UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007
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SECTION 35 59 13.14 20

POLYMERIC FENDER PILES
07/06

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NOTE: This guide specification covers the requirements for polymeric fender piling. These fender piling are typically used for secondary fender systems.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

Comments 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).
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NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
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NOTE: The following information shall be shown on the drawings:

1. Locations of the fender piles. (If more than one type of fender is used, the location of each type should be indicated)

2. Fender design loads.

3. Size, shape, and length of piles.

4. Connection details.

5. Length of polymeric pile protection. (The camels, seperators or watercraft should bear on the protective layer throughout the entire tidal range.

6. Soil data, where available.

7. Embedment depth. (The piles are typically designed as pinned/pinned, therefore the bottom of the piles should have lateral restraint but not fixity.

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PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 318/318M	(2002) Building Code Requirements for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM D 1599	(2005) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 2240	(2005) Rubber Property - Durometer Hardness
ASTM D 2310	(2006) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2996	(2001) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 4060	(2001) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4329	(2005) Standard Practice for Fluorescent UV Exposure of Plastics
ASTM D 570	(1998; R 2005) Water Absorption of Plastics
ASTM D 6109	(2005) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products

ASTM D 638	(2003) Tensile Properties of Plastics
ASTM D 6662	(2006) Standard Specification for Polyolefin-Based Plastic Lumber Decking Boards
ASTM D 695	(2002a) Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D 746	(2004) Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 792	(2000) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 883	(2000) Terminology Relating to Plastics
ASTM E 84	(2007) Standard Test Method for Surface Burning Characteristics of Building Materials

1.2 Glossary

See ASTM D 883 for standard terminology related to plastics.

Extrusion - A manufacturing process where molten polymer is forced through a die of a desired shape, to encapsulate fiberglass reinforced plastic or steel bars, which run continuously throughout the length of the product without joints.

FRP - Fiber reinforced polymer. A polymer matrix, either thermoset or thermoplastic, reinforced with a fiber or other material with a sufficient aspect ratio (length to thickness) to provide a discernable reinforcing function in one or more directions.

GFRP - Glass fiber reinforced plastic. A composite made from fiberglass reinforcement in a plastic (polymer) matrix.

Polymer - Any of numerous natural and synthetic compounds of usually high molecular weight consisting of up to millions of repeated linked units, each a relatively light and simple molecule.

Polymeric Pile - Piling products characterized by the use of polymers, where by (1) the pile strength or stiffness requires the inclusion of the polymer or (2) a minimum of 50% of the weight or volume is derived from the polymer. Polymeric piles may be reinforced by composite design for increased stiffness or strength.

Pultrusion - A continuous process for manufacturing composites that have a cross sectional shape. The process consists of pulling a fiber reinforcing material through a resin impregnation bath and through a shaping die, where the resin is subsequently cured.

Resin - Any of numerous physically similar polymerized synthetics or chemically modified natural resins. Two main types of polymers used for resins include thermoset and thermoplastic materials.

Thermoset Plastics (thermosets) - Refer to a range of polymer materials that once cured do not flow, or melt when heated. Thermoset materials are transformed, through the addition of energy, to a stronger substance. Thermoset materials are usually liquid or malleable prior to curing, and designed to be molded into their final form, or used as adhesive. Thermoset polymer resins can be transformed into plastics or rubbers by cross-linking. A thermoset material cannot be melted and re-molded after it is cured. Thermoset materials are generally stronger than thermoplastic materials. They are also better suited to high temperature applications. They are not easily recyclable like thermoplastics, which can be melted and re-molded. Examples of thermoset plastics include: natural rubber, Bakelite, Urea-Formaldehyde, Melamine, Polyester Resin, and Epoxy Resin.

Thermoplastics - Most thermoplastics are high molecular weight polymer chains, mostly joined through weak dispersion forces and more rarely dipole-dipole interactions. Thermoplastic polymers are usually contrasted with thermosetting polymers, which cannot go through melt/freeze cycles. Many thermoplastic materials are addition polymers (chain growth polymers), such as polyethylene and polypropylene.

1.3 SUBMITTALS

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

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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.] [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 01 33 00 SUBMITTAL PROCEDURES:

SD-02, Shop Drawings

Polymeric piles G

SD-03, Product Data

Polymeric piles G

Include dimensions, material specifications, and method of manufacture.

