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SUPERSEDING
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# MILITARY SPECIFICATION

## ANTENNA, HIGH FREQUENCY (HF) FIXED ROTATABLE LOG PERIODIC

This specification is approved for use by the Naval Electronic Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the high frequency (HF) rotatable log periodic antenna (RLPA), hereinafter referred to as the antenna, to transmit or receive communications, or both, for use at Naval shore communications stations.

1.2 Classification. Antennas shall be of the following types, as specified (see 6.2):

Type I: One kilowatt (kW) average; 2 kW peak envelope power (PEP)
Type II: 25 kW average; 50 kW, PEP

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

| | |
|---|---|
| W-C-375 | Circuit Breakers, Molded Case, Branch Circuit And Service |
| CC-M-1807 | Motors, Alternating Current, Fractional And Integral Horsepower (500 HP And Smaller) |
| QQ-A-200/8 | Aluminum Alloy 6061, Bar, Rod, Shapes, Tube And Wire, Extruded |
| QQ-A-200/9 | Aluminum Alloy, 6063, Bar, Rod, Shapes, Tube And Wire, Extruded |
| QQ-A-200/16 | Aluminum Alloy Bar Structural Shapes, Extruded, 6061 |
| QQ-A-250/11 | Aluminum Alloy 6061, Plate And Sheet |
| RR-W-410 | Wire Rope And Strand |
| TT-P-641 | Primer Coating; Zinc Dust-Zinc Oxide (For Galvanized Surfaces) |

MILITARY

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| MIL-I-10 | Insulating Compound, Electrical, Ceramic, Class L |
| MIL-P-116 | Preservation, Methods Of |
| MIL-C-8514 | Coating Compound, Metal Pretreatment, Resin-Acid |
| MIL-M-13231 | Marking Of Electronic Items |
| DoD-P-15328 | Primer (Wash), Pretreatment (Formula No. 117 For Metals) (Metric) |
| MIL-C-16173 | Corrosion Preventive Compound, Solvent Cutback, Cold-Application |
| MIL-E-16400 | Electronic, Interior Communication And Navigation Equipment, Naval Ship And Shore: General Specification For |
| MIL-E-17555 | Electronic And Electrical Equipment, Accessories, And Repair Parts, Packaging And Packing Of |
| DoD-P-21035 | Paint, High Zinc Dust Content, Galvanizing Repair (Metric) |
| MIL-A-21180 | Aluminum-Alloy Castings, High Strength |
| MIL-S-23196 | Steel Plate, Sheet And Strip, Corrosion Resistant |
| MIL-F-24044 | Flanges, Coaxial Line, Rigid Air Dielectric, General Specification For |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be *of use in improving this document should be addressed to:* Commander, Naval Electronic Systems Command (ELEX-8111), Washington, DC 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

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| MIL-T-28732 | Transformer, Impedance Matching (Balun) |
| MIL-C-28777 | Cable Assembly, Electronic Test Equipment, (3 Wires, 125 And 250 Volts AC And 28 Volts DC) Grounding Plug Connector, General Specification For |
| MIL-S-38228 | Sealing Compound, Environmental, For Aircraft Surfaces |
| MIL-A-40147 | Aluminum Coating (Hot-Dip) For Ferrous Parts |
| MIL-A-46106 | Adhesive Sealants, Silicone, Rtv, General Purpose |
| MIL-H-46855 | Human Engineering Requirements For Military Systems, Equipment And Facilities |

STANDARDS

FEDERAL

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| FED-STD-595 | Colors |

MILITARY

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| MIL-STD-12 | Abbreviations For Use On Drawings, And In Specifications, Standards And Technical Documents |
| MIL-STD-108 | Definitions Of And Basic Requirements For Enclosures For Electric And Electronic Equipment |
| MIL-STD-109 | Quality Assurance Terms And Definitions |
| MIL-STD-129 | Marking For Shipment And Storage |
| MIL-STD-188 | Military Communication System Technical Standards |
| MIL-STD-415 | Test Provisions For Electronic Systems And Associated Equipment, Design Criteria For |
| MIL-STD-454 | Standard General Requirements For Electronic Equipment |
| MIL-STD-461 | Electromagnetic Emission And Susceptibility Requirements For The Control Of Electromagnetic Interference |
| MIL-STD-462 | Electromagnetic Interference Characteristics, Measurement Of |
| MIL-STD-471 | Maintainability Verification/Demonstration/Evaluation |
| MIL-STD-781 | Reliability Design Qualification And Production Acceptance Tests: Exponential Distribution |
| MIL-STD-810C | Environmental Test Methods |
| MIL-STD-965 | Parts Control Program |
| MIL-STD-1364 | Standard General Purpose Electronic Test Equipment |
| MIL-STD-1472 | Human Engineering Design Criteria For Military Systems, Equipment And Facilities |

