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Preparing Activity: NASA New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated October 2009

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### SECTION 06 71 33

#### FIBERGLASS REINFORCED PLASTIC (FRP) LADDERS 05/09

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

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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#### PART 1 GENERAL

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Include in drawings a complete design indicating the character of the work to be performed and giving the following:

Location and details of each fabricated FRP ladder component showing all dimensions, shapes, and sizes of members, connections, and the relation of items to other building components.

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.

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## 1.1 SUMMARY

This Section includes, but is not limited to, new fiberglass reinforced plastic (FRP) ladder systems including safety ladder cages, mounting systems and related accessories.

## 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 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 LADDER INSTITUTE (ALI/LADDER)

ALI/LADDER A14.3 (2002) Standard for Fixed Ladders and Safety Requirements

### AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-05 (2006; Errata 2007) Minimum Design Loads for Buildings and Other Structures

### ASTM INTERNATIONAL (ASTM)

ASTM D 1148 (2007a) Standard Test Method for Rubber Deterioration-Discoloration from Ultraviolet (UV) and Heat Exposure of Light-Colored Surfaces

ASTM D 2344/D 2344M (2000; R 2006) Standard Test Method for Short-Beam Strength of Polymer Matrix

## Composite Materials and Their Laminates

|             |   |
|-------------|---|
| ASTM D 4000 | (2009b) Standard Classification System for Specifying Plastic Materials   |
| ASTM D 430  | (2006) Standard Test Methods for Rubber Deterioration - Dynamic Fatigue   |
| ASTM D 495  | (1999; R 2004) Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation  |
| ASTM D 638  | (2008) Standard Test Method for Tensile Properties of Plastics  |
| ASTM D 696  | (2008) 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 D 790  | (2007e1) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials  |
| ASTM E 84   | (2009c) Standard Test Method for Surface Burning Characteristics of Building Materials  |

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

|          |   |
|----------|---|
| NFPA 101 | (2008; Amendment 2009) Life Safety Code |
|----------|---|

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

|                |  |
|----------------|--|
| 29 CFR 1910.27 | Fixed Ladders                                  |
| 29 CFR 1926    | Safety and Health Regulations for Construction |

### 1.3 PERFORMANCE REQUIREMENTS

#### 1.3.1 Structural Performance of Ladders

Provide ladders capable of withstanding the effects of gravity loads as per [ASCE 7-05](#) and the International Building Code, as well as loads and stresses within limits and under conditions specified in [29 CFR 1910.27](#) and [ALI/LADDER A14.3](#).

#### 1.3.2 Thermal Movements

Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss. The design criteria temperature change (range) is 120 degrees F, ambient; 180 degrees F, material surfaces.

### 1.3.3 Safety Performance of Ladders

Provide a ladder system, which fully complies with NFPA 101, OSHA 29 CFR 1910.27 and ALI/LADDER A14.3 for distance between rungs, cleats, steps and minimum clearances for cages and climbing space.

### 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 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.][for information only. When used, a designation following the "G" designation 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

Qualification of Manufacturer

Qualification of Engineer of Record

#### SD-02 Shop Drawings

Submit fabrication and installation drawings and details for FRP

fabrications.

Include plans, elevations, sections, and details of FRP fabrications and their connections. Show anchorage and all accessory items.

Provide templates for anchors and bolts specified for installation under other Sections.

For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### SD-03 Product Data

Submit [Manufacturer's catalog data](#) including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

[FRP Ladders and Ladder Safety Cages](#)

[Anchorage Materials](#)

#### SD-06 Test Reports

[Ultraviolet Testing](#)

[Thermal Expansion](#)

[Flame Spread](#)

#### SD-07 Certificates

[Manufacturer's Sample Warranty](#)

#### SD-08 Manufacturer's Instructions

Submit [Manufacturer's recommendations](#) for shipping, handling, erection procedures, and care and maintenance upon completion of installation.

#### SD-11 Closeout Submittals

[Manufacturer's Warranty](#)

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Qualification of Manufacturer

Fiberglass Reinforced Plastic (FRP) manufacturer is required to have a minimum of [10][\_\_\_\_\_] years experience in manufacturing FRP products.

[A record of a minimum of at least 5 previous, separate, similar installations within the last [5] [10] [\_\_\_\_\_] years.]