Pile driving equipment G

Driving helmet G

Pile caps G

Pile driving tips G

Driving pads G

Pile tops G

Manufacturer's Warranty G

Contractor's Warranty G

SD-05 Design Data

Polymeric piles G

Design calculations G

Concrete mix design G

SD-06, Test Reports

Material Test Reports G

Performance Test Data G

Delivery inspection list

Field inspect and submit a verification list of each pile indicating the condition of the polymeric. Do not incorporate materials damaged in transport from plant to site.

SD-07, Certificates

Driving hammer G

Polymeric piles G

SD-11, Closeout Submittals

Pile records

Submit the close out version of the pile driving records in a type written format within 14 calendar days after completion of driving.

1.4 DELIVERY, STORAGE, AND HANDLING

The Contractor shall inspect each pile, upon delivery, for surface damage, cracks, blemishes, scaring and straightness. The condition of each pile shall be recorded and the delivery inspection list shall be submitted to the Contracting Officer. The Contractor shall handle the piles with ropes or nylon slings without dropping, breaking, bruising or penetrating outer surface with tools. Do not use cant dogs, peaveys, hooks or pikepoles. Protect piles from damage. Store piles above the ground on blocking which is shaped or padded and prevent scaring or sagging of the piles. Storage racks shall be arranged to permit air circulation and shall be covered.

1.5 BASIS OF BIDS

1.5.1 Fender Piles

Base bids on the number, circumference, and length of piles as indicated. Should the total number of piles vary from that specified as the basis for bidding, the Contract price will be adjusted in accordance with Contract Clause entitled "Changes". Adjustment in Contract price will not be made for cutting off piles, for any portion of a pile remaining above the cutoff elevation, or for broken, damaged or rejected piles.

PART 2 PRODUCTS

2.1 PILE CLASSIFICATION

1. Type 1 - Polymeric only

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NOTE: Non-composite plastic piles are not commonly used for fender pile applications.
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2. Type 2 - Polymeric with reinforcement in the form of chopped, milled or continuous fiber or mineral

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NOTE: Non-composite fiberglass pile are not commonly used for fender pile applications.
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3. Type 3 - Polymeric with reinforcement in the form of metallic bars, or cages, or shapes

****
NOTE: The most common Type 3 fender piles are plastic piles with steel reinforcing.
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4. Type 4 - Polymeric with reinforcement in the form of non-metallic bars or cages

****

NOTE: The most common Type 4 fender piles are plastic piles with fiberglass reinforcing.

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5. Type 5 - Polymeric composite tube with a concrete core

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NOTE: The most common Type 5 fender piles are fiberglass tubes with concrete fill.

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6. Type 6 - Any other polymeric piling meeting the requirements of this specification and not otherwise described above

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NOTE: The Type 6 fender pile section provides for new types of polymeric pilings.

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2.2 POLYMERIC PILES

Provide polymeric piles manufactured as specified. All polymeric fender piles of a particular type shall be the product of a single manufacturer. Each pile shall be permanently tagged with the pile's serial number, date of fabrication and manufacturer's name. The stamp or tag shall be placed two to four feet from the top of the pile and shall be visible after installation. The tags shall not be placed on the outer face (berthing side) of the pile. Piles shall be in one piece. Splices will not be permitted, unless approved by the Contracting Officer. Provide pile driving tips, when required, per Manufacturer's recommendations. All polymeric fender piles shall be delivered to the job site complete and ready to drive. Pile diameter shall be as indicated.

2.3 PERFORMANCE REQUIREMENTS

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NOTE to Designer: Polymeric piles are not recommended for the replacement of single piles when the polymeric pile stiffness is different than that of the pile being replaced. When this occur, the less stiff pile will not carry its share of the berthing load. As an example, polymeric piles will usually be more flexible than timber piles, in which case the timber piles adjacent to the polymeric piles will take increased loads, which may cause the piles to fail. Therefore, single or limited replacement of the timber piles are not recommended. Transverse misalignment of the piles can also cause individual piles to fail, and precautions to minimize this occurrence should to be taken.

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The cross-sectional dimensions of piles shall be determined on the basis of the ability to perform satisfactorily under the physical loading and environmental conditions imposed and to effectively perform the energy absorption properties desired. The Contractor shall submit the Performance Test Data and or Design Calculations to substantiate the performance.

