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USACE / NAVFAC / AFCEC / NASA **UFGS-31 62 23.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 31 - EARTHWORK

SECTION 31 62 23.13

CONCRETE-FILLED STEEL PILES

02/21

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SECTION 31 62 23.13

CONCRETE-FILLED STEEL PILES
02/21

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NOTE: This guide specification covers the requirements for procurement, installation, and testing of cast-in-place concrete piles utilizing steel casing.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

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

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

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PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT PROCEDURES

Bids will be based on the number of piles as indicated, and on lengths from tip to cutoff as follows:

Number of piles	Length, meters feet
[_____]	[_____]

From the data obtained as a result of driving the test piles [and load tests] specified hereinafter, the Government will determine and will list the "calculated" pile tip elevations and the driving resistances for all piles. This list will be used as the basis for ordering piles. Payment will be on the basis of length of piling from cutoff elevation to final

tip elevation, established by the requirements specified elsewhere in this section. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment on the contract price and the time for completion will be made. If excavation is made adjacent to piling and below the grade indicated and if piling is driven before backfilling of over-excavation, no payment will be made for the length of piling equal to the depth of the over-excavation. No additional payment will be made for cutting off piles, for any portion of a pile remaining above cutoff elevation, or for broken, damaged, or rejected piles.

1.1.1 Unit Price

The Contracting Officer reserves the right to increase or decrease the total length of piles to be furnished and installed, by changing the foundation pile locations or elevations, requiring the installation of additional piles, or requiring omission of piles from the requirements shown and specified. Whether or not such changes are made, payment will be made at the contract unit price per linear meter foot(including control test piles), multiplied by the total linear meters feet of acceptable piles actually installed.

1.1.2 Full Compensation

Payment in accordance with the above paragraph, "Unit Price," will constitute full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the foundation piles. No payment will be allowed for withdrawn, broken or rejected piles, nor (except for control test piles) for a portion of any pile remaining above the cut-off point.

1.1.3 Load Tests

The contract includes [_____] pile load tests. The Contracting Officer reserves the right to increase or decrease the number of pile tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Pile Load Test" or "Omitted Pile Load Test."

1.2 REFERENCES

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

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

References not used in the text will automatically be deleted from this section of the project

specification when you choose to reconcile references in the publish print process.
****

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A252	(2010) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2019) Structural Engineering

1.3 SYSTEM DESCRIPTION

Perform the work through a general Contractor or a specialty subcontractor specialized in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions.

1.3.1 Subsurface Soil Data

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NOTE: Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.
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Subsurface soil data logs are [as indicated] [appended to the SPECIAL CONTRACT REQUIREMENTS] [found in Section 00 31 32.13 Subsurface Drilling and Sampling Information]. The subsurface investigation reports [and samples of materials as taken from subsurface investigations] are available for examination at [_____].

1.3.2 Equipment

Submit descriptions of all pile driving equipment to be employed in the work, prior to commencement of pile installations, including details of the pile hammer, power plant, leads, pile cushion, cap block, and helmet.

1.3.2.1 Pile Hammers

Provide a hammer having a delivered energy suitable for the total weight of the pile, the character of subsurface material to be encountered, and the pile capacity to be developed. The driving energy of the hammer shall be not less than [_____] newton-meters foot-pounds.

1.3.2.2 Driving Helmets and Pile Cushions

Use a driving helmet, cap block, and pile cushion between the top of the pile and the ram to prevent impact damage to the pile and capable of protecting the head of the pile, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over the top of the pile. The driving helmet shall fit loosely around the top of the pile so that the pile is not restrained if the pile tends to rotate during driving. The pile cushion and cap block may be of solid wood or of laminated construction using plywood, softwood, or hardwood boards or other cushion material as approved by the Contracting Officer. The pile cushion shall completely cover the top surface of the pile and shall be retained by the driving helmet. The minimum thickness of the pile cushion and of the cap block shall be 76 mm 3 inches each and the thickness shall be increased so as to be suitable for the size and length of pile, character of subsurface material encountered, hammer characteristics, and required driving resistance.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

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

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

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

SD-02 Shop Drawings

Installation

SD-03 Product Data

Driving Pile Casings
Equipment

SD-06 Test Reports

Test Piles.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Concrete

NOTE: Delete or modify second sentence when the job is small or the existence of certified plants is beyond acceptable distance of small jobs. Insert the ultimate compressive strength required by design.

