FAA-E-2702
May 10, 1979
SUPERSEDING FAA-E-2640,
dated 8/4/76, and
FAA-E-2659, dated 9/7/76

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

LOW-IMPACT RESISTANT STRUCTURES

1. SCOPE

1.1 Scope.- This specification sets forth the requirements for the design and fabrication of low-impact resistant (LIR) structures for use in supporting approach lighting systems (ALS).

1.2 General.- This specification will be used in conjunction with the drawings referenced in the solicitation. Materials and methods specified herein and as shown on the drawings will be used. A table of metric conversion factors is included in appendix 1.

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The following FAA standards and drawings, in effect on the date of the solicitation, form a part of this specification and are applicable to the extent specified herein.

FAA-STD-013 Quality Control Program Requirements

2.1.2 FAA drawings.

B-21216	Standard Nameplate
D-6155-0	ALSF-2 (6′-128′) and MALSR (40′-128′) LIR Structures - Title Sheet
D-6155-1	Light Mounting Height 6′-1"-128′ - Structure Configurations
D-6155-2	Light Mounting Height 6′-1"-128′ - Tee, Tee-Bar, and Tube Cap Assemblies
D-6155-3	Light Mounting Height 6′-1"-128′ - Tee Brace Assembly, Tee Brace Clamp Assembly and Details
D-6155-4	Light Mounting Height 21′-2"-40′ - Horizontal Stabilizer Details
D-6155-5	Light Mounting Height 21′-2"-40′ - Stabilizer Rod Assembly and Details
D-6155-6	Light Mounting Height 6′-128′ - LIR Tubes, and Tube Splice
D-6155-7	Light Mounting Height 6′-128′ - Details for Tube "A", "B", and Tube Splice
D-6155-8	Light Mounting Height 40′-128′ - Mast Lifting Frame Subassembly
D-6155-9	Light Mounting Height 40′-128′ - Mast Lifting Frame Assembly
D-6155-10	Light Mounting Height 40′-128′ - Mast Lifting Frame Details
D-6155-11	Light Mounting Height 40′-128′ - Mast Clamp Sleeve Details
D-6155-12	Light Mounting Height 40′-128′ - Mounting Socket Assembly and Details
D-6155-13	Light Mounting Height 6′-1"-21′-1" - Mounting Stand Assembly

D-6155-14	Light Mounting Height 6'-1"-21'-1" - Mounting Stand Details
D-6155-15	Light Mounting Height 21-2"-40' - Mounting Frame Assembly and Details
D-6155-16	Light Mounting Height 21-2"-40" - Mounting Frame Details
D-6155-17	Light Mounting Height 21-2"-40' - Mounting Frame Details
D-6155-18	Light Mounting Height 6'-1"-128' - Test Methods and Requirements
D-6155-19	Not Used
D-6155-20	Not Used
D-6155-21	Assembly Instructions for LIR Structures - MG-20, MG-30, and MG-40
D-6155-22	Assembly Instructions for LIR Structure - MS-20

2.2 Military and federal publications.- The following military and federal publications, of the issues in effect on the date of the solicitation, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military specifications.-

MIL-A-8625	Anodic Coating, for Aluminum and Aluminum Alloys
MIL-R-9300	Resin, Epoxy, Low-Pressure Laminating
MIL-E-17555	Electronic and Electrical Equipment and Repair Parts; Packaging and Packing of
MIL-R-60346	Roving Glass Fiberous (for Filament Winding Application)
MIL-C-81773	Coatings; Polyurethane, Aliphatic, Weather Resistant

2.2.2 Military standards.-

MIL-STD-129	Container Marking for Shipment and Storage
MIL-STD-417	Classification System and Tests for Solid Elastomeric Materials

2.2.3 Federal standard.-

102	Preservation, Packaging, and Packing Levels
595	Colors

2.3 Other publications.- The following publications, of the issues in effect on the date of the solicitation, form a part of this specification and are applicable to the extent specified herein.