2.4 PERFORMANCE CHARACTERISTICS

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NOTE: The designer shall select the appropriate pile types and fill in the required performance characteristics for each pile.

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Each fender pile shall have the following performance characteristics:

		OPERATIONAL CONDITIONS		
PILE TYPE	ENERGY ABSORPTION (ft-kips)	MINIMUM ELASTIC DEFLECTION (inches)	DESIGN FLEXURAL STIFFNESS (EI) ($lb\text{-}in^2$)	ALLOWABLE FLEXURAL STRENGTH (Ma) (lb-in)
[1]	[_____]	[_____]	[_____]	[_____]
[2]	[_____]	[_____]	[_____]	[_____]
[3]	[_____]	[_____]	[_____]	[_____]
[4]	[_____]	[_____]	[_____]	[_____]
[5]	[_____]	[_____]	[_____]	[_____]
[6]	[_____]	[_____]	[_____]	[_____]

		OPERATIONAL CONDITIONS		
PILE TYPE	ENERGY ABSORPTION (kN-m)	MINIMUM ELASTIC DEFLECTION (mm)	DESIGN FLEXURAL STIFFNESS (EI) ($N\text{-}mm^2$)	ALLOWABLE FLEXURAL STRENGTH (Ma) (N-mm)
[1]	[_____]	[_____]	[_____]	[_____]
[2]	[_____]	[_____]	[_____]	[_____]
[3]	[_____]	[_____]	[_____]	[_____]
[4]	[_____]	[_____]	[_____]	[_____]
[5]	[_____]	[_____]	[_____]	[_____]
[6]	[_____]	[_____]	[_____]	[_____]

2.4.1 Flexural Strength

Test Procedures shall be per ASTM D 6109 except as modified herein:

Specimens Tested

A minimum sample size of five specimens shall be tested to determine the flexural properties of the fender pile type.

Allowable Flexural Strength

The Allowable Flexural Strength (Ma) of the pile is given as the Nominal Flexural Strength Mn, divided by the General Adjustment Factor, Ga. The Nominal Flexural Strength, Mn, of the pile is product of the mean value minus one standard deviation at 3 percent strain (Fb @ 3%strain) and the section modulus S, of the pile. The General Adjustment Factor, Ga, which accounts for end use and the duration of the tests, is given as 3.0.

Ma=Mn/Ga and Mn=(Fb @ 3%strain) x S

Laterally-loaded piles shall be cycled five times to the lesser of 1.0 percent strain or 30 percent of failure.

2.4.2 Flexural Stiffness

The Design Flexural Stiffness, (EI) of the pile is the product of the Modulus of Elasticity (E) of the pile and the Moment of Inertia (I)of the gross section of the pile. The Modulus of Elasticity (E), is the average value of the Chord Modulus at 1% strain determined in accordance with ASTM D 6109. A factor of safety of 2 shall be used for flexure.

2.5 SIZE TOLERANCES

2.5.1 Circular Piles

The tolerance against the specified diameter shall be plus or minus 3 percent. The maximum eccentricity (out of roundness)at any cross-section is e=0.2 when calculated as follows:

e=(square root of (a^2-b^2)) divided by a; where 2a = major diameter and 2b = minor diameter.

2.5.2 Square Piles

The dimensions shall not vary from the specified dimension by more than 3 percent. The squareness of the piles shall not be greater than 3 percent when calculated as follows: the percentage shall be determined by measuring the opposing diagonals and using the larger diameter as the numerator and the smaller diagonal as the denominator.

2.6 MATERIALS

2.6.1 Physical Properties

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NOTE: The designer shall select the appropriate pile types and fill in the required physical properties for each pile. Properties which do not apply to a particular pile type may be deleted or indicated as n/a.

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The physical properties for each type of material shall be as follows: The Contractor shall submit Material Test Reports, as applicable, for each type of material.

