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UFGS-02463A (May 1993)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

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### SECTION 02463A

#### STEEL H-PILES FOR CIVIL WORKS 10/01

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NOTE: This guide specification covers the requirements for furnishing all plant, 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 H-piles in accordance with these specifications and applicable drawings.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## PART 1 GENERAL

### 1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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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.

ASTM INTERNATIONAL (ASTM)

ASTM A 27/A 27M	(2003) Steel Castings, Carbon, for General Application
ASTM A 36/A 36M	(2003a) Carbon Structural Steel
ASTM A 572/A 572M	(2003a) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 690/A 690M	(2000a) High-Strength Low-Alloy Steel H-Piles and Sheet Piling for Use in Marine Environments
ASTM D 1143	(1981; R 1994e1) Piles Under Static Axial Compressive Load
ASTM D 3689	(1990, R 1995) Individual Piles Under Static Axial Tensile Load
ASTM D 3966	(1990; R 1995) Piles Under Lateral Loads
ASTM D 4945	(2000) High-Strain Dynamic Testing of Piles

1.2 UNIT PRICES

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NOTE: If Section 01270 MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01270.  
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1.2.1 Furnishing and Delivering Steel H-Piles

1.2.1.1 Payment

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

1.2.1.2 Measurement

Furnishing and delivering permanent 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].

1.2.1.3 Unit of Measure

Unit of measure: linear meter. foot.

## 1.2.2 Driving Steel H-Piles

### 1.2.2.1 Payment

Payment will be made for costs associated with driving permanent 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.

### 1.2.2.2 Measurement

Permanent 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 Unit of Measure

Unit of measure: linear meter. foot.

## 1.2.3 Pulled Piles

### 1.2.3.1 Payment

Payment will be made for costs associated with 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".

### 1.2.3.2 Measurement

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

paragraph UNIT PRICES, under "Furnishing and Delivering Steel H-Piles" and "Driving Steel H-Piles".

#### 1.2.3.3 Unit of Measure

Unit of measure: linear meter. foot.

#### 1.2.4 [Steel H-Pile Driving Tests]

##### 1.2.4.1 Payment

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].

##### 1.2.4.2 Measurement

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

##### 1.2.4.3 Unit of Measure

Unit of measure: each.

#### 1.2.5 [Steel H-Piles for Load Tests]

##### 1.2.5.1 Payment

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.

##### 1.2.5.2 Measurement

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

##### 1.2.5.3 Unit of Measure

Unit of measure: each.

#### 1.2.6 [Steel H-Pile Compressive Load Tests]

##### 1.2.6.1 Payment

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.

#### 1.2.6.2 Measurement

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

#### 1.2.6.3 Unit of Measure

Unit of measure: each.

#### 1.2.7 [Steel H-Pile Tensile Load Tests]

##### 1.2.7.1 Payment

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.

##### 1.2.7.2 Measurement

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

##### 1.2.7.3 Unit of Measure

Unit of measure: each.

#### 1.2.8 [Steel H-Pile Lateral Load Tests]

##### 1.2.8.1 Payment

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.

##### 1.2.8.2 Measurement

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

##### 1.2.8.3 Unit of Measure

Unit of measure: each.

#### 1.2.9 [Pulled Load Test H-Piles]

##### 1.2.9.1 Payment

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 redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Steel H-Piles". The cost of redriving pulled, undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Steel H-Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled 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".

#### 1.2.9.2 Measurement

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

#### 1.2.9.3 Unit of Measure

Unit of measure: as specified in paragraph UNIT PRICES, under "Driving Steel H-Piles" and "Steel H-Piles for Load Tests", respectfully.

#### 1.2.10 [Steel H-Pile Points]

##### 1.2.10.1 Payment

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.

##### 1.2.10.2 Measurement

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

##### 1.2.10.3 Unit of Measure

Unit of measure: each.

#### 1.2.11 [Steel H-Pile Caps]

##### 1.2.11.1 Payment

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.