Conform materials, mixing, and placing of concrete to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Minimum compressive strength at 28 days shall be[_____] MPa psi. Maximum coarse aggregate size shall be 19 mm 3/4 inch.

2.1.2 Reinforcement

NOTE: Reinforcement should be required for the unsupported sections of piles, for uplift or tension piles, for piles exposed to high bending stresses not resisted by batter piles, and for anchoring the top of the pile to the pile cap or slab. Tension or uplift piles shall be reinforced throughout their entire length.

Conform materials, assembly, and placement of reinforcement to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Assemble and place reinforcement in the casing as a unit as detailed and scheduled.

2.1.3 Casings

****

NOTE: Closed-end steel pipes should generally be used. Open-end steel pipes should be considered where:

a. It is important to avoid soil displacement as in piles driven adjacent to existing structures.

b. Soil conditions indicate a dense or clayey soil, or extremely coarse granular soil is present, such as gravel.

Where open-end pipes are specified, concrete should not be placed until all soil, water and foreign material are removed from inside casing.

****

Provide casings of steel and sufficient strength to prevent harmful distortions during driving, after completion of driving, and during driving of adjacent casings. Casings driven without the use of an internal mandrel shall have walls of a thickness sufficient to withstand the driving stresses. Casings shall be closed at the tip, except for steel pipe casings conforming to ASTM A252 that may be open-end driven. Make joints and tip connections watertight. Nominal circumference at any cross-section in length shall be circular, whether or not modified by helical corrugations or flutings. Leave casings permanently in place; provide any one of the following types or combination of types; but use only one type or combination throughout.

2.1.3.1 Uniform Taper

Diameter shall increase from tip to cutoff at a uniform rate. Minimum nominal diameter at tip and two-third points above tip shall be as indicated.

2.1.3.2 Step-Taper

Section increments shall increase in diameter uniformly. Minimum nominal diameter at tip and two-third points above tip shall be as indicated.

2.1.3.3 Constant Section

Steel pipes, conforming to ASTM A252, Grade 2, may be used in lieu of casings of constant section. Minimum nominal diameter shall be as indicated.

2.1.3.4 Combination Type

Combination type cast-in-place concrete piles, steel casing, may be any of the following or other types, depending upon design criteria. Specification requirements shall be in accordance with applicable paragraphs of this section.

a. Steel pipe lower section with metal casing taper or constant-diameter upper section.

b. Constant-diameter or tapered lower section with tapered upper section.

c. Tapered lower section with constant-diameter upper section.

PART 3 EXECUTION

3.1 INSTALLATION

Submit drawings demonstrating compliance of driving equipment and steel casing with contract documents. Include in the drawings shop and erection details, casing details, end closures, splices, driving helmets, and reinforcement.

3.1.1 Driving Pile Casings

Submit a complete and accurate record of each driven pile, within 3 days of completion of driving. Indicate in the record the pile location (as driven), driven length, embedded length, final elevations of tip and top, pile weight, butt and tip diameter, quantity and strength of concrete used in each pile, number of splices and locations, blows required for each meter foot of penetration throughout the entire length of the pile and for the final 150 mm 6 inches of penetration, and the total driving time. Also include in the record the type and size of the hammer used, the rate of operation, and the type and dimensions of driving helmet, pile cushion, and cap block used. Record any unusual conditions encountered during pile installation and immediately report to the Contracting Officer.

3.1.1.1 Driving Procedure

****

NOTE: The next-to-last sentence, concerning tip elevation and driving resistance, should be edited to conform to subsurface conditions and type of pile (friction or end bearing).

Insert the radius distance (3 to 6 meters10 to 20 feet) and the time (2 to 7 days). No concrete shall be placed in any pile until all other casings within a radius of 3 to 6 meters 10 to 20 feet have been driven and inspected.