2.3.1 American Society for Testing and Materials (ASTM).-

ASTM-A-36	Structural Steel
ASTM-A-123	Zinc (Hot Galvanized) Coating on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips
ASTM-A-153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM-E-229	Test for Shear Strength and Shear Modulus of Structural Adhesives
ASTM-A-325	High Strength Bolts for Structural Steel Joints Including Suitable Nuts and Plain Hardened Washers
ASTM-A-500	Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM-A-666	Austenic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Application
ASTM-D-638	Test for Tensile Properties of Plastics
ASTM-D-695	Test for Compressive Properties of Rigid Plastics
ASTM-D-732	Test for Shear Strength of Plastics
ASTM-D-790	Test for Flexural Properties of Plastics

2.3.2 The Aluminum Association.-

Section 3	Engineering Data for Aluminum Structures
	Aluminum Standards and Data

2.3.3 American Iron and Steel Institute.-

Mechanical and Physical Properties of Austenic Chromium-Nickel Stainless Steels at Ambient Temperatures

Welding of Austenic Chromium-Nickel Stainless Steels - Techniques and Properties

Fabrication of Stainless Steel

2.3.4 American Institute of Steel Construction, Inc. (AISC).-

AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings

AISC Code of Standard Practices

2.3.5 American Welding Society (AWS).-

AWS D1.1-79 AWS Structural Welding Code

(Copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the Federal Aviation Administration office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specification, standard, and amendment. Requests should cite the invitation for bid, request for proposal, or the contract involved or other use to be made of the requested material.)

(Single copies of applicable federal and military specifications and standards may be obtained by ordering through the Naval Publications and Forms Center (NPFC), Phildelphia, Pennsylvania, which is the Department of Defense Single Stock Print (DOD-SSP) and distribution center for unclassified specifications and standards. Documents may be ordered by writing: Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120; or calling 215-697-3321, Monday through Friday, from 8 a.m. to 4:30 p.m. (Philadelphia time).)

(Information on obtaining copies of the American Society for Testing and Materials specifications may be obtained from 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Information on obtaining copies of the specified publication of the Aluminum Association may be obtained from 750 Third Avenue, New York, New York 10017.)

(Information on obtaining copies of the specified publications of the American Iron and Steel Institute may be obtained from 633 Third Avenue, New York, New York 10017.)

(Information on obtaining copies of the Manual of Steel Construction may be obtained from the American Institute of Steel Construction, 101 Park Avenue, New York, New York 10017.)

(Information on obtaining copies of the AWS Structural Welding Code may be obtained from the American Welding Society, Inc., 2501 7th Street, Miami, Florida 33125.)

3. REQUIREMENTS

3.1 General.- The LIR structures specified herein will be used to support lights in a fixed alignment and orientation, at elevations from 6 feet-1 inch to 40 feet-0 inches above terrain. For elevations above 40 feet-0 inches, the LIR structures will be mounted on rigid towers. The LIR structures will be raised and lowered for replacement of lights.

3.1.1 Service conditions.- The materials and workmanship associated with the fabrication of structures and all accessory equipment supplied under this specification shall be suitable to withstand outdoor use under the following conditions without permanent deformation, damage, or degradation of operation during a 20-year expected useful life of the equipment.

Temperature	-55°C to +55°C
Relative humidity	5% to 100% including condensation due to temperature changes
Wind loads	0 to 100 miles per hour (mph) 75 mph with 1/2-inch radial ice load

3.2 Drawing submittal.- Fabrication drawings, complete and in sufficient detail to perform all the necessary fabrication, shall be submitted for approval. The drawings shall demonstrate conformance with the design concept of the equipment to be furnished and compliance with the information furnished in the specification. For the glass reinforced plastic (GRP) members, generic and/or brand-named materials used, shall be noted on the fabrication drawings of the GRP members.

3.3 Materials.- Unless otherwise indicated, materials shall conform to the requirements of this specification and the drawings referenced in paragraph 2.1.2.