##### 1.2.11.2 Measurement

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

1.2.11.3 Unit of Measure

Unit of measure: each.

1.2.12 [Steel H-Pile Splices]

1.2.12.1 Payment

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

1.2.12.2 Measurement

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

1.2.12.3 Unit of Measure

Unit of measure: each.

1.2.13 [Steel H-Pile Tension Anchors]

1.2.13.1 Payment

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

1.2.13.2 Measurement

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

1.2.13.3 Unit of Measure

Unit of measure: each.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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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.] The following shall be submitted in accordance with Section 01330 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 Driving Records

Submit pile driving records [daily] [weekly] [monthly] [after pile driving is completed].

#### 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.]

[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.]

### 1.4 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling of materials shall conform to the requirements specified herein and in Section 05055A METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Plans for the delivery, storage, and handling of piles shall be developed and submitted in accordance with paragraph SUBMITTALS.

#### 1.4.1 Delivery and Storage

Piles shall be stacked 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. Piles shall not be stacked more than 1.5 m 5 feet high.

#### 1.4.2 Handling

Piles shall be lifted 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 shall 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. Piles shall not be dragged across the ground. The Contractor shall inspect piles for excessive camber and sweep and for damages 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, shall be measured with the pile flange base laying on a flat surface and shall be 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, shall be measured with the pile flange tips laying on a flat surface and shall be the distance between the flange tips at the mid-length of the pile and the flat surface. The maximum permissible camber [and] [or] sweep shall be 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

Material orders, material lists and material shipping bills shall conform to the requirements of Section 05055A METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

#### 2.1.1 Steel

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**NOTE: For greater corrosion resistance applications in salt or brackish water, use the most economical of ASTM A 690/A 690M steel, or ASTM A 36/A 36M or ASTM A 572/A 572M steel with a protective concrete encasement or heavy coating of coal tar paint or coal tar epoxy applied to areas of the steel susceptible to corrosion.**

**High-strength steel shall be used only when design analyses show that the use is the most economical solution.**

**ASTM A 27/A 27M cast steel is used for some commercially available pile points.**

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Steel for H-piles [, pile caps] [, pile tension anchors] [and] [splice plates] shall conform to [ASTM A 36/A 36M] [ASTM A 572/A 572M] [ASTM A 690/A 690M]. [Steel for pile points shall conform to ASTM A 27/A 27M.]

#### 2.1.2 H-Piles

H-piles shall be of the shape and sections shown and shall have standard square ends unless otherwise directed. Lengths of piles shall be determined as specified in paragraph INSTALLATION, subparagraph LENGTHS OF PERMANENT PILES [and paragraph PILE TESTS, subparagraph TEST PILES].

#### 2.1.3 [Pile Splices

Materials for pile splices shall be as shown.]

#### 2.1.4 [Pile Points

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**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.**

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Pile points shall [be the type] [conform to details] shown and shall be provided on all piles.]

#### 2.1.5 [Pile Caps

Pile caps shall conform to details shown.]

#### 2.1.6 [Pile Tension Anchors

Pile tension anchors shall conform to details shown.]

### 2.2 [FABRICATION

Fabrication shall conform to the requirements shown and as specified herein and in Section 05055A METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.]

#### 2.2.1 [Pile Splices

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NOTE: Splices should generally not be permitted where required lengths are available in one piece or the pile is designed for a moment connection. Where splices are permitted, details of the splice should be shown.  
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Pile splices shall be fabricated as shown. Detail drawings of splices shall be submitted in accordance with paragraph SUBMITTALS.]

#### 2.2.2 [[Pile Caps,] [Pile Points,] [Pile Tension Anchors]

[[Pile caps,] [pile points,] [and] [pile tension anchors] shall be attached to piles as shown.] [The top of piles shall be ground 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

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NOTE: The minimum and maximum hammer energies required may be determined from experience on other jobs or by a series of wave equation analyses.  
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Pile driving hammers shall be of the impact [or vibratory] type.