****

Stop excavation at 300 mm (1 foot) above foundation grade before casings are driven. When pile driving is accomplished, complete excavation to lines and grades shown. Drive permanent pile casings, without interruption, to the "calculated" tip elevation to reach a driving resistance in accordance with the schedule which the Government will prepare from the test-pile driving data. The pile hammer used for driving shall be the same type and operated at the same rate and in the same manner as that used for driving the test piles. Operate diesel powered hammers at the rate recommended by the manufacturer throughout the entire driving period. Maintain sufficient pressure at the steam hammer so that:

a. For a double-acting hammer, the number of blows per minute during and at the completion of driving of a pile is equal approximately to that at which the hammer is rated.

b. For a single-acting hammer, there is a full upward stroke of the ram.

c. For a differential-type hammer, there is a slight rise of the hammer base during each upward stroke.

Use a new pile cushion at the start of driving for each pile; replace the cushion whenever it has become highly compressed, charred, burned, or deteriorated in any manner during driving. Notify the Contracting Officer, to determine what procedure will be followed, if a pile reaches the "calculated" pile tip elevation without reaching the required driving resistance; or if the required driving resistance is reached before the "calculated" pile tip elevation. Casings will not be driven within a radius of [_____] mfeet of any other casing in which the concrete and reinforcement has been placed for less than [_____] days.

3.1.1.2 Tolerance in Driving

Drive casings with a variation of not more than 20 mm per m 0.25 inch per foot of pile length from the vertical. Butts shall be within 100 mm 4 inches of the location indicated. Manipulation of casings to force them into position will not be permitted. Check casings for heave, after all piles are driven in a cluster or under any conditions of relatively close spacing; redrive those found to have heaved to the required tip elevation. The center of gravity of each group of footing piles shall be maintained by templates or other approved means to conform to locations shown. Casings damaged, mislocated, or driven out of alignment shall be replaced or additional casings driven as directed.

3.1.1.3 Jetting of Pile Casings

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NOTE: Jetting should generally not be permitted for piles:

a. Dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for soil to reconsolidate around the piles.

b. Subject to uplift.

c. Adjacent to existing structures.

d. In closely spaced clusters unless the load capacity is confirmed by test and unless all jetting is done before final driving of any pile in the cluster.

****

Jetting of pile casings [may be used when permitted by the Contracting Officer] [will be permitted by the Contracting Officer as indicated] [will not be permitted]. [Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the "calculated" pile tip elevation; make the final 1.5 m5 feet of penetration by driving. Before commencing with the driving of the final 1.5 meters 5 feet, the pile casing shall be firmly seated in place by the application of a number of reduced energy hammer blows.]

3.1.2 Filling of Casings

Visually inspect each casing after its final installation and prior to depositing the concrete and placing the reinforcement. Notify the

Contracting Officer prior to each such inspection to allow for quality assurance inspections of all casings. The inspection will verify the integrity of the casing throughout its length and the absence of distortion and reduction in area. Deposit concrete in the casing in a continuous operation by means of a funnel or hopper after all mud, water and other extraneous material has been removed from its interior.

3.1.3 Cutting of Casings

Cut casings with an acetylene torch or saw with prior approval by the Contracting Officer.

3.1.4 Welding

Perform shop and field welding, qualification of welders, and inspection of welds in accordance with AWS D1.1/D1.1M.

3.1.5 Splicing

Splices may be used after review by the Contracting Officer. No more than two splices per full length of casing will be permitted. They shall be able to transmit any vertical and lateral forces adequately, and in addition, develop no less than 50 percent of the flexural capacity of the ordinary pile casing cross section. Make lateral joints with a continuous full penetration butt weld in accordance with AWS D1.1/D1.1M or as approved by the Contracting Officer.

3.2 FIELD TESTS AND INSPECTIONS

3.2.1 Test Piles

Submit a complete report on the load test, within [seven] [_____] days of completion of load test, including, but not limited to, a description of the pile driving equipment, driving records for both test piles and reaction piles, complete test data, analysis of test data, and recommended allowable design loads based on the load test results. The report shall be prepared by or under the direct supervision of a registered professional engineer experienced in pile load testing and load test analysis.

3.2.1.1 Pile Driving

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NOTE: Insert the number of test piles required. A minimum of three driving tests should be made; and possibly more, where subsurface conditions are questionable.