3.3.1 Aluminum.- All aluminum parts, except for aluminum castings, shall be manufactured of alloy 6061-T6 and 6061-T6511 as specified in the Engineering Data for Aluminum Structures, as published by the American Aluminum Association. All aluminum castings shall be of aluminum alloy A356-T6.

3.3.2 Aluminum hardware.- Aluminum bolts, nuts, and washers shall be manufactured from Alloy 2024-T4, as specified in the Engineering Data for Aluminum Structures.

3.3.3 Structural steel plates and angles.- All steel plates and angles shall be ASTM-A-36. All structural steel work shall comply with the AISC publications, Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings, and the AISC Code of Standard Practice.

3.3.4 Steel tubing.- All steel tubing shall conform to ASTM-A-500.

3.3.5 Stainless steel.- All stainless steel shall be annealed of the 300 series 1/4 hard as specified in Mechanical and Physical Properties of Austenic Chromium-Nickel Stainless Steel at Ambient Temperatures, and conform to ASTM-A-666. All stainless steel work shall comply with the Fabrication of Stainless Steel as published by the American Iron and Steel Institute.

3.3.6 Steel hardware.- All steel bolts and nuts shall be in accordance with ASTM-A-325.

3.3.7 Glass-reinforced plastics (GRP). The materials for GRP structural components, where not specified in the contract documents, shall be suitable for the service conditions specified in paragraph 3.1.1. The GRP structural components shall achieve the physical properties specified in the contract documents. Molded or flat plates shall have glass cloth fiber reinforcing. For the filament wound tubes, the glass reinforcement shall be per MIL-R-60346, Type I, Grade 0, Form B, and the epoxy resin shall be per MIL-R-9300, Type I. For all the GRP members, except where specifically indicated otherwise in the drawings, a light absorber, American Cyanamid Company's "Cyasorb UV9 Light Absorber," or equal, and orange pigment, Color 12197, per FED-STD-595, shall be incorporated into the resin in accordance with the manufacturer's instructions.

3.3.8 Welding.- All stainless steel welding shall comply with the "Welding of Austenic Chromium-Nickel Steel at Ambient Temperatures" as published by the American Iron and Steel Institute. All structural steel welding shall comply with AWS D1.1-79.

3.3.9 Nonmetallic connections.- Drilled holes, and cut edges of the glass-reinforced plastic members shall be coated with the same as the original resin. All bonding area, whether metallic or nonmetallic, shall be roughened by sandblasting and shall be thoroughly cleaned with a solvent before applying a structural adhesive.

3.3.10 Adhesive.- Unless otherwise specified in the drawings, the adhesive used in fabrication shall be a structural adhesive type, with bondline shear of minimum 2500 psi per ASTM-E-229.

3.3.11 Neoprene.- All neoprene rubber shall be in accordance with MIL-STD-417, Type S, Class SC610.

3.3.12 Silicone.- All silicone rubber sheets shall be in accordance with MIL-STD-417, Type I, Class TA610.

3.4 Fabrication.- Fabrication shall be in accordance with this specification and the drawings referenced in paragraph 2.1.2. Members shall have no sharp edges which could be hazardous during handling or other irregularities which could interfer with erection.

3.4.1 Galvanizing.- All ferrous parts except stainless steel shall be hot-dip galvanized after fabrication in conformance with ASTM-A-123. Steel surfaces shall be sandblasted to base metal before galvanizing. Ferrous hardware (nuts, bolts, washers, and other minor items) shall be galvanized by the hot-dip method in conformance with ASTM-A-153.

3.4.2 Anodizing.- All aluminum members shall be anodized with a matt finish in accordance with MIL-A-8625, Type 2, Class 1.

3.4.3 Painting.- All glass-reinforced plastic members shall be coated with a 4 to 6 mil thickness polyurethane coating in accordance with MIL-C-81773, Color 12197, in accordance with Federal Standard 595. Prior to application of polyurethane coating, all ridges, knots, bumps, and bulbs shall be removed by sanding or machining to a finish 250 RMS and surface cleaned with a suitable solvent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control provisions.- The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013. All tests and inspections made by the contractor shall be subjected to Government inspection. The term "Government inspection", as used in this specification, means that an FAA representative will witness the contractor's testing and inspection and will carry out such visual and other inspection as deemed necessary to assure compliance with contract requirements.