Physical Properties of Polymeric Material

Property	Type 1	Types 2,3 & 4	Type 5	Type 6
Density ASTM D 792 lb/ft^3	34-50 core 50-65 skin	34-50 core 50-65 skin	140 min.	[_____]
Water Absorption ASTM D 570 at 24 hours	< 3%	< 3%	< 3%	[_____]
Brittleness ASTM D 746	No Break	No Break	No Break	[_____]

Physical Properties of Polymeric Material

Property at -40^{0}F	Type 1	Types 2,3 & 4	Type 5	Type 6
Hardness ASTM D 2240 Shore D	45-55	45-55	[_____]	[_____]
Ultraviolet ASTM D 4329 Change in Shore D Durometer Hardness after 500 hours Exposure	<or= 10%	<or= 10%	[_____]	[_____]
Weatherability ASTM D 6662 Change in Flexural Modulus and Strength after 2000 hours Exposure	<or= 10%	<or= 10%	<or= 10	[_____]
Flame Spread Rating ASTM E 84	<or= 200	<or= 200	<or= 200	[_____]
Abrasion ASTM D 4060 Weight loss Wear Index: 2.5-3.0 Cycles: 10,000	<0.5g	<0.5g	n/a	[_____]
Compressive Modulus ASTM D 695 psi, minimum	3,500	40,000	50,000	[_____]
Tensile Properties ASTM D 638 psi, minimum	500	500	60,000	[_____]
Tensile Strength Circumferential ASTM D 1599 psi, minimum	[_____]	[_____]	35,000	[_____]
Fiber Percent by Volume minimum	n/a	[_____]	50	[_____]

Physical Properties of Polymeric Material

Property	Type 1	Types 2,3 & 4	Type 5	Type 6
Fiber Percent by Weight minimum	n/a	[_____]	68	[_____]
Laminate Void Content percent	n/a	n/a	-2	[_____]

Physical Properties of Polymeric Material

Property	Type 1	Types 2,3 & 4	Type 5	Type 6
Density ASTM D 792 kg/m^3	540-800 core 800-1050 skin	540-800 core 800-1050 skin	2,200 min.	[_____]
Water Absorption ASTM D 570 at 24 hours	< 3%	< 3%	< 3%	[_____]
Brittleness ASTM D 746 at -40^{0}C	No Break	No Break	No Break	[_____]
Hardness ASTM D 2240 Shore D	45-55	45-55	[_____]	[_____]
Ultraviolet ASTM D 4329 Change in Shore D Durometer Hardness after 500 hours Exposure	<or= 10%	<or= 10%	[_____]	[_____]
Weatherability ASTM D 6662 Change in Flexural Modulus and Strength after 2000 hours Exposure	<or= 10%	<or= 10%	<or= 10	[_____]
Flame Spread Rating ASTM E 84	<or= 200	<or= 200	<or= 200	[_____]
Abrasion ASTM D 4060 Weight loss Wear Index: 2.5-3.0	<0.5g	<0.5g	n/a	[_____]

Physical Properties of Polymeric Material

Property	Type 1	Types 2,3 & 4	Type 5	Type 6
Cycles: 10,000				
Compressive Modulus ASTM D 695 kPa, minimum	24,000	275,000	340,000	[_____]
Tensile Properties ASTM D 638 kPa, minimum	3,450	3,450	410,000	[_____]
Tensile Strength Circumferential ASTM D 1599 kPa, minimum	[_____]	[_____]	240,000	[_____]
Flexural Properties ASTM D 6109, except as modified herein psi, minimum	[_____]	[_____]	[_____]	[_____]
Fiber Percent by Volume minimum	[_____]	[_____]	50	[_____]
Fiber Percent by Weight minimum	[_____]	[_____]	68	[_____]
Laminate Void Content percent	[_____]	[_____]	-2	[_____]

2.6.2 Type 2 and 3 Polymeric Piles

2.6.2.1 Placement of Reinforcing

Longitudinal reinforcement shall remain within 5 percent of the specified radial location as measured from centroid of the cross-section of the pile. Longitudinal reinforcement shall not twist more than 5 degrees over any 20 foot6.1 m section of the pile. The minimum cover shall be 1 inch25 mm.

2.6.3 Type 5 Polymeric Piles

2.6.3.1 Polymeric Composite Tube

The polymeric composite pile shall be comprised of material which provides the tube strength. The polymeric material shall be "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin). The tube shall be manufactured in accordance with ASTM D 2996 and ASTM D 2310.

2.6.3.2 Outer Surface

The outer surface is to provide a protective barrier as well as wear and

impact resistance and shall be comprised of a suitable, high impact, marine grade coating. It shall provide an ultraviolet and chemical resistant barrier of at least 0.03 inch0.75 mm thickness and be of a black opaque color.