****

Drive test piles in the manner specified for all piling elsewhere in this section. Keep a record for each test pile of the number of blows required for each foot of penetration throughout the entire length of the pile, the penetration per blow at such intervals as directed, and the number of blows for the final 150 mm 6 inches of penetration. The record shall include the type and size of the hammer used, the rate of operation, and the type and dimensions of casings. Record any unusual occurrence during driving of the pile casing and any increase and decrease of driving resistance and bring it to the attention of the Contracting Officer. The Government will use load test and test pile data to determine the

"calculated" pile tip elevation and the necessary driving resistance. [_____] test piles shall be driven in the locations indicated, with surrounding earth at the elevations shown. Test piles properly driven and located and with adequate driving resistance may be used in the finished work. Jetting will be permitted by the Contracting Officer only when test pile driving clearly establishes the validity of its use.

3.2.1.2 Load Tests

****

NOTE: Delete this paragraph for projects for which load testing is not specified. Insert the number of piles to be load tested. The provisions of ASTM D1143/D1143M, such as pile set-up time after driving, test load, method of applying load, loading and unloading procedures, instrumentation, etc., should be carefully examined and modified as necessary to fit the specific load test being conducted. When it is desirable to show analysis for determination of pile capacities from load tests and for relating load test capacities to job capacities, include the following:

a. Test Measurements: Maintain the ultimate test load for not less than 24 hours and then release it. The safe design capacity of a test pile as determined from the results of load tests will be the lesser of the two values computed according to the following:

(1) One-half the load that causes a net settlement after rebound of not more than 0.23 mm per metric ton 0.01-inch per ton of total test load.

(2) One-half the load that causes a gross settlement of not more than 25 mm 1 inch provided that the load settlement curve shows no sign of failure.

b. Pile Capacity: The capacity, as driven, of single piles not in clusters in the structure should be not less than [_____] metric ton tons. The capacity will be determined by the following formulas, modified according to the data obtained by the load tests:

For single-acting hammers: R = 166.7WH/(s+2.54P/W) (R = 2WH/(s+0.1P/W))

For double-acting hammers: R = 166.7E/(s=0.1P/W) (R = 2E/(s=0.1P/W))

Where: R is the allowable static pile load in newtons pounds.

W is the weight of the striking part of the hammer in newtons pounds.

H is the effective height of fall in meters feet.

E is the actual energy delivered by the hammer per blow in newton-meters foot-pounds.

S is the average net penetration in millimeters inches per blow for the last five blows after the pile has been driven to a depth where successive blows produce approximately equal net penetration a minimum distance of 1 m 3 feet for friction piles.

P is the weight of the pile in newtons (pounds). If P is less than W, P/W will be taken as unity.

Dynamic pile stresses should not exceed the crushing strength of piles.

****

Perform load tests in accordance with ASTM D1143/D1143M, [_____] loading method. The apparatus for applying the vertical loads shall be as given by the method, either for load supported directly by the pile, or load from weighted box or platform or reaction frame attached to sufficient uplift piles to take safely the required load applied to the pile by hydraulic jack. Perform the load tests; at locations shown or directed, on test piles driven to the tip elevation used for establishing lengths of piles for bidding, except as otherwise directed. Additional load test, at the expense of the Government, may be required. Pile shall have been in a place a minimum of 3 days before loading. Perform loading, testing, and recording of data under the direct supervision of a registered professional engineer. The analysis of the load test data shall be done by the registered professional engineer. The registered professional engineer shall be provided and paid for by the Contractor.

3.2.2 Concrete Testing

****

NOTE: The following table is recommended for use in determining the number of test cylinders required in relation to the size of each lot of piles to be tested.

Pile Lot	Number of Test Cylinders
25	2
100	4
1000	20
5000	50
10,000	100

Samples taken from random batches of concrete.

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During Concrete placement, strength tests will be made by a testing service provided and paid for by the Contractor in accordance with

requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Take at least two specimens from each random batch and one test will be made for every [_____] piles with no less than two tests for any 1 day's operation.

3.3 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 Appendix 11A of ASCE 7-16.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-301-01 and Appendix 11A of ASCE 7-16. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

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Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-301-01 and Section 01 45 35 SPECIAL INSPECTIONS.

-- End of Section --