4.2 Test methods.- Testing shall be performed in three categories as follows.

4.2.1 Preproduction qualification tests.- Prior to the fabrication of glass reinforced plastic (GRP) members for the prototype LIR structures (4.2.2), the contractor shall perform the preproduction qualification tests specified in 4.3.1 through 4.3.4 to demonstrate that the materials manufactured and the GRP structural component test samples meet the requirements of this specification.

4.2.2 Prototype tests.- Prior to the manufacture of any production units (4.2.3), the contractor shall fabricate, assemble, and erect prototype LIR structures MG-20, MG-40, and MS-20, of maximum height with tee-bar support, as shown on drawing D-6155-1. Assembly instructions are shown on drawings D-6155-21 and -22. The contractor shall provide secured anchor bolts in a rigid foundation for each prototype to be erected. Each of the erected LIR structures shall demonstrate proper fit and function of the component parts and the proper raising and lowering of each LIR structure. Before demonstrating the raising and lowering of any LIR structure, a 3-pound equivalent weight for each lamp (total of 5 x 3 = 15 pounds) and a 5-pound equivalent weight for flasher shall be attached to the tee-bar. Each of the prototype structures shall be raised and lowered 20 times. The prototype LIR structure MS-20 shall be raised and lowered using the mast lifting frame assembly (drawing D-6155-9). The prototype LIR structures MG-20 and MG-40 shall be raised and lowered using a suitable winch mounted on a rigid vertical stand or a block and pulley arrangement (tilting device to tilt the LIR structure) connecting to one point (shackle, Item 19, Drawing D-6155-13; or slotted plate, Item 8, Drawing D-6155-15) on the base of each LIR structure. Should the prototype(s) be found to be defective in materials or workmanship, or otherwise not in conformance with the requirements of this specification, it shall be rejected.

4.2.3 Production unit tests.- After successful completion of the preproduction qualification tests (4.2.1) and prototype tests (4.2.2), production units shall be tested in accordance with paragraphs 4.3.5 and 4.3.6.

4.3 Test procedures.-

4.3.1 Physical properties tests.- Each of the physical properties tests specified in 4.3.1.1 through 4.3.1.3 shall be performed three times on three separate specimens per ASTM methods referenced.

4.3.1.1 Filament wound tube.- Specimens of laminate of filament wound tubes shall be tested to demonstrate that the minimum physical properties of tensile strength, compression strength, flexural strength, and shear strength specified on drawing D-6155-18 have been achieved. The test specimens shall be prepared separately. The tests shall be performed in accordance with the ASTM procedures referenced on drawing D-6155-18 and listed in paragraph 2.3.1.

4.3.1.2 Pultruded members.- Pultruded members shall be tested to demonstrate that the minimum physical properties of tensile strength, compression strength, flexural strength, and shear strength specified on drawing D-6155-18 have been achieved. The tests shall be performed in accordance with the ASTM procedures referenced on drawing D-6155-18 and as listed in paragraph 2.3.1. The modulus of elasticity shall be calculated from the tensile strength test data.

4.3.1.3 Structural adhesive.- The bondline shear for structural adhesives noted in paragraph 3.3.10 shall be tested to demonstrate that the minimum shear strength specified in paragraph 3.3.10 has been achieved. The tests shall be performed in accordance with the ASTM procedure referenced in paragraph 3.3.10.

4.3.2 Helix ring joint tests.- For the filament wound GRP tubes (see drawing D-6155-7), the contractor shall prepare test samples and perform flexural (flexural test method), impact (impact test method), compression (compression test method), and shear (shear test method) tests on full sections of the filament wound tubes with helix ring(s) built into the test samples as shown on drawing D-6155-18. The helix ring joint (HRJ) test samples for flexural, compression, shear, and impact tests shall be fabricated using the materials and methods described on Drawing D-6155-7, except that the location of the helix rings in the test samples shall be as shown on drawing D-6155-18. Each of the flexural, impact, compression, and shear tests shall be performed three times. All the tests shall demonstrate that the helix ring joint achieves the flexural, impact compression, and shear requirements specified on the Drawings D-6155-18.