2.6.3.3 Inner Surface

The inner surface shall be comprised of a pure polymeric liner layer of at least 0.025 inch0.64 mm thickness for alkalinity resistance. The inner surface shall be roughened or wrinkled to provide adhesion of the inner shell to the concrete fill.

2.6.3.4 Concrete Fill

The concrete fill shall be secured and engaged within the polymeric composite tube and act compositely. The concrete fill shall have a minimum 28-day compressive strength of 6,000 psi41.4 MPa. Core concrete shall be expansive in nature and must set to a permanent positive stress, with a minimum outward expansion of 20 psi0.14 MPa. Submit a concrete mix design certifying that the proportioning of the mix is in accordance with ACI 211.1 or ACI 318/318Mfor specified strength and is based upon aggregate data which has been determined by laboratory tests during the last twelve months. All material to be provided by an approved batch plant.

2.7 PILE FINISHING

2.7.1 Polymeric Pile Protection

The top of the polymeric piles shall have an abrasion resistance less than 0.5g per ASTM D 4060. If the materials are reactive to seawater, the pile shall be protected by encasement in an abrasion resistant polymer. [The protective encasement shall extend, as a minimum, from 2 feet0.6 m below the lowest low water to 2 feet0.6 m above the highest high water, unless indicated otherwise.]

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NOTE: For barges or other flat sided vessels and for systems supporting deep draft seperators, the length of protection may need to be increased. For barges, the contact surface may be near the deck level if there is a rail, or if the piles are sloped the contact area may be near the bottom of the hull. For deep draft seperators, the contact areas will be at the upper and lower rub strips.

****

2.7.2 Surface Condition

The pile surface exhibiting roughness or corrugations due to manufacturing processes, shall not have depressions or projections greater than 1/2 inch 12 mm and less than 9 $in^2$5,800 mm^2 in surface area. The surface of the pile shall contain no cracks or splits, in any orientation.

2.7.3 Pile Tops

The tops of the polymeric piles shall be covered with an approved cap or encapsulated in polymeric material.

2.7.3.1 Pile Top Caps

The caps shall be made of a polyethylene material, have a thickness of approximately 0.125 inches3 mm and be colored to match the pile. The caps shall be secured in place with 1/4" diameter by 1 1/2 inch6 mm diameter by 38mm long stainless steel screws spaced a maximum of 8 inches200 mm on center, The screws shall be centered in the ribbon band of the cap. The screw types shall be appropriate for the matrix material and be placed in pilot holes.

2.8 SOURCE QUALITY CONTROL

2.8.1 Plant Inspection

The Contracting Officer reserves the right to perform plant inspection of the polymeric pile manufacturing process. Provide the Contracting Officer with a minimum 2-week advance notice, indicating the date manufacturing is to start, and tests that are to be conducted. Allow the Contracting Officer unlimited access to the plant and inspection privileges for each facet of the manufacturing process.

2.8.2 Curing

2.8.2.1 Type 1, 2, 3 and 4 Polymeric Piles

The polymeric piles, Types 1, 2, 3 and 4 shall cure at the plant a minimum of three weeks prior to shipment to the site.

2.8.2.2 Type 5 Polymeric Piles

Concrete filled piles shall be filled with concrete prior to driving. Support the pile to prevent sag during concrete placement and curing. The Type 5 polymeric piles shall cure a minimum of one week prior to placement of the concrete fill. Piles shall be moved to curing table within 20 minutes of wet concrete placement. Do not handle or transport piles for seven days or until concrete has reached 2,500 psi17 MPa strength. Drive piles after full strength has been obtained or after 28 days of curing.

2.9 MANUFACTURER'S WARRANTY

In addition to the Manufacturer's standard one year warranty, the Manufacturer shall warranty all polymeric piles to be free from defects in materials and workmanship for a period of ten years. The Contracting Officer has the right to require complete replacement of any pile with material or workmanship defects. The Manufacturer shall cover all construction costs related to the repair or replacement of the defective piles. This warranty need not cover repairs required as a result of normal wear and tear, misuse, mishandling, extreme weather or other acts of God, failure to perform routine maintenance, non-recommended or improperly executed alterations by anyone other than the Manufacturer, tampering, loading of the pile beyond its rated capacity, improper installation, or other use inconsistent with Manufacturer's specifications.