#### 3.1.1.1 Impact Hammers

Impact hammers shall be steam, air, or diesel hammers of the single acting, double-acting, or differential acting type. [The size or capacity of hammers shall be as recommended by the manufacturer for the pile mass weight and soil formation to be penetrated.] [The rated energy of hammers shall be limited to a minimum of [\_\_\_\_\_] joules foot-pounds and a maximum of [\_\_\_\_\_] joules foot-pounds.] [Hammers shall be capable of [, and so demonstrated during the development of refusal criteria,] hard driving in excess of 20 blows per 25 mm.inch.] Boiler, compressor, or engine capacity shall be sufficient to operate hammers continuously at the full rated speed. Hammers shall have a gage to monitor hammer bounce chamber pressure for diesel hammers or pressure at the hammer for air and steam hammers. This gage shall be operational during the driving of piles and shall be mounted in an accessible location for monitoring by the Contractor and the Contracting Officer. [Two spare operational bounce chamber read out units shall be available on site.] [The Contractor shall 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.] 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 shall be as recommended by the manufacturer for the pile mass weight and soil formation to be penetrated.] The hammer shall 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. Nonvibrating mass (kilonewtons). weight (pounds).
- i. Power pack description.]

### 3.1.2 Pile Driving Leads

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**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.**

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Hammers shall be supported and guided with [suspended leads,] fixed extended leads or fixed underhung leads. [Vibratory hammers shall be operated free hanging without leads.] [For driving battered piles, impact hammers shall be supported and guided 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, vibratory hammers shall be supported and guided with fixed extended leads or templates.] [Two intermediate supports for the pile in the leads shall be provided 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

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**NOTE: Jetting should not be used on piles carrying significant tension loads, lateral loads, or compression loads developed predominantly from skin friction.**

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Jetting equipment shall have not less than two removable or fixed jets of the water or combination air-water type. Water jets shall be designed so that the discharge volume and pressure are sufficient to freely erode the

material immediately under and adjacent to piles without resulting in pile drift. Jetting equipment including plant description, volume of water and pressure, and size and length of hoses and pipes shall be submitted in accordance with paragraph SUBMITTALS.]

### 3.2 INSTALLATION

#### 3.2.1 Lengths of Permanent Piles

The estimated quantities of piles listed in the unit price schedule 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 bearings 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

Develop a form for compiling pile driving records which must be approved. Complete and accurate records of the pile driving operations shall be compiled on the approved form and submitted in accordance with paragraph SUBMITTALS. Driving records for each pile shall include date driven, pile identification number, pile dimensions, location, 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, and depth and description of voids formed adjacent to the pile. Additional data required to be recorded for impact hammers include the rate of hammer operation and the length of the bounce hose. Additional data required to be recorded for vibratory hammers include hammer power pack description, wattage horsepower applied to pile, and hammer operating frequency.

#### 3.2.3 Pile Placement

A pile placement plan which shows the installation sequence and the methods proposed for controlling the location and alignment of piles shall be developed and submitted in accordance with paragraph SUBMITTALS.

[Foundation preparation [removal of unsuitable material and densification of foundation fill] shall be completed in the area prior to the placement of piles for driving.] Piles shall be placed accurately in the correct location and alignments, both laterally and longitudinally, and to the vertical [or batter] lines indicated. The Contractor shall establish a permanent base line to provide for inspection of pile placement by the Contracting Officer during pile driving operations. The base line shall be established prior to driving permanent piles and shall be maintained during the installation of the permanent piles. A final lateral deviation from the correct location at the cutoff elevation of not more than 75 mm 3 inches will be permitted for vertical [and battered] piles. A final variation in alignment of not more than 25 millimeters per meter 1/4 ipf of longitudinal axis will be permitted. [A final variation in rotation of the pile about

the center line of the web of not more than 7.5 degrees will be permitted.] [A vertical deviation of not more than [25] [50] mm [1] [2] inch from the correct cut off elevations shown will be permitted.] The correct relative position of all piles shall be maintained by the use of templates or by other approved means. Piles not located properly or exceeding the maximum limits for rotation, lateral deviation, [and] [or] variation in alignment shall be pulled and redriven at as location directed at no additional cost to the Government.