2.1.2 Other Government publications. The following other Government publications form a part of this specification to the extent specified herein.

PUBLICATIONS

FEDERAL AVIATION ADMINISTRATION (FAA)

| | |
|---|---|
| FAA-AC 70/7460-1 | Obstruction Marking And Lighting |

NAVAL FACILITIES ENGINEERING CENTER (NAVFAC)

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| NAVFAC DM-2.2 | Design Manual, Structural Engineering Loads |
| NAVFAC DM-4 | Electrical Engineering |

(Copies of specifications, standards, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

Design, Fabrication, And Erection Of Structural Steel For Buildings

(Application for copies should be addressed to the American Institute of Steel Construction, Inc., 101 Park Avenue, New York, NY 10017.)

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

Proceedings, December 1962, Papers No. 3341 And 3342: Suggested Specifications For Structures Of Aluminum Alloys 6061-T6 And 6062-T6, And Suggested Specifications For Structures Of Aluminum Alloys 6063-T5 And 6063-T6.

(Application for copies should be addressed to the American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

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|---|---|
| RS-222C | Structural Standards For Steel Antenna Towers And Antenna Supporting Structures |
| RS-310C-77 | Racks, Panels And Associated Equipment |

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, NW, Washington, DC 20006.)

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

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| A36 | Specification For Structural Steel |
| A123 | Zinc (Hot-Galvanized) Coatings On Products Fabricated From Rolled, Pressed And Forged Steel Shapes, Plates, Bars, And Strip |
| A153 | Zinc Coating (Hot Dip) On Iron And Steel Hardware |
| A325 | High Strength Bolts For Structural Steel Joints Including Suitable Nuts And Plain Hardened Washers |
| A475 | Zinc-Coated Steel Wire Strand (Galvanized And Class A (Extra Galvanized)) |
| B233 | Rolled Aluminum Rods, (EC Grade) For Electrical Purposes |
| B260 | Aluminum Alloy Brazing Filler Metal |
| B285 | Aluminum Alloy And Aluminum Alloy Welding Rods And Bare Electrodes |
| B398 | Specification For Aluminum Alloy 6201-T81 Wire For Electrical Purposes |
| B415 | Hard-Drawn Aluminum Clad Steel Wire |
| B416 | Concentric-Lay-Stranded Aluminum-Clad Steel Conductors |
| D2303 | Test For Liquid-Contaminant, Inclined Plane Tracking And Erosion Of Insulation Materials |

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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|---|---|
| NFPA 70-1983 | National Electrical Code |

(Application for copies should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 General. The antenna shall be in accordance with MIL-E-16400 to the extent specified herein.

3.2 First article. When specified, a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.3 Antenna description and major components. The antenna shall provide unidirectional gain (see 6.4) for communications in the frequency range specified in 3.3.11.1 without tuning or adjustment. The antenna shall be designed and fabricated in accordance with log periodic antenna principles. The antenna shall be continuously rotatable in both directions over 360 degrees. The complete antenna shall be easily erected using only standard hand tools and simple erection equipment within 8 days, using a maximum of six men working 8 hours per day. The use of cranes or other heavy erection equipment shall not be required. The antenna shall consist of the major assemblies specified in a through l:

a. Radiating elements and horizontal boom
b. Supporting structure (tower)
c. Rotator assembly
d. Transmission line
e. Transformer, balanced to unbalanced (balun)
f. Junction box
g. Local control unit
h. Remote control unit
i. Obstruction lighting kit
j. Raising and lowering assembly
k. Embedment hardware
l. Installation kit

