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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UML dated 23 June 2005

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05/05

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SECTION 02466A

DRILLED FOUNDATION CAISSONS (PIERS) 05/05

NOTE: This guide specification covers the requirements for drilled foundation caissons (piers) including reinforcing and cast-in-place concrete.

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.

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	(2004) Structural Welding Code - Steel
AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2004b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 996/A 996M	(2004) Rail-Steel and Axle-Steel Deformed Bars or Concrete Reinforcement
ASTM D 1143	(1981; R 1994e1) Piles Under Static Axial Compressive Load
ASTM D 1586	(1999) Penetration Test and Split-Barrel Sampling of Soils

1.2 BASIS OF BID AND UNIT PRICES

NOTE: This paragraph anticipates bids on a lump sum price for an entire project including caisson work with directed changes being in accordance with the CONTRACT CLAUSES or in accordance with unit prices as defined in paragraph "Unit Prices." Delete "in accordance with the CONTRACT CLAUSES" or paragraphs "Tests" and "Unit Prices" for lump sum projects.

1.2.1 Bids

The bid shall be based on the number and total length of caissons, established by top and bottom elevations and diameters, as indicated and specified. Adjustment of the contract will be made [in accordance with the CONTRACT CLAUSES], should the total length of caissons installed and approved be greater or less than the total length shown. The Contractor will not be allowed payment for rejected caissons or for those not conforming to specifications.

1.2.2 Tests

1.2.2.1 Load Test

Contract shall include [_____] load tests rated at [_____] metric ton ton per caisson. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Caisson Load Test" or "Omitted Caisson Load Test".

1.2.2.2 Penetration Test

Contract shall include [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Penetration Test" or "Omitted Penetration Test".

1.2.2.3 Proof Test Hole

Contract shall include [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole".

1.2.3 Unit Prices

1.2.3.1 Additional Caisson Lengths

Additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Length" for each diameter of caisson installed as approved.

1.2.3.2 Omitted Caisson Lengths

The contract price will be reduced by the amount bid for "Omitted Caisson Length" for each diameter of caisson omitted as directed.

1.2.3.3 Casings Permanently Left in Place

Steel casings permanently left in place due to contract conditions:

- a. Total pounds of steel beyond casings indicated will be paid for at the contract unit price per pound for "Additional Steel Casing."
- b. Omitted Casing Steel: The contract price will be reduced by the amount bid for "Omitted Casing Steel" omitted as directed.

1.2.3.4 Reinforcing Steel for Additional Caisson

Reinforcing steel for additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Reinforcing Steel" installed as approved.

1.2.3.5 Reinforcing Steel for Caissons Omitted

The contract price will be reduced by the amount bid for "Omitted Caisson Reinforcing Steel" omitted as directed.

1.2.3.6 Removal of Rock

Removal of rock within the limit of caissons will be paid for at the contract unit price for "Removal of Rock" per linear meter foot, for each diameter of caisson installed. Rock excavation is defined as any hard dense material that cannot be removed with caisson drilling equipment having the specified capacity and could only be removed by hand, air tools, blasting, or other specialized methods.

1.2.3.7 Removal of Obstructions Other Than Rock

Removal of obstructions other than rock within the limits of the caissons which cannot be removed using standard caisson drilling equipment with the specified capacity will be paid for at the contract unit price per linear meter foot for "Removal of Obstructions" for each diameter of caisson installed.

1.3 BASIS OF PAYMENT

**NOTE: Where the basis for bidding is based entirely
on unit price, paragraph BASIS OF BID AND UNIT
PRICES should be deleted and the following paragraph
substituted.**

1.3.1 Unit Price

The Contracting Officer shall have the right to increase or decrease the total length linear footage of drilled foundation caissons to be furnished and installed by changing the foundation caisson elevations, by requiring the installation of additional caissons, or omission of caissons from the requirements shown and specified. Whether or not such changes are made, the Contractor shall be paid at the contract unit price per linear meter foot (including test caissons) multiplied by the total linear meters feet of acceptable caissons actually installed provided, however, that in the event the Contracting Officer requires an increase or decrease in the total length linear footage of caissons furnished and installed, the contract unit price will be adjusted in accordance with the CONTRACT CLAUSES.