#### 3.2.4 Pile Penetration Criteria

The controlling [depth of penetration] [refusal blow count (number of blows required to attain the final 25 mm inch of penetration)] for permanent piles will be determined by the Contracting Officer. [The required [depth of penetration] [refusal blow count] will be established subsequent to the analysis of pile tests as specified in paragraph PILE TESTS.] [Driving with a vibratory hammer shall be terminated when the rate of penetration is less than [\_\_\_\_\_] mm inch per minute.]

#### 3.2.5 Pile Driving

The Contracting Officer shall be notified 30 days prior to the date pile driving is to begin. Piles shall not be driven within 30 m 100 feet of concrete less than 7 days old. Permanent [and test] piles shall be driven with hammers of the same model and manufacturer, same energy and efficiency, and using the same driving system. Hammers shall be operated at all times at the speed and under the conditions recommended by the manufacturer. [Where heave is anticipated, the sequence of installation shall 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, each pile shall be checked 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, conditions such as alignment [and batter] shall be kept constant. [The alignment of battered piles shall be checked and monitored during driving with an accurate batter board level [and surveying instrument]]. Each pile shall be driven continuously and without interruption until the required [depth of penetration] [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, shall be pulled and redriven or shall be cut off and abandoned, whichever is directed. After piles are driven, they shall be cutoff square as required at the indicated cutoff elevation. [Cutoff piles shall be capped as shown.] Any voids around piles or abandoned holes for pulled piles shall be backfilled and densified to the same density as the surrounding soil.

##### 3.2.5.1 Splicing Piles

[Splicing of piles will not be permitted.] [A pile that has not reached the required refusal blow count when the top has been driven to the top elevation shall be spliced as shown and driven to a sufficient depth to develop the required refusal blow count.]

##### 3.2.5.2 Jetting

[Jetting of piles will not be permitted.] [Jetting shall be used to assist

driving piles through strata that can not be penetrated practicably by use of the hammer alone when authorized. After the penetration of the strata requiring jetting has been accomplished, jetting shall be discontinued and the driving shall be resumed with the hammer alone. Jetted piles shall be seated by driving not less than 300 mm 1 foot after jetting has been stopped.]

#### 3.2.5.3 Heaved Piles

When driving piles in clusters or under conditions of relatively close spacing, observations shall be made to detect heave of adjacent piles. Heaved piles shall be backdriven to original [depth of penetration] [refusal blow count] without additional cost to the Government.

#### 3.2.5.4 Pulled Piles

Piles damaged or impaired for use during driving shall be pulled and replaced with new piles, or shall be cut off and abandoned and new piles driven as directed without additional cost to the Government. The Contracting Officer may require that any pile be pulled for inspection. Piles pulled as directed and found to be in suitable condition shall be redriven at another location as directed. Piles pulled as directed and found to be damaged shall be replaced by new piles at the Contractor's expense.

### 3.3 [PILE TESTS

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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 test required for a project.

\*\*\*\*\*

Pile Tests - [Pile driving tests] [and] [pile load tests] shall be performed 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 permanent 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, required additional [pile driving tests] [and] [pile load tests] shall be performed at the Contractor's expense and no additional contract time will be allowed.] [In accordance with paragraph SUBMITTALS, develop and submit a detailed pile load test plan which shall

include 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 shall not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.]

#### 3.3.1 [Test Piles

Test piles shall be of the indicated lengths and shall be placed at the [indicated] [or] [directed] locations. Test piles shall be driven with the same equipment specified in paragraph PILE DRIVING EQUIPMENT and in the same manner specified in paragraph DRIVING for permanent piles. The driving record data shall be recorded for each test pile driven. [A pile driving analyzer shall be provided and operated as specified by the manufacturer during the driving of each test pile.]]