The antenna shall be provided in kit form consistent with the requirements of 3.3.10 and 3.3.12. Parts required for the erection of a complete antenna shall be provided, excluding only the items specified in 1 through 3:

1. Coaxial cable to mate with the contractor-furnished input connector specified in 3.3.4
2. Concrete and reinforcing rods
3. Antenna control and power cable between the antenna's junction box and the building housing the remote control unit

3.3.1 Radiating elements and horizontal boom. The antenna shall consist of radiating elements supported by a horizontal boom or booms. The configuration shall consist of a series of horizontal radiating elements of constant length and spacing ratios, arranged in a single planar array. The radiating elements shall be preassembled to minimize field assembly. All metallic portions of the radiating elements, horizontal boom, and feed straps shall be constructed of aluminum; however, aluminum clad steel may be used in wire strung arrays. The array and boom shall be designed so that the array and boom can be easily raised and lowered as a complete unit. The height of the boom above the top of the concrete mounting base shall not exceed 110 feet (ft).

3.3.2 Supporting structure. The supporting structure or tower(s) shall be designed to support the radiating elements and boom during the raising and lowering process and under the specified operating conditions. To provide rigidity, the supporting structure shall be guyed and mounted on a concrete base. The supporting structure shall be fabricated for erection in sections, but each section shall be shipped disassembled (knocked-down). All required parts, cabling, grounding rods, and connectors necessary for grounding shall be furnished.

3.3.3 Rotator assembly. Upon receipt of a signal from the control unit, the rotator assembly shall rotate the radiating elements and horizontal boom, hereinafter referred to as the antenna array. The antenna array shall be continuously rotatable through 360 degrees and in either direction, and shall be capable of being positioned within ±5 degrees of any azimuth. Acceleration and deceleration in response to the position controls shall be smooth, without chatter, and without detrimental oscillations. The rotator assembly shall be preassembled to allow modular installation, and subassemblies and components within the assembly shall be of modular design to permit replacement without disassembly. The rotator assembly shall rotate the antenna array to 1 revolution per minute ±10 percent when a 60 hertz (Hz) power source is used. The rotator assembly shall be designed to prevent rotation of the antenna array by the force of the wind on the antenna array or by any other force than that from the rotator assembly. Belt drives shall not be used. If a clutch is used, a means shall be provided for inspection of the clutch without disassembly of the rotator assembly. The rotator motor and the drive mechanism shall be capable of delivering 50 percent more torque than that required to rotate the antenna array under the specified wind and wind plus ice condition. The rotator motor shall comply with CC-M-1807. Rotation shall be possible when the antenna array is subjected to the environmental conditions of 3.8 without the necessity for changing lubricants or performing special servicing in preparation for adverse weather conditions.

3.3.3.1 Rotator relays. The antenna rotator control switches, both local and remote, shall control the rotator only via the operation of control relays. The control relays shall be the time delay type, with circuitry designed to provide the following fail-safe feature: If the antenna rotator control switch is switched from one direction of rotation to the reverse direction, reversing power shall not be applied to the motor until all components placed in motion from motor to antenna array elements shall have reached stationary equilibrium. All contacts, such as relay contacts which control power to the motor, shall be self-wiping and arc-free when in the fully closed or open position, and shall be capable of carrying current at least 100 percent greater than the starting current of the motor under full load. Slip rings shall not be used for control or power circuits.

3.3.4 Transmission line. A transmission line compatible with the performance requirements specified in 3.3.11 shall be provided from the base of the support structure to the radiating element array. A 3.125 inch (in.) EIA coaxial antenna input connector (flange) shall be provided at the foot of the tower. With the antenna group in the operating position, the flange shall be inclined at 90 degrees with respect to the vertical (axis horizontal), and shall be no higher than 3 ft above the concrete mounting base. The flange shall be located in such a manner that neither the flange nor the incoming coaxial line will in any way interfere with the lowering operation. Preparation for lowering shall only require removal of the flange screws. All coaxial connections shall be made with EIA flanges capable of handling the radio frequency (RF) powers specified in 3.3.11.2.

3.3.4.1 Rotary joint. A rotating joint, if required, shall be provided and shall handle the RF powers specified in 3.3.11.2 while the array is being rotated.

