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USACE / NAVFAC / AFCEC / NASA | **UFGS-06 82 14 (May 2018)**

Preparing Activity: NASA | **Superseding UFGS-06 82 14 (February 2015)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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05/18

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SECTION 06 82 14

FIBERGLASS REINFORCED PLASTIC (FRP) PIPE AND TUBE RAILINGS
05/18

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NOTE: This guide specification covers the requirements for fiberglass reinforced plastic (FRP) pipe and tube railings, customarily manufactured to meet specific requirements in building construction and fabricated FRP items, which are not a part of the structural FRP components or framework.

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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NOTE: Units of work normally included in this section should be FRP items that require specific fabrication to meet the desired project requirements.
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NOTE: Include in drawings a complete design indicating the character of the work to be performed and showing the following:

a. Location and details of each fabricated FRP pipe and tube railings components showing all dimensions, shapes, and sizes of members and connections, and the relation of items to other building components.

b. All sizes and dimensions.

c. Special fastenings, attachments or anchoring, including anchorage devices embedded in other construction, including but not limited to, precast concrete wall panels, precast concrete structural members, precast concrete roof decking, brick and block masonry, and precast stone work; anchorage devices to structural steel framework, including, but not limited to, steel bar grating, steel floor plates, and structural steel roof or floor decking.

d. Location and special details of expansion joint covers.

e. Connection details, other than manufacturer's standard for pipe and tube railings.

f. Locations and details removable sections of handrails.

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PART 1 GENERAL

This Section includes new fiberglass reinforced plastic (FRP) pipe and tube railing/guards, mounting systems and accessories.

1.1 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.

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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.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2013; R 2017) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2013) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D430	(2006; R 2012) Standard Test Methods for Rubber Deterioration - Dynamic Fatigue
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D1148	(2013; R 2018) Standard Test Method for Rubber Deterioration—Discoloration from

	Ultraviolet (UV) or UV/Visible Radiation and Heat Exposure of Light-Colored Surfaces
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E488/E488M	(2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2018) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2021) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1926	Safety and Health Regulations for Construction

1.2 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.

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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-01 Preconstruction Submittals

Qualifications of Manufacturer; G[, [____]]

Qualifications of Engineer of Record; G[, [____]]

SD-02 Shop Drawings

Installation Drawings; G[, [____]]

SD-03 Product Data

FRP Pipe and Tube; G[, [____]]

Railings/Guards; G[, [____]]

Anchorage Materials; G[, [____]]

Adhesives; G[, [____]]

Resins; G[, [____]]

Hardeners; G[, [____]]

Manufacturer's Sample Warranty

SD-06 Test Reports

Ultraviolet Test Reports

Thermal Expansion Test Reports

Flame Spread Test Reports

SD-07 Certificates

Manufacturer's Certification by the State of [_____] Product Approval

Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR)

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-09 Manufacturer's Field Reports

Manufacturer's Certification of Installation

SD-11 Closeout Submittals

Manufacturer's Warranty

1.3 QUALITY CONTROL

1.3.1 Qualifications of Manufacturer

Submit Qualifications Of Manufacturer documentation certifying that the Fiberglass Reinforced Plastic (FRP) manufacturer has a minimum of [10][_____] years of experience in manufacturing FRP products.

Provide items within this section from manufacturers having a minimum of [5] [10] [_____] years of experience in the design and manufacture of similar products and systems.

[Submit documentation proving a minimum of five separate, similar installations within the last [5] [10] [_____] years.

][Submit the Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR).

][Submit the manufacturer's certification by the State of [_____] Product Approval.

] Provide the manufacturer's sample warranty for all FRP products against defects in material and workmanship for a minimum of [5] [_____] years. Provide evidence of manufacturer's ISO 9001:2000 standard certification.

1.3.2 Qualifications of Engineer of Record

[Submit Qualifications of Engineer of Record documentation that the Engineer of Record is currently licensed within the jurisdiction of the project.