#### 3.3.2 [Pile Driving Tests

[\_\_\_\_] pile driving tests shall be performed. The Contracting Officer will be present during each pile driving test. Pile driving tests shall be carried to completion without interruption. Any pile driving test not accomplished in accordance with this specification shall be redone at no additional cost to the Government. Each driving test pile shall be pulled within one (1) [day] [week] after the completion of that pile driving test, damages documented, and stored at construction site. Pulled test piles shall be removed from the site when directed.]

#### 3.3.3 Dynamic Testing of Piles

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**NOTE:** Dynamic testing should be specified 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.

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The Contractor shall [[provide] [employ] a specialty engineering firm to] perform dynamic testing of piles [and permanent 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]. Personnel experienced in performing wave equation analysis, dynamic testing, and interpretation of results shall be furnished to install and operate the testing equipment, and to furnished to install and operate the testing equipment, and to interpret its results. Equipment to obtain dynamic measurements, record, reduce and display its data shall be furnished and meet the requirement of ASTM D 4945. The equipment shall have been calibrated within 12 months thereafter throughout the contract duration. All power requirements for operating the equipment shall be supplied by the Contractor. Prior to commencing pile driving, a wave equation analysis shall be performed and the results submitted in accordance with paragraph SUBMITTALS.

#### 3.3.3.1 Test Piles

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

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Dynamic testing shall be performed on [\_\_\_\_\_] test piles as indicated. Testing shall be performed during the full length of pile driving. Piles which are statically load tested shall be restruck within 48 hours after completion of static load test to correlate static and dynamic test results. [Piles installed as part of pile driving test shall be restruck after a minimum waiting period of [\_\_\_\_\_] days.] The hammer shall be warmed up prior to restriking. Restriking shall consist of restriking 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 [Permanent Piles

Dynamic pile testing shall be performed on [\_\_\_\_\_] permanent piles during the full length of initial driving [and during restrike driving]. Tested piles shall 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

A summary report of dynamic test results for test piles shall be prepared and submitted in accordance with paragraph SUBMITTALS. The report shall discuss 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. [A CAPWAPC, or similar, analysis of the dynamic test data shall be performed on data obtained from the end of initial driving and the beginning of restrike for [\_\_\_\_\_] test piles as directed. The analysis shall be used to predict pile capacity, establish resistance distribution, and predict quake and damping factors.] Refined wave equation analyses incorporating the results of

dynamic testing and analysis shall be included. [For permanent piles, a field summary report shall be prepared and submitted in accordance with paragraph SUBMITTALS. The field summary report shall minimally contain energy transferred to the pile, calculated driving stresses, pile integrity and estimated pile capacity at the time of testing.] The report for the test piles [and the monthly report for permanent piles] shall include the pile driving record as an attachment and also address the items listed in paragraph "7.1.5 Dynamic Testing" of ASTM D 4945.

#### 3.3.4 [Pile Load Tests]

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**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.**  
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Pile load tests shall be performed 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 shall be ready to be placed in operation as soon as a load test pile has been driven. The loading equipment shall be of sufficient capacity to apply the maximum load specified in a safe manner. Loading of each test pile shall be started when directed. The Contractor shall be responsible for the application of loads. The magnitude of applied loads shall be accurately determined and controlled 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 shall be conducted for each rejected pile load test. The Contractor shall compile a report for each pile load test which shall include, 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 D 1143 [, as modified]. A compressive load of [\_\_\_\_\_] kN tons shall be applied to each compressive load test pile.]

##### 3.3.4.2 [Tensile Load Test]

Perform [\_\_\_\_\_] pile tensile load tests in accordance with ASTM D 3689[, as modified]. A tensile load of [\_\_\_\_\_] kN tons shall be applied to each tensile load test pile.]

##### 3.3.4.3 [Lateral Load Test]

Perform [\_\_\_\_\_] pile lateral load tests in accordance with ASTM D 3966[, as modified]. Lateral load tests shall consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. A lateral load of [\_\_\_\_\_] kN tons shall be applied to each pair of lateral load test piles. Required movement readings shall be made and recorded for each pile.]

-- End of Section --