3.3.4.2 Pressurization. The transmission line shall be capable of being pressurized through the rotary joint from the feedline when the radiating element array is fed by a coaxial transmission line. A pop-off pressure valve shall be provided in the array for purging the coaxial transmission line. The pop-off valve shall remain closed through a range of 0 pounds per square inch (psi) to 10 psi. The pop-off valve shall open at pressure of 13 psi ±10 percent. The pop-off valve shall remain open above a pressure of 12 psi. After initial pressurization to 10 pounds per square inch gage (psig) the pressure shall not drop below 2 psig in a period of 1 week. A means for purging the line shall be provided at the top end of the coaxial line.

3.3.4.3 Vertical rotating shaft. If a vertical rotating shaft is employed, the shaft shall have a minimum outside diameter of 8 in. and a minimum wall thickness of 0.25 in. and shall contain the transmission line.

3.3.5 Junction box. A weatherproof junction box with a hinged front cover shall be provided for mounting at the base of the support structure. Access cover fasteners shall be designed so that repeated opening and closing does not mar the external finish of the enclosure. The junction box shall, as a minimum, contain the items specified in a through g:

a. An antenna local control unit
b. Terminals and power cabling for applying primary power to the rotator assembly, raising and lowering assembly, obstruction lighting, and convenience outlets
c. Terminal for the control cable from the remote control unit
d. Telephone circuit for maintenance purposes shall be terminated within the junction box into jacks
e. One 15 ampere (A), 125 volts (V), 2-pole, 3-wire grounding type, breaker protected duplex convenience receptacle for maintenance and test purposes. The convenience receptacle shall be designed so that the receptacle can be operated when power is removed from all other components of the antenna group and shall be provided with ground-fault interrupt protection.
f. Circuit breaker protected power circuit for powering the raising and lowering assembly (electric winch)
g. Individual circuit breakers for the obstruction lighting kit and rotator motor

3.3.6 Antenna local control unit. A local control panel shall be provided in the junction box to permit local rotation of the antenna in accordance with 3.3.3. A local-remote switch shall be provided on the panel to allow transfer of control of the rotator. When the switch is in the local position, a safety feature shall lock out the remote control function. When the switch is in the local position, the switch position shall be so indicated at the remote control unit.

3.3.7 Antenna remote control unit. An antenna remote control unit shall be provided for mounting in a standard rack, as specified in RS-310C-77, to be located in a housed area. The standard rack shall conform to MIL-STD-454, Requirement 55, and shall not use more than 6 in. of vertical rack space nor have a depth, including connectors, greater than 18 in. The remote control unit shall be capable of controlling the antenna rotator (see 3.3.3) from distances up to 3600 ft.

3.3.7.1 Remote controls and indicators. The remote control unit shall have the controls and indicators specified in a through d:

a. Antenna position indicator
b. Antenna rotation control switch
c. Indicator lights
d. Remote reset controls for the circuit breakers on the local control unit

3.3.7.1.1 Position indicator. A position indicator shall be provided to display the azimuth of the antenna array. Either an analog or digital indicator shall be supplied. The analog indicator shall be a circular compass type indicator not less than 3 in. in diameter and shall be marked in increments of at least 15 degrees from 0 degrees to 360 degrees. The digital indicator shall be either a light emitting diode or liquid crystal diode display. Digits shall be at least 0.5 in. high. Zero degrees to 360 degrees position information shall be displayed in increments of 1 degree, but the accuracy of the information displayed when compared to the actual antenna position is not required to be better than ±5 degrees. Provisions shall be made for calibration of the position indicator to the antenna's position.

3.3.7.1.2 Antenna rotation control switch. A control switch shall be provided for rotating the antenna array clockwise and counterclockwise. The switch shall automatically stop rotation of the antenna if the operator removes his hand from the switch, unless the antenna rotator is designed to stop when the antenna array reaches the desired azimuth.

3.3.7.1.3 Indicator lights. Indicator lights shall be provided on the remote control unit to indicate, as a minimum, conditions in a through d:

a. White light - power on
b. White light - indicates antenna in motion
c. Amber light - indicates rotator motor under control of local control unit
d. Red light - indicates rotator motor nonoperative due to operation