anchors] as shown.] [Ground the top of piles sufficiently smooth to provide a good welding surface for structural-shape pile caps.]

] PART 3 EXECUTION

3.1 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 [specified and] directed. No additional contract time will be allowed for Contractor proposed changes in the equipment.

3.1.1 Pile Driving Hammers

NOTE: When specifying the minimum driving energy, make an allowance for reduced penetration caused by shock absorption of pile caps. 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 (Metric Tons) (Tons)	Minimum Rated Hammer Driving Energy (Joules) (Foot-Pounds)
Up to 60	20,350 15,000
Over 60	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.

3.1.1.1 Impact Hammers

Provide steam, air, 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 mminch.] 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 and steam 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.] Obtain driving energy by use of a heavy ram and a short stroke with low impact velocity, rather than a light ram and a long stroke with high impact velocity. 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. Steam or 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.

3.1.1.2 [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.

]3.1.2 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[suspended leads,] fixed extended leads or
fixed underhung leads.[Operate vibratory hammers free hanging without
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 fore and aft
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].[For driving battered piles, support and guide
vibratory hammers with fixed extended leads or templates.][Provide two
intermediate supports for the pile in the leads to reduce the unbraced
length of the pile during driving and pulling.]

3.1.3 Pile Extractors

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

3.1.4 [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."

]3.2 INSTALLATION

Inspect piles when delivered and when in the leads immediately before
driving.[Handle piles so as to protect pile coatings. Repair damage or
defects in pile coatings as specified.] 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 Job Piles

The estimated quantities of piles are given for bidding purposes only. The Contracting Officer will determine the actual lengths of piles required to be driven below cutoff elevation for the various locations in the work and will furnish the Contractor a quantities list indicating lengths and locations of all piles to be installed. [These actual lengths will be determined from the results of the pile tests specified in paragraph "Pile Tests."] [The Contracting Officer will determine the number of overlength piles required to provide for variations in subsurface conditions.] Where required bearing capacities are attainable with piles of lesser length than those specified, shorter piles may be used subject to prior written approval.

3.2.2 [Pile Driving Records](#)

**NOTE: Select first sentence if specifier forms are
not used, and delete second bracketed option.**

[Develop a form for compiling pile driving records, which must be approved,] [Use the preprinted forms attached at the end of this section] for recording pile driving data.

Compile and submit accurate records of the pile driving operations on the approved form in accordance with paragraph "Submittals." Include in driving records for each pile date driven, pile identification number, cross section shape and pile dimensions, location, deviations from design location, original length, ground elevation, top elevation, tip elevation, [batter alignment,] description of hammer used, number of blows required for each **300 mm foot** of penetration throughout the entire length of the pile and for each **25 mm inch** of penetration in the last **300 mm foot** of penetration, total driving time in minutes and seconds, and any other pertinent information as required or requested such as unusual driving conditions, interruptions or delays during driving, damage to pile resulting from driving, heave in adjacent piles, redriving, weaving, obstructions, jetting, predrilling, and depth and description of voids formed adjacent to the pile.

Additional data required to be recorded for impact hammers includes the rate of hammer operation, make, size, and the length of the bounce hose. Additional data required to be recorded for vibratory hammers includes hammer power pack description, make, size, **wattage horsepower** applied to pile, and hammer operating frequency.

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. Complete all [foundation preparation [removal of unsuitable material and densification of foundation fill] 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 job piles and maintain during the installation of the job piles.

A final lateral deviation from the correct location at the cutoff elevation of not more than [75] [100] mm [3] [4] inches will be permitted for vertical [and battered] piles. [Manipulation of piles will not be permitted.] [Manipulation to move piles into position will be permitted only within the aforementioned tolerance to return the pile to the design location[, however, do not manipulate piles more than 1.5 percent of the exposed length above the [ground] [mudline] surface].] A variation of not more than 21 mm per meter 0.25 inch per foot of pile length from the vertical for vertical piles nor more than 42 mm per meter 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. With prior approval of the Contracting Officer, the Contractor may provide additional concrete and reinforcement to maintain the required minimum clear distance. Redesign of pile caps or additional work required due to improper location of piles is the responsibility of the Contractor.] [A final variation in rotation of the pile about the center line of the web of not more than 7.5 degrees is permitted.] [A vertical deviation of not more than [25] [50] mm [1] [2] inch from the correct cutoff elevations shown is permitted.] Inspect piles for heave. Redrive heaved piles to the required tip elevation. 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 rotation, lateral and vertical deviation, [and] [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 and before superimposed 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.