][Submit documentation that the Engineer of Record is approved, authorized, and currently licensed by the State of [_____], and has a minimum of [5] years of experience as an approved Engineer for manufacturers of similar pipe and tube railing systems. Require the Engineer of Record to supply the name and location of [five] projects of similar size and scope for which they have provided engineering calculations using the manufacturer's products submitted for this project within the previous [3] [_____] years. Provide certified and signed calculations prepared by Engineer for:

] a. The design in accordance with International Building Code and ASCE 7-16

b. Installation drawings

1.4 DELIVERY, HANDLING, AND STORAGE

Deliver all manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturers,

clearly marked and identified relative to the complete system. Provide all adhesives, resins and their catalysts and hardeners in clearly marked or noted crates or boxes. Store all manufactured materials in dry indoor facilities with a constant temperature range between 21.11 and 29.44 degrees C 70 and 85 degrees F until they are required.

Handle all materials to prevent abrasion, cracking, chipping, twisting, or other deformations, and other types of damage.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Installation Drawings

Submit templates and erection and installation drawings indicating thickness, type, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

Include plans, elevations, sections, details, and attachments to other work. Indicate for installed products to comply with design loads. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2.1.2 Product Data

Submit the manufacturer's catalog data including two copies of manufacturer's specifications, load tables, dimension diagrams, and anchor details for the following items:

a. FRP Pipe and Tube

b. Railings/Guards

c. Anchorage Materials

d. Adhesives

e. Resins

f. Hardeners

2.1.3 Design Requirements

Ensure that all posts and rails are FRP structural shapes manufactured by the pultrusion process. Compose structural shapes of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design requirements in accordance with ASCE 7-16, 29 CFR 1910.23, NFPA 101, and dimensions specified.

Ensure that fiberglass reinforcements are a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application required, the physical properties required, or both.

Provide resins, with appropriate hardeners, of isophthalic polyester, with the chemical formulation necessary for corrosion resistance, strength, and

other physical properties.

Ensure that all finished surfaces of FRP items, including FRP pipe and tube, railings/guards, anchorage materials, and fabrications, are smooth, resin-rich, and free of voids, dry spots, cracks, and unreinforced areas. Provide complete coverage of all glass fibers with resin to protect against their exposure to wear or weathering.

Protect all pultruded structural shapes from ultraviolet (UV) attack with:

a. Integral UV inhibitors within the resin

b. Synthetic surfacing veil to help produce a resin-rich surface

c. UV-resistant coating for outdoor exposures

Provide FRP products that have a flame spread rating of 25 or less as specified in ASTM E84, Tunnel Test. Submit [_____] copies of Flame Spread Test Reports to the Contracting Officer.

Ensure that rails, posts, and kick plates are integrally pigmented yellow. Submit [_____] copies of Ultraviolet Test Reports for FRP material, similar to the requirements of ASTM D1148 for rubber deterioration, and ASTM D430, to the Contracting Officer. Submit testing data relating to Thermal Expansion Test Reports.

Provide structural shapes in the guardrail system to meet minimum longitudinal mechanical properties as follows:

Tensile Strength	ASTM D638	2.068427e+008 pascal
Tensile Modulus	ASTM D638	1.723689e+010 pascal
Flexural Strength	ASTM D790	2.068427e+008 pascal
Flexural Modulus	ASTM D790	1.241056e+010 pascal
Flexural Modulus-Full Section		1.930532e+010 pascal
Short Beam Shear	ASTM D2344/D2344M	3.102641e+007 pascal
Shear Modulus-Transverse		3.102641e+009 pascal
Coefficient of Thermal Expansion	ASTM D696	2.032e-005 cm/cm/m
Flame Spread	ASTM E84	2.032e-005 cm/cm/m

Tensile Strength	ASTM D638	30,000 psi
Tensile Modulus	ASTM D638	2,500,000 psi

Flexural Strength	ASTM D790	30,000 psi
Flexural Modulus	ASTM D790	1,800,000 psi
Flexural Modulus-Full Section		2,800,000 psi
Short Beam Shear	ASTM D2344/D2344M	4,500 psi
Shear Modulus-Transverse		450,000 psi
Coefficient of Thermal Expansion	ASTM D696	.000008 in/in/F
Flame Spread	ASTM E84	25 or less

2.1.4 Performance Requirements

2.1.4.1 Structural Performance of Pipe and Tube Railings

Provide a pipe and tube railing system capable of withstanding the effects of gravity loads in accordance with ASCE 7-16 and International Building Code, ICC IBC the State of [_____] Building Code, with the following loads and stresses within limits and under the conditions indicated:

a. Handrails:

(1) Uniform load of 6.91 Kgf/m 50 lbf/foot applied in any direction.

(2) Concentrated load of 90.72 Kgf 200 lbf applied in any direction.