1.3.2 Full Compensation

Payment in accordance with the above paragraph Unit Price shall 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 caissons. The Contractor will not be allowed payment for rejected caissons.

1.3.3 Load Tests

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

1.3.4 Penetration Tests

Contract shall include [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Penetration Test" or "Omitted Penetration Test."

1.3.5 Proof Test Holes

Contract shall include [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole."

1.4 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

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, 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.] [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

Caissons[; G][; G, [____]]

Detailed records in an approved form, for each caisson, showing shaft and bell diameters, depths of test holes, top and bottom elevations, bearing strata description, casing description, water conditions, concrete strength, concrete volume, rock elevations, dates of excavation and concrete placement, and other pertinent information. Upon completion of caisson work, the Contractor shall provide a record of centerline locations based on the survey of the registered surveyor or engineer provided by the Contractor.

In addition, corrective measures shall be similarly recorded. A complete tabulation of all records pertaining to approved caissons shall be delivered to the Contracting Officer.

SD-06 Test Reports

Load Tests
Penetration Tests

Test Results.

SD-07 Certificates

Caissons

A certified copy of the survey. Lines and levels shall be established and caisson centerline locations staked and maintained by a registered surveyor or engineer provided by the Contractor.

Qualifications[; G][; G, [____]]

Qualifications of the foundation system Contractor shall show that he has been engaged in the successful installation of drilled foundation caissons for at least [____] years.

1.5 QUALIFICATIONS

1.5.1 Specialty Subcontractor

NOTE: Select applicable paragraph for agency requirements. Basically, from 3 to 5 years should be required for second paragraph.

The work shall be performed by a specialty subcontractor, specializing in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions.

1.5.2 Welding

Detail and field welding shall be in accordance with AWS D1.1/D1.1M. Qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1/D1.1M, Section 5. Records of test results of welding procedures not prequalified and copies of records for each qualified welding operator, containing records on positions of welding and types of electrode qualifications, shall be kept by the Contractor and be

available for examination by the Contracting Officer.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Subsurface Data

NOTE: Include location of available samples.

Subsurface soil data logs are shown on the drawings. The subsurface investigation report and samples of materials, as taken from subsurface investigations, are available for examination at [____].

1.6.2 Caisson Drilling Equipment

NOTE: Caisson drilling equipment criteria should be evaluated and specified for contract site conditions. Reference: Drilled Pier Foundations - Woodward, Gardner, Greer - McGraw-Hill Book Co. Requirements should be included for determination of minimum equipment standards.

Caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the contract site conditions.

1.7 SEQUENCE OF WORK

NOTE: Sequence of work criteria should be modified for agency requirements.

1.7.1 Caisson Excavation

Excavation of caissons or groups of caissons shall be performed so that reinforcing steel and concrete placement is a continuous operation performed the same day that the excavation is completed. Excavations shall not be left open overnight.

1.7.2 Acceptance

Concrete shall be placed within 3 hours after approval of the completed excavation.

1.8 SUPERVISION, INSPECTION, AND SAFETY

1.8.1 Contractor Supervision

The Contractor shall provide for the supervision of all phases of drilled pier construction. Supervision shall be the Contractor's responsibility as outlined in Quality Control provisions of the SPECIAL CONTRACT REQUIREMENTS. Each drilled pier excavation shall be checked by the Contractor for its depth, water removal, cleanup, workmanship, and for all tolerance requirements before any concrete is placed.

1.8.2 Government Inspection

The Contracting Officer will inspect each drilled pier excavation. Concrete shall not be placed until the excavation has been approved by the Contracting Officer. The Contractor shall furnish the Contracting Officer all necessary equipment required for proper inspection of drilled pier excavations.

1.8.3 Safety Precautions for Workmen and Inspectors

1.8.3.1 Life Line

Each person entering a drilled pier excavation shall be provided with a life line rigged so that the person can be immediately hoisted out of the excavation in an emergency. The life line shall be suitable for instant rescue, securely fastened to a shoulder harness, and separated from any line used to remove excavated materials. No person shall be lowered into a drilled pier excavation prior to casing the shaft through the overburden.

1.8.3.2 Ventilation

Each drilled pier excavation shall be provided with a ventilating device of sufficient capacity to assure a safe and healthy atmosphere before workmen and inspectors are permitted to enter the drilled pier excavation and during all work periods.