3.2.4 Pile Penetration Criteria

The controlling [tip elevation] [depth of penetration] [driving resistance] [refusal blow count (number of blows required to attain the final 25 mm inch of penetration)] for job piles will be determined by the Contracting Officer. [The required [tip elevation] [depth of penetration] [driving resistance] [refusal blow count] will be established subsequent to the analysis of pile tests as specified in paragraph "Pile Tests."] [Terminate driving with a vibratory hammer when the rate of penetration is less than [_____] mm inch per minute.]

3.2.5 Pile Driving

Notify the Contracting Officer 30 days prior to the date pile driving is to begin. Do not drive piles within 30 m 100 feet of concrete less than 7 days old. Drive job [and test] piles with hammers of the same model and manufacturer, same energy and efficiency, and using the same driving system. Operate hammers at all times at the speed and under the conditions

recommended by the manufacturer.[Where heave is anticipated, the sequence of installation must be such that pile heave is minimized by starting pile driving at the center of the group and proceeding outward[and by driving vertical piles prior to driving battered piles where practicable.]] Prior to driving and with the pile head seated in the hammer, check each pile to ensure that it has been aligned correctly and that the orientation of the web about the centerline is as shown. Once pile driving has begun, keep conditions such as alignment[and batter] constant.[Check and monitor the alignment of battered piles during driving with an accurate batter board level[and surveying instrument]]. Drive each pile continuously and without interruption until the required[tip elevation][depth of penetration][driving resistance][refusal blow count] has been attained. Deviation from this procedure will be permitted only when driving is stopped by causes that reasonably could not have been anticipated. A pile that can not be driven to the required depth because of an obstruction, as indicated by a sudden unexplained change in blow count and drifting, must be pulled and redriven or cut off and abandoned, whichever is directed. After piles are driven, cutoff square as required at the indicated cutoff elevation.[Cap cutoff piles as shown.] Backfill any voids around piles or abandoned holes for pulled piles with sand and compact to the same density as the surrounding soil. If, in driving, it is found that pile is not of sufficient length to give the capacity specified, notify the Contracting Officer, who will determine the procedure to be followed.

[3.2.5.1 Splicing Piles

[Splicing of piles is not permitted.] [A pile that has not reached the required refusal blow count when the top has been driven to the cutoff elevation must be spliced as shown and driven to a sufficient depth to develop the required refusal blow count.] [When approved, provide splices of the full penetration butt weld type [or proprietary prefabricated splicer sleeves.] Use only one splice per length of pile. Avoid field splices for lengths under 24 m 80 feet. Construct splices to maintain the true alignment and position of the pile sections. Splices must develop the full strength of the pile in both bearing and bending.]

3.2.5.2 Jetting

NOTE: Jetting is not generally be permitted when:

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

[Jetting of piles is not be permitted.] [Use jetting to assist driving piles through strata that can not be penetrated practicably by use of the hammer alone when authorized by the Contracting Officer. After the

penetration of the strata requiring jetting has been accomplished, discontinue jetting and resume driving with the hammer alone. Seat jetted piles by driving not less than 300 mm 1 foot after jetting has been stopped.] [Use jetting of piles in driving only when specifically authorized by the Contracting Officer.] [Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the required pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration. Jetting method and equipment must be approved by the Contracting Officer prior to commencing jetting operation.]

]3.2.5.3 Predrilling

NOTE: Predrilling is not generally be permitted when:

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

Predrilling[is permitted] [is not be permitted] [is provided]. [Discontinue predrilling when the pile tip is approximately 1.5 m 5 feet above the required pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration. Predrilling equipment and method must be approved by the Contracting Officer prior to commencing predrilling operation.]

3.2.5.4 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[depth of penetration] [tip elevation] [refusal blow count] without additional cost to the Government.

3.2.5.5 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.

3.2.5.6 Long Piles

Handle and drive piles of a high slenderness ratio carefully to prevent overstress. 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.

3.2.5.7 Welding

AWS D1.1/D1.1M.

3.3 [PILE TESTS

NOTE: This specification allows for two types of pile tests: pile driving tests and pile load tests. Pile driving tests are used to determine the blow count required to drive a pile to a given penetration or to refusal on a hard layer. Pile driving tests may be performed with a pile driving analyzer attached to piles to record the information listed below. Pile load tests are used to determine pile capacity. The combination of pile driving tests and pile load tests gives information on pile capacity versus refusal blow count. Pile driving analyzer data may be used in some instances in place of pile load tests to reduce the number of load tests required for a project.