(3) Uniform and concentrated loads need not be assumed to act concurrently.

b. Top Rails of Guards:

(1) Uniform load of 6.91 Kgf/m 50 lbf/foot applied in any direction.

(2) Concentrated load of 90.72 Kgf 200 lbf applied in any direction.

(3) Uniform and concentrated loads need not be assumed to act concurrently.

c. Infill of Guards:

(1) Concentrated load of 6.91 Kgf/m 50 lbf applied horizontally on an area of 929 square centimeter 1 square foot.

(2) Uniform load of 1.2 kilopascal 25 lbf/square foot applied horizontally.

(3) Infill load and other loads need not be assumed to act concurrently.

2.2 FABRICATION

Perform fabrication of the handrail post/rail connection such that the

rails are unbroken and continuous through the post without the use of packs or splices. Install the bottom rail through the post at a prepared hole made to fit the outside dimensions of the rail, and the top rail fit into a machined, u-shaped pocket formed into the top of the post such that the rail is located at the center of the post. Radius all exposed corners to eliminate sharp edges. Join the rails to the post through a combination of bonding and riveting. Ensure that no sharp, protruding edges remain after assembly of the handrail. Space the posts no more than 1.83 m 72 inches apart. Attach post bases according to the construction contract drawings. Reinforce post bases to a height of 22 cm 8 1/2 inches. Coat all field-fabricated and shop-fabricated cuts with a vinyl ester resin to provide maximum corrosion resistance.

2.3 MATERIALS

2.3.1 Fasteners

Provide Type 316 stainless-steel concealed fasteners, unless unavoidable or standard for railings indicated.

2.3.2 Anchors

Provide cast-in-place epoxy mechanical anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the design load imposed when installed in unit masonry and equal to four times the design load imposed when installed in concrete, as determined by testing as specified in ASTM E488/E488M.

2.3.3 Grout And Anchoring Cement

Provide factory-packaged, nonshrink, nonmetallic grout complying with ASTM C1107/C1107M; or water-resistant, nonshrink anchoring cement; recommended by the manufacturer for exterior use. Ensure that all other adhesives conform to the manufacturer's recommendations and instructions.

2.3.4 Component Connections

2.3.4.1 Lag Screws and Bolts

Provide lag screws and bolts conforming to ASME B18.2.1, of the type and grade best suited for the purpose.

2.3.4.2 Toggle Bolts

Provide toggle bolts conforming to ASME B18.2.1.

2.3.4.3 Bolts, Nuts, Studs, and Rivets

Provide bolts, nuts, studs, and rivets conforming to ASME B18.2.2 and ASTM A307.

2.3.4.4 Powder-Driven Fasteners

Follow safety provisions of ASSP A10.3 .

2.3.4.5 Screws

Provide screws conforming to ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.

2.3.4.6 Washers

Provide plain washers conforming to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers conforming to ASME B18.21.2M and ASME B18.21.1.

PART 3 EXECUTION

3.1 INSTALLATION

Install items in accordance with 29 CFR 1910.23 and 29 CFR 1926 at locations indicated, according to the manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Include all materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation. Submit [_____] signed copies of Manufacturer's Certification of Installation.

a. Set posts plumb within a tolerance of 1.6 mm 1/16 inch in 0.91 meter 3 feet.

b. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 6.4 mm 1/4 inch in 3.66 meter 12 feet.

3.1.1 Anchorage, Fastenings, and Connections

Provide anchorage where necessary for fastening miscellaneous FRP items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through-bolts for masonry; machine and carriage bolts for steel; through-bolts and screws. Conceal fastenings where practicable.

3.1.2 Workmanship

Ensure that FRP work is well formed to shape and size, with sharp lines and angles and true curves. Ensure that drilling and punching produces clean true lines and surfaces. Ensure that exposed surfaces of work-in-place to have smooth finishes. Mill joints where tight fits are required. Ensure that corner joints are coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fasten in place. Ensure that the installation is in accordance with the manufacturer's installation instructions and the approved drawings, cuts, and details.

3.2 CLOSEOUT ACTIVITIES

3.2.1 Warranty

Submit [_____] signed copies of the Manufacturer's Warranty 30 calendar days before final inspection.

3.2.2 Manufacturer's Instructions

Submit the manufacturer's instructions for shipping and handling, and procedures for erection, care, and maintenance upon completion of installation.

-- End of Section --