PART 2 PRODUCTS

2.1 CONCRETE WORK

NOTE: Include information for concrete work.
Correlate with Section 03300A CAST-IN-PLACE
STRUCTURAL CONCRETE for pertinent information or
include concrete specifications in this section.

Concrete work shall be in accordance with requirements of Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE, as modified herein:

2.1.1 Coarse Aggregate

Maximum size of coarse aggregate shall be [____].

2.1.2 Reinforcing Steel

Reinforcing steel shall conform to [ASTM A 615/A 615M] [ASTM A 996/A 996M] Grade [____]. Steel shall be welded into cages in accordance with AWS D1.4 and inserted securely in the caissons, in position and alignment, as shown, [prior to concrete placement] [prior to the concrete reaching an elevation of [____] meters feet below the bottom elevation of the reinforcement].

2.1.3 Strength

Concrete strength shall be [____] MPa psi at 28 days. Slump shall be from [____] to [____] mm inches.

PART 3 EXECUTION

3.1 PREPARATION

**NOTE: Caissons selected for contract shall be based
on analysis of subsurface investigation and design
requirements. Complete installation information.**

- a. Caissons shall be excavated to established depths and dimensions shown. Bottoms of caissons shall be cleaned of loose or soft material and leveled. Excavated material shall be disposed of in accordance with Section 02300 EARTHWORK.
- b. In drilling caissons, the surrounding soil and the earth walls shall be adequately and securely protected against cave-ins, displacement of the surrounding earth, and retention of ground water, by means of temporary steel casings. Casings shall have outside diameters not less than indicated shaft sizes, shall be a minimum of 6.4 mm 1/4 inch thick, and shall not be removed if the structural integrity of the caisson will be impaired, as determined by the Contracting Officer. Temporary steel casings shall be withdrawn, as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Casings may be jerked upward a maximum of 100 mm 4 inches to break the bottom seal, but thereafter shall be removed with a smooth, continuous motion.
- c. The inside of steel casings shall be thoroughly cleaned and oiled before reuse.
- d. The temporary casing shall be in place from the caisson top to the ground surface until the concrete has set if the elevation of the top of the caisson is below the adjacent ground surface.
- e. The outside diameter of permanent casing shall be the same as the nominal shaft diameter. Wall thickness of permanent casings shall be a minimum of [_____] mm inches.
- f. Water that flows into the excavations shall be continuously removed and all water shall be removed from the excavation bottom, to the extent possible, prior to concrete placement. The maximum permissible depth of water will be 50 mm 2 inches. In the event of a severe water condition that makes it impossible or impractical to dewater the excavation, concrete shall be placed using underwater tremie after water movement has stabilized.
- g. The bottoms of excavations indicated to be "belled" shall be enlarged to diameters and shapes shown. Bells shall be excavated or drilled in a similar manner to that used for shafts.
- h. The excavations for caissons indicated to be ["ribbed"] [_____] shall be of the dimensions and shapes indicated.
- i. Each caisson excavation will be inspected and approved by the Contracting Officer prior to placing concrete. A record of all inspections, with related construction changes, shall be kept by

the Contractor. The Contractor shall provide support personnel for inspection and testing procedures.

3.2 INSTALLATION

- a. Concrete shall be continuously placed by methods that ensure against segregation and dislodging of excavation sidewalls, and shall completely fill the shaft. Concrete shall be placed by pumping or drop chutes in dry holes and by tremie or pumping in wet holes. The discharge shall be kept a minimum of 1 m 3 feet below the fresh concrete surface during placement. Drilling of caissons or driving of casings shall not be within 6 m 20 feet of concrete placed within the last 3 days.
- b. Concrete shall be brought to a true level surface inside the shaft and a full width cross key formed, or dowels installed, should it become necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, surfaces shall be cleaned of laitance and slush with one-to-one portland cement grout. The grout shall have a water-cement ratio not exceeding that of the concrete.
- c. Concrete in dry batter caissons shall be placed with a drop chute extending within 1 m 3 feet of the concrete surface in the excavation.
- d. Concrete shall be vibrated for [full height of caisson] [upper [_____] meters feet of caisson]. Belled caissons shall be vibrated full height.