Pile Tests - Perform [pile driving tests] [and] [pile load tests] as [specified and as shown] [or] [as directed]. The Contracting Officer will develop the correlation between [pile driving resistance] [pile length] and pile capacity during the [pile driving tests] [and] [pile load tests] for the selected pile driving system.

Based on the correlations developed, the Contracting Officer will determine the [refusal blow count] [pile length] for the job piles. Changes in the approved pile driving system during or after completion of tests will not be allowed unless additional tests are performed as directed to establish the correlation between [driving resistance] [length] and pile capacity for the proposed changed system. For changes in the approved pile driving system proposed by the Contractor, perform required additional [pile driving tests] [and] [pile load tests] at the Contractor's expense. No additional contract time will be allowed. [In accordance with paragraph "Submittals," develop and submit a detailed pile load test plan which includes drawings as appropriate and contain the following information:

- a. Method of reacting static test loads.
- b. Method of supporting reference beams.
- c. Method of attaching and supporting dial gages for measuring pile movements.
- d. Method of applying static test load to piles.
- e. Method of setup of secondary measurement system (surveyor's level, laser beam, etc.).
- f. Details of strain rod fabrication and installation.
- g. Details of loading frame and reaction systems design, including design computations and fabrication details.

h. Calibration curves for the load cell and readout device.

[i. Details of inclinometer installation.]

Approval of the plan does not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.]

]3.3.1 [Test Piles

NOTE: Insert the number of test piles required. The number of test piles is normally between 5 and 10 percent of the total number of piles required, dependent upon the magnitude of the project. Test piles are furnished 1.5 m 5 feet longer than job piles to allow additional penetration if driving conditions dictate. Delete this paragraph if test piles are not required.

Provide [] test piles of the same size and type as specified for job piles. [Furnish test piles [1.5] [] meter [5] [] feet longer than length specified for job piles and drive the additional depth, if directed.] Provide test piles [of the indicated lengths and] place at the [indicated] [or] [directed] locations. Drive test piles with the same equipment specified in paragraph "Pile Driving Equipment" and in the same manner specified in paragraph "Pile Driving" for job piles. Record the driving record data for each test pile driven as specified in paragraph "Pile Driving Records." Provide and operate [a pile driving analyzer as specified by the manufacturer during the driving of each test pile.] If approved after test completion, include properly located test piles in the finished work. [Withdraw [] test piles after reaching the specified tip elevation to provide for visual inspection of the pile.]

]3.3.2 [Pile Driving Tests

Perform [] pile driving tests. The Contracting Officer will be present during each pile driving test. Complete all pile driving tests without interruption. Any pile driving test not accomplished in accordance with this specification must be redone at no additional cost to the Government. [Pull each driving test pile within one (1) [day] [week] after the completion of that pile driving test, document damages , and store at construction site. Remove pulled test piles from the site when directed.]

]3.3.3 Dynamic Testing of Piles

NOTE: Specify dynamic testing during initial driving if its purpose is to monitor drive system performance and driving stresses. If the purpose is to evaluate pile capacity, specify restriking of piles and dynamic testing during restrike. Restriking is best performed on test piles. Restrike driving may significantly affect the Contractor's installation sequence; therefore, identify the locations and piles to be restruck whenever possible.

[[Provide] [Employ] a specialty engineering firm to] perform dynamic testing of piles [and job piles] to determine velocity of stress wave propagation, acceleration, monitor hammer and drive system performance, assess pile installation stresses and integrity [, and to evaluate pile capacity]. Furnish personnel experienced in performing wave equation analysis, dynamic testing, and interpretation of results to install and operate the testing equipment and to interpret its results. Furnish equipment to obtain dynamic measurements, record, reduce and display its data and meet the requirement of **ASTM D4945**. The equipment must have been calibrated within 12 months thereafter throughout the contract duration. Supply all power requirements for operating the equipment. Prior to commencing pile driving, a perform and submit wave equation analysis in accordance with paragraph "Submittals."

3.3.3.1 Test Piles

**NOTE: Delete the first bracket insert if testing is
to be performed on all test piles.**

Perform dynamic testing on [_____] test piles as indicated. Perform testing during the full length of pile driving. Restrike piles which are statically load tested within 48 hours after completion of static load test to correlate static and dynamic test results. [Restrike piles installed as part of pile driving test after a minimum waiting period of [_____] days.] Warm up the hammer prior to restriking. Restrike the pile for 50 blows or until the pile penetrates an additional **75 mm 3 inches**, whichever occurs first. In the event the pile movement is less than one-quarter inch during restrike, the restrike may be terminated after 20 blows.