Manufacturer is to warranty all FRP products against defects in material and workmanship for a minimum of [5] [\_\_\_\_\_] years. Manufacturer to provide evidence of ISO 9001-2000 standard certification. Submit [\_\_\_\_\_] copies of [Manufacturer's catalog data](#) and [Manufacturer's Sample Warranty](#).

### 1.5.2 Qualification of Engineer of Record

[Engineer of Record (ER) is to be currently licensed within the jurisdiction of the project.]

[Provide documentation that the Engineer of Record (ER) is approved, authorized, and currently licensed by the state of [\_\_\_\_], and has a minimum of five years experience as an approved Engineer for manufacturers of similar ladder systems. Supply the names and locations of five projects of similar size and scope for which the ER has provided engineering calculations using the manufacturer's products submitted for this project within the previous three years. Provide ER certified engineering calculations and sealed documents for:]

ASCE 7-05, in accordance with International Building Code

Fabrication and installation drawings and details

### 1.6 PRODUCT DELIVERY 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 to facilitate their safe movement to a dry indoor storage facility with a constant temperature range between 70 and 85 degrees Fahrenheit until they are required.

Submit [Manufacturer's recommendations](#) for shipping and handling. Handle all materials to prevent abrasion, cracking, chipping, twisting, or other deformations and other types of damage.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

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

### 2.2 PRODUCT REQUIREMENTS

All ladder side rails, rungs, mounting brackets, cage straps, and related safety rail system are to be FRP structural shapes manufactured to comply with or exceed the specified standards contained in this Section. Provide [FRP ladders and ladder safety cages](#) and [anchorage materials](#), including cage hoops, brackets, and all other structural shapes composed of reinforced fiberglass components and resin in qualities, quantities, properties, arrangements and dimensions as specified in the Contract Documents. Complete assembly is to meet the minimum requirements of [ASCE 7-05](#), Florida Building Code, and [29 CFR 1910.27](#).

Fiberglass reinforcement is to be a combination of continuous roving, continuous strand mat, bi-directional roving mat and surfacing veil in sufficient quantities as required by the application and/or physical properties. Clearly identify components per [ASTM D 4000](#). Submit documentation verifying structural integrity in relation to [thermal expansion](#).

Make all finished surfaces of FRP items smooth, resin-rich, free of voids and dry spots, cracks, crazes or unreinforced areas. Provide system which is completely covered with resin protection against exposure due to wear, weathering, and ultraviolet light damage. Submit [Ultraviolet Testing](#)(UV) results and documented protection with:

- a. Integral UV inhibitors in the resin.
- b. A synthetic resin rich surfacing veil, meeting or exceeding the requirements of [ASTM D 1148](#).

Provide FRP products which have a tested [flame spread](#) rating of 25 or less per [ASTM E 84](#) Tunnel Test, with a ladder system meeting the minimum requirements of [ASTM D 430](#) and [ASTM D 495](#).

Provide 316 stainless steel bolts for attaching ladder cage vertical bars to hoops, ladder hoops to brackets, ladder cage brackets to the ladder, wall brackets to the ladder, and landing safety rails to the system. Mechanically attach all rungs to the ladder with 18-8 stainless steel rivets and chemically bond with resin.

All ladder and cage components are to be integrally pigmented yellow. All wall and vertical rail base mount brackets are to be light gray.

Provide structural shapes in the ladder system meeting minimum longitudinal mechanical properties as follows:

|                                   |                                     |                 |
|-----------------------------------|-------------------------------------|-----------------|
| Tensile Strength:                 | <a href="#">ASTM D 638</a>          | 30,000 psi      |
| Tensile Modulus:                  | <a href="#">ASTM D 638</a>          | 2,500,000 psi   |
| Flexural Strength:                | <a href="#">ASTM D 790</a>          | 30,000 psi      |
| Flexural Modulus:                 | <a href="#">ASTM D 790</a>          | 1,800,000 psi   |
| Flexural Modulus-Full Section:    |                                     | 2,800,000 psi   |
| Short Beam Shear:                 | <a href="#">ASTM D 2344/D 2344M</a> | 4,500 psi       |
| Shear Modulus-Transverse:         |                                     | 450,000 psi     |
| Coefficient of Thermal Expansion: | <a href="#">ASTM D 696</a>          | .000008 in/in/F |
| Flame Spread:                     | <a href="#">ASTM E 84</a>           | 25 or less      |