3.3 TOLERANCES

NOTE: Tolerances should be correlated with design criteria and types of caisson.

- a. Any caisson out of center or plumb beyond the tolerance specified shall be corrected as necessary to comply with the tolerances and the Contractor shall bear any cost of correction.
- b. Cross sections of shafts and bells shall not be less than design dimensions.
- c. Caissons shall be installed with top location deviating a maximum of [75] [_____] mm [3] [_____] inches from centerline locations.
- d. Vertical caissons shall be installed plumb within a maximum of 38 mm 1-1/2 inches for the first 3 m 10 feet and within 13 mm 1/2 inch for each 3 m 10 feet of additional depth.
- e. Batter caissons shall be installed a maximum of [2] [_____] percent of length from specified inclination.

3.4 PENETRATION TESTS

NOTE: Penetration tests should be included when bearing investigations are determined to be a

contract requirement.

Penetration Tests shall conform to the following:

- a. After excavation, penetration tests in the bottoms of the caissons, in [locations indicated] [[_____] caissons], to determine bearing conditions, shall be made in accordance with ASTM D 1586.
- b. The tests shall be made after caisson bottoms have been cleaned out. Minimum blow count shall be [_____] per meter foot. [Penetration tests shall be taken to a depth of [_____] meters feet below the bearing elevation. The Contractor shall obtain and retain jar samples, as directed by the Contracting Officer.]
- c. If the minimum blow count is not obtained, the shaft shall be drilled an additional [_____] meters feet and the penetration test rerun.
- d. Reports shall be submitted to the Contracting Officer in accordance with ASTM D 1586.

The Contracting Officer will approve tests and authorize subsequent concrete placement or initiate redesign procedures.

3.5 PROOF TEST HOLE REQUIREMENTS

NOTE: Omit proof test holes if rock bearing is not anticipated or nature of rock and extent of principal testing makes further testing unnecessary.

Rock Soundness test shall conform to the following:

- a. After excavation, the rock below each caisson bearing level shall be proof tested for soundness by percussion or rotary core drilling one hole in each caisson in locations indicated.
- b. Holes shall be of 50 mm 2 inch diameter and drilled with a uniform downward pressure to a depth below the bearing level equal to the design caisson shaft diameter but to a minimum of 1.2 m 4 feet.
- c. Penetration time for successive 150 mm 6 inch increments shall be recorded, noting conditions encountered.

The Contracting Officer will approve test holes and authorize subsequent concrete placement or initiate redesign procedures.

3.6 LOAD TESTS

NOTE: Specify load tests to confirm caisson design. Indicate number, size, and location of test caissons and sequence.

3.6.1 General Requirements

- a. Caisson load tests shall be performed in locations indicated.
- b. Tests shall be performed under supervision of a registered engineer provided by the Contractor and in the presence of the Contracting Officer. Test procedure shall be approved by the Contracting Officer prior to commencement of work.
- c. Load shall be applied in concentric manner with magnitude of load accurately determined and controlled.
- d. Top of caisson shall be laterally supported during entire load test.
- e. [Caisson shall be loaded to [150] [200] percent of design load, but shall not exceed ultimate concrete strength at time of loading. Load shall be applied in increments of [____]. Full test load shall be maintained for a period of [24] [____] hours and settlement readings made at not less than [1/2] [____] -hour intervals.] [Load test shall be performed in accordance with ASTM D 1143, except the maximum load shall not exceed [____] [200] percent of the design load.]
- f. [____] copies of the test report shall be submitted directly to the Contracting Officer.
- g. Tested installations will be considered of adequate design and construction if:
 - (1) No apparent distress occurs in caisson construction.
 - (2) Residual settlement, after test load is removed, does not exceed [____] mm inches.
 - (3) Twice the design load does not cause a gross settlement of more than [____] mm inches.

3.6.2 Replacements

Test caissons found inadequate because of improper instrumentation, testing, or construction procedures shall be replaced and retested, at no additional cost to the Government.

3.7 PROTECTION

Protection shall be provided around top of the excavation to prevent debris from being dislodged into the excavation and concrete.

3.8 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 TI 809-04, SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs done according to TI 809-05, 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.

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section 01452 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

-- End of Section --