3.3.3.2 [Job Piles

Perform dynamic pile testing on [_____] job piles during the full length of initial driving [and during restrike driving]. Tested piles must be as [indicated] [selected by the Contracting Officer over the duration of installation]. The Contracting Officer will direct testing of additional piles if the hammer or driving system is modified or replaced.

]3.3.3.3 Reports

Prepare and submit a summary report of dynamic test results for test piles . Discuss in the report pile capacity obtained from dynamic testing as it compares to static test results computed by the Government, and also include velocity of stress wave propagation, acceleration, evaluation of hammer and driving system performance, driving stress levels, and pile integrity. Perform [a CAPWAPC, or similar, analysis of the dynamic test data on data obtained from the end of initial driving and the beginning of restrike for [_____] test piles as directed. Use the analysis to predict pile capacity, establish resistance distribution, and predict quake and damping factors.] Include refined wave equation analyses incorporating the results of dynamic testing and analysis. [For job piles, prepare and submit a field summary report . The field summary report must minimally contain energy transferred to the pile, calculated driving stresses, pile integrity and estimated pile capacity at the time of testing.] Include in the report for the test piles [and the monthly report for job piles] the pile driving record as an attachment and also address the items listed in paragraph "7.1.5 Dynamic Testing" of **ASTM D4945**.

3.3.4 [Pile Load Tests]

NOTE: Each ASTM pile load test specification listed offers a number of options as to how the test is performed. Specify the required load testing option and any modifications to include other desired requirements.

Insert the number of test piles to be load tested. The safe design capacity of a test pile as determined from the results of load test shall be the lesser of the two values computed according to the following:

1. One-half the test load which causes a settlement/movement of 0.25 mm per 907 kg 0.01 inch per ton of test load.
2. One-half the test load that causes a gross settlement/movement of 25 mm one inch provided the load-settlement curve shows no sign of failure.

Perform load tests at locations shown, or as directed. Provide testing and measuring equipment, perform loading, and provide observation facilities for personnel to inspect, record, and analyze settlement/movement and deflection of piles under test loads. Do not mobilize load test equipment until directed by the Contracting Officer. Perform pile load tests under the supervision of a registered professional engineer provided by the Contractor and experienced in conducting pile load tests. Loading frames and equipment for pile load tests must be ready to be placed in operation as soon as a load test pile has been driven. Provide loading equipment of sufficient capacity to apply the maximum load specified in a safe manner. Start loading of each test pile when directed.

The Contractor is responsible for the application of loads. Accurately determine and control the magnitude of applied loads using a calibrated load cell and readout device. The design working load, as confirmed by the results of load tests, will be determined by the Contracting Officer. Load test piles indicated or directed to be driven in permanent locations may be incorporated into the work if, after satisfactory completion of load test, they are approved for inclusion in the work. Any pile load test not accomplished in accordance with this specification will be rejected. A new pile load test must be conducted for each rejected pile load test. The Contractor must compile a report for each pile load test including, as a minimum, all applicable information required by the specified test.

]3.3.4.1 [Compressive Load Test

Perform [_____] pile compressive load tests in accordance with ASTM D1143/D1143M [, as modified]. Apply a compressive load of [_____] kN tons to each compressive load test pile.

]3.3.4.2 [Tensile Load Test

Perform [_____] pile tensile load tests in accordance with ASTM D3689[, as

modified]. Apply a tensile load of [_____] kN tons to each tensile load test pile.

]3.3.4.3 [Lateral Load Test

Perform [_____] pile lateral load tests in accordance with ASTM D3966/D3966M [, as modified]. Perform lateral load tests consisting 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 tons to each pair of lateral load test piles. Take required movement readings and record for each pile.

]3.3.5 Safe Design Capacity

Load test piles to twice the anticipated working load unless failure occurs first. The safe design capacity of a load test as determined from the results of load tests is the lesser of the two values computed according to the following:

- a. One-half the load that causes a net settlement after rebound of not more than 0.029 mm per kN 0.01 inch per ton of total test load.
- b. One-half the load that causes a gross settlement of not more than 25 mm 1 inch provided the load settlement curve shows no sign of failure.

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 paragraph 3.2 of FEMA 302, NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES.

This paragraph will be applicable to both new buildings designed according to UFC 3-310-03A "Seismic Design For Buildings", and to existing building seismic rehabilitation designs done according to UFC 3-301-05A, "Seismic Evaluation And Rehabilitation 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 3 of FEMA 302. 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.

-- End of Section --