4.3.3 Tube splice bonded joint test.- Using the flexural test method, drawing D-6155-18, the contractor shall demonstrate that the flexural capacity of the tube splice bonded joint (TBJ) achieves the requirements specified on Drawing D-6155-18. The flexural test shall be performed three times. The tube splice bonded joint flexural test sample is shown on drawing D-6155-18.

4.3.4 Stabilizer rod tension test.- The stabilizer rod tension test (drawing D-6155-18) shall be performed three times to demonstrate each time that the minimum requirements specified on the drawings are achieved. The stabilizer rod tension test sample is shown on drawing D-6155-18.

4.3.5 Dimensional verification.- First unit of production of each component specified in the contract shall be submitted for inspection at the contractor's plant. After acceptance, this unit shall serve as a model for all subsequent production units of each item. All subsequent production units shall be verified for physical dimensions and workmanship against the first unit of production.

4.3.6 Production unit helix ring joint test.- One unit out of every 100 production units of the filament wound tubes (Drawing D-6155-7), shall be randomly selected by the Government and tested in flexure by the contractor. At least one of the helix ring joints of the selected tube shall be subjected to flexural test using the flexural test method, Drawing D-6155-18, to demonstrate that the moment capacity of the joint is within the specified values. The flexural elastic modulus shall be computed to show that it exceeds the minimum specified value.

5. PREPARATION FOR DELIVERY

5.1 General.- Each unit package/container shall contain only those component parts and/or hardware needed to complete one assigned national stock numbered item. A brief description of the content and quantity contained therein shall be indicated on each package/container per MIL-STD-129.

5.2 Preservation and packaging.- The degree of preservation and the packaging level which will afford protection against deterioration and physical damage during shipment, handling, storage, and redistribution shall meet Level B of MIL-E-17555, and as further defined in FED-STD-102.

5.3 First article testing.- First article tests per 4.2.1.2 of Specification MIL-E-17555 are required for the prototype pack designed for the filament wound glass reinforced plastic tubes (Items 2, 3, and 4, drawing D-6155-6) and the stabilizer rod assemblies (drawing D-6155-5). A copy of the test results shall be forwarded to the following address:

Federal Aviation Administration
Aeronautical Center
6500 S. MacArthur Blvd.
Oklahoma City, Oklahoma 73125
Attention: AAC-431

6. NOTES

6.1 Note on information items.- The subparagraphs below are only for the information of the Contracting Officer, intended to assist him in formulating a contract. They are not contract requirements, nor binding on either the Government or the contractor, except to the extent that they may be specified elsewhere in the contract as such. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's own risk.

6.1.1 Equipment to be furnished.- The contract schedule should identify the national stock numbers for the standard structural parts of the LIR structures to be furnished under this specification. The standard structural parts of the LIR structures are identified on drawing D-6155-1.

6.1.2 Fabrication drawings.- The contract schedule should contain the requirements for submitting fabrication drawings in accordance with paragraph 3.2 of this specification.

6.1.3 Test methods.- The contract schedule should contain the requirements for testing in accordance with paragraph 4.2 of this specification.

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METRIC CONVERSION FACTORS

Source: Units of Measurement, Conversion Factors and Special Tables, October 1972; National Bureau of Standards, Department of Commerce

To Convert From	To	Multiply By
inches (in)	centimeters	2.54
feet (ft)	meters	0.3048
square inches (in^2)	square centimeters	6.4516
miles per hour (mph)	kilometer per hour	1.6093
feet per minute (fpm)	meters per minute	0.3048
pounds (lb)	kilograms	0.4536
pounds per foot (lb/ft)	kilograms per meter	1.4881
pounds per square inch (psi)	kilogram per square centimeter	0.0703
square feet (ft^2)	square meters	0.0929

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