2.10 CONTRACTOR'S WARRANTY

The Contractor shall warranty all polymeric piles to be free from defects in materials caused by mishandling prior to installation and improper installation for a period of ten years. The Contracting Officer has the right to require complete replacement of any pile deemed by the Contracting

Officer to have defects due to mishandling or improper installation. The Contractor shall cover all construction costs related to the repair or replacement of the defective piles.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Type 5 Polymeric Piles

3.1.1.1 On Site Storage

Piles shall be stored and continually supported in a manner which minimizes creep, saddling and sag.

3.1.2 Preexcavation

3.1.2.1 Jetting of Piles

Jetting of piles shall not be permitted without the approval of the Contracting Officer.

3.1.2.2 Spudding of Piles

Spudding of piles shall not be permitted without the approval of the Contracting Officer. If spudding is allowed, it shall be limited to an elevation 5 feet above the specified pile tip elevation.

3.1.2.3 Predrilling of Piles

Predrilling of piles shall not be permitted without the approval of the Contracting Officer.

3.1.3 Driving Piles

3.1.3.1 Equipment

Pile driving equipment shall be an air, steam, or diesel powered hammer, and be of an approved type. The driving hammer shall have a capacity at least equal to the hammer Manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. Provide driving helmet, pile caps, pile driving tips and driving pads as recommended by the pile Manufacturer for the polymeric piles. If a pile fails to reach the indicated tip elevation, notify Contracting Officer, provide pile record and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB.

3.1.3.2 Protection of Piles

Square the heads and tips of piles to the driving axis. Laterally support piles during driving, but do not unduly restrain piles from rotation in the leads. The use of swinging or hanging leads shall be at Contractor's risk. Any damage incurred by such use shall be repaired by the Contractor at the Contractor's expense.

3.1.3.3 Tolerances in Driving

Piles shall be driven in the locations indicated. Each fender pile, at its contact with the design mudline or mudline elevation indicated in the

construction documents, shall be placed a maximum of 0.5 inch per foot40 mm per meter of free pile length (length in feetmeters above the average soil contact line at each pile)in a direction parallel to the pier face and 0.125 inch per foot10 mm per meter of the free pile length in a direction perpendicular to the pier face. Remove and replace with new piles those damaged, mislocated, driven below the design cutoff, or driven out of alignment.

3.1.4 Buoyant Piles

After driving buoyant piles, the contractor shall provide temporary framing or weights to prevent the pile from floating up out of the ground. The temporary framing or weights shall remain in place until the pile is secured in place. If there is sufficient friction provided by the soil to prevent the pile from floating, the Contractor may, at his own risk, waive the temporary framing or weight requirement.

3.1.5 Pile Cut-Off

Each polymeric pile provided shall be a minimum of 2 feet0.6 meter longer than the specified length to allow the top to be cut-off if it is damaged during driving. Cut off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods per the polymeric pile Manufacturer's recommendations. Use of explosives for cutting is not permitted. Pile heads at cut-off shall be level and sound. The Contractor shall cut off piles at no additional cost to the Government.

3.1.6 Fastening

Fasten the polymeric piles to the existing pier as indicated.

3.2 FIELD TREATMENT

3.2.1 Polymeric Work

Field treat cuts, bevels, notches, refacing and abrasions made in the field in accordance with the Manufacturer's recommendations. The tops of the piles shall be covered with an approved cap. The cover shall be applied per the Manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspections

Inspect piles when delivered and when in the leads immediately before driving. Secure piles in their proper alignment.

When Government inspections result in product rejection, the Contractor shall promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor an additional cost of inspection or testing when prior rejection makes reinspection or retesting necessary.

3.3.1.1 Straightness

Each pile shall be measured for straightness prior to driving by placing a straight line from the center of the top to the center of the tip. The line shall lie entirely within a 10 inch250 mm diameter circle centered at the centerline of the pile, when it is suspended from the head. The piles

shall also be free of short crooks that deviate more than 2½ inch64 mm from straightness in any 20 feet6 meter length. Piles not meeting with criteria shall be rejected.

3.3.1.2 Cracks and Defects

Each pile shall be inspected for cracks and defects prior to driving. After the piles are installed and all connections to the structure are completed, each pile shall again be inspected for cracks and defects. The Contractor shall notify the Contracting Officer of any cracking or other defects observed, and await direction. The Contracting Officer may reject any piles with defects. The Contractor shall be responsible for all costs incurred to replace the rejected piles.