## 2.3 LADDERS

The ladder fabrication and installation is to comply with [ALI/LADDER A14.3](#) and [29 CFR 1910.27](#). The ladder side rails are to be continuous pultruded [4.5 cm 1-3/4 inch](#) square tube with a minimum wall thickness of [0.635 cm 1/4 inch](#) or greater. The ladder rungs are to be [3.175 cm 1-1/4 inch](#) diameter pultruded structural shapes, continuously fluted to provide a non-slip surface. Rungs that are gritted as a secondary operation are not permitted. Rungs are to be fitted in the centerline of the siderails.

Ladder wall and floor mounts are to be fabricated from pultruded angles, [0.953 3/8 inch](#) minimum thickness. Mechanically attach all ladder rungs to ladder side rails by use of stainless steel rivets and a chemical bond of epoxy.

Protect all pultruded ladder components from ultraviolet (UV) attack by providing integral UV inhibitors in the resin and a synthetic surfacing veil to help produce a resin rich surface.



## 2.4 LADDER SAFETY CAGES

The fabrication and installation of ladder safety cage is to comply with [ALI/LADDER A14.3](#) and [29 CFR 1910.27](#).

Provide primary hoops at the top and bottom of the safety cage, spacing to be no more than 6 m 20 feet o.c. Provide secondary intermediate hoops with spacing no more than 1200 mm 48 inches o.c. between primary hoops.

The safety cage vertical bars to be [3.81 cm 1-1/2 inch](#) wide by [1.59 cm 5/8 inch](#) pultruded I-beam shapes to offer protection to workers from exposed hardware. Safety cage hoops and brackets to be manufactured by the open mold hand lay-up process. All cage hoops to be a minimum [7.62 cm 3 inches](#) wide by [0.635 cm 1/4 inch](#) thick.

## PART 3 EXECUTION

### 3.1 GENERAL

Install fabricated FRP work in accordance with the approved detail drawings and descriptive data for each item of fabricated FRP, in conformance with [29 CFR 1926](#), and as specified.

Fabricated items to be securely fastened plumb and true to lines and levels.

### 3.2 FABRICATION

The design and layout of ladders and safety cages to comply with [ALI/LADDER A14.3](#) and [OSHA 29 CFR 1910.27](#). All ladder rungs are to penetrate the tube side wall of the ladder rails and the connection is to be both chemically locking epoxy and mechanically locking rivets.

Fully shop assemble ladders. Test assemble safety cages; drill and fit to ensure proper field assembly. Leave safety cage brackets attached with bolts to the ladder for shipping, but disassemble ladder cage components. Package and ship each set of cage components with each respective ladder.

Field attach hoops to the brackets. Seal all cut, machined edges, holes and notches to provide maximum corrosion resistance. Contractor to coat all field fabricated cuts in accordance with the manufacturer's instructions.

### 3.3 FASTENING TO CONSTRUCTION-IN-PLACE

Provide anchorage devices and fasteners where necessary for fastening fabricated FRP items to construction-in-place. Fastening to include threaded fasteners for concrete inserts embedded in cast-in-place concrete; masonry anchorage devices and threaded fasteners for solid masonry and concrete-in-place; toggle bolts for hollow masonry and stud partitions; through bolting for masonry and wood construction; lag bolts and wood screws for wood construction; and connections for structural steel.

### 3.4 PERFORMANCE REQUIREMENTS

Installed ladder system is to fully comply with [OSHA 29 CFR 1910.27](#), [ALI/LADDER A14.3](#) and support a concentrated vertical load of 1200 pounds applied at mid-span of the rung.

### 3.5 INSTALLATION

Assemble and install ladder system and all components in strict accordance with the manufacturer's assembly documentation. Seal all cut or drilled surfaces per manufacturer's instructions. Provide adequate ventilation during all drilling, cutting, and resin application procedures.

### 3.6 MANUFACTURER'S WARRANTY

Submit [[\_\_\_\_\_] copies of ][Manufacturer's Warranty](#).

-- End of Section --