3.3.2 Pile Driving Inspection

The Contractor shall perform special inspection of the pile installation. The Contractor shall employ approved Special Inspectors as required in the paragraph entitled "QC Specialist Duties and Qualifications" in Section 01 45 00.00 20, "CONSTRUCTION QUALITY CONTROL"

3.3.3 Pile Records

For each pile, keep a record of the number of blows required for each 0.30 m foot of penetration and the number of blows for the last 150 mm 6 inch penetration or fraction thereof. Include in the record the beginning and ending times of each operation during driving of pile, type and size of the hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of the hammer cushion (capblock) and pile cushion used. Record re-tap data and any unusual occurrence during driving of the pile. Include in the record performance characteristics of jet pump, unassisted penetration of pile, jet-assisted penetration of pile, and tip elevation before driving and at end of driving. Notify Contracting Officer 10 days prior to driving of piles. Submit complete and accurate records of installed piles to Contracting Officer within 15 calendar days after completion of the pile driving. Make pile-driving records available to the Contracting Officer at the job site within 24 hours of each day's pile driving. A preprinted form for recording pile driving data is included at the end of this section.

PILE DRIVING LOG

CONTRACT NO._____ CONTRACT NAME_____
CONTRACTOR_____ TYPE OF PILE_____
PILE LOCATION_____ PILE SIZE: BUTT/TIP: _____ LENGTH_____
GROUND ELEVATION_____ CUT OFF ELEVATION_____
PILE TIP ELEVATION_____ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION_____ COMPANY_____

HAMMER: MAKE & MODEL_____ WT. RAM_____
STROKE_____ RAM RATED ENERGY_____
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____
CUSHION MATERIALS & THICKNESS_____

INSPECTOR_____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO MUDLINE ELEVATION

TIME: START DRIVING_____ FINISH DRIVING_____ DRIVING TIME_____
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_____
JET PRESSURE & ELEVATIONS_____

DRIVING RESISTANCE

DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS
0	_____	3.0	_____	7.0	_____	10.0	_____
0.3	_____	3.3	_____	7.3	_____	10.3	_____
0.6	_____	3.6	_____	7.6	_____	10.6	_____
0.9	_____	3.9	_____	7.9	_____	10.9	_____
1.2	_____	4.2	_____	8.2	_____	11.2	_____
1.5	_____	4.5	_____	8.5	_____	11.5	_____
1.8	_____	4.8	_____	8.8	_____	11.8	_____
2.1	_____	5.1	_____	9.1	_____	12.1	_____
2.4	_____	5.4	_____	9.4	_____	12.4	_____
2.7	_____	5.7	_____	9.7	_____	12.7	_____

REMARKS_____

_____

_____

_____

PILE TOP ELEVATION: FROM DRAWING _____

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = _____

DRIVEN LENGTH = PILE TOP ELEVATION - TIP ELEVATION = _____

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = _____

PILE DRIVING LOG

CONTRACT NO._____ CONTRACT NAME_____
CONTRACTOR_____ TYPE OF PILE_____
PILE LOCATION_____ PILE SIZE: BUTT/TIP: _____ LENGTH_____
GROUND ELEVATION_____ PILE TOP ELEVATION_____
PILE TIP ELEVATION_____ COMPANY_____

HAMMER: MAKE & MODEL_____ WT. RAM_____
STROKE_____ RAM RATED ENERGY_____
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____
CUSHION MATERIALS & THICKNESS_____

INSPECTOR_____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO MUDLINE ELEVATION

TIME: START DRIVING_____ FINISH DRIVING_____ DRIVING TIME_____
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_____
JET PRESSURE & ELEVATIONS_____

DRIVING RESISTANCE

DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS
0	_____	10	_____	20	_____	30	_____
1	_____	11	_____	21	_____	31	_____
2	_____	12	_____	22	_____	32	_____
3	_____	13	_____	23	_____	33	_____
4	_____	14	_____	24	_____	34	_____
5	_____	15	_____	25	_____	35	_____
6	_____	16	_____	26	_____	36	_____
7	_____	17	_____	27	_____	37	_____
8	_____	18	_____	28	_____	38	_____
9	_____	19	_____	29	_____	39	_____

REMARKS_____

_____

_____

_____

PILE TOP ELEVATION: FROM DRAWING _____

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = _____

DRIVEN LENGTH = PILE TOP ELEVATION - TIP ELEVATION = _____

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = _____

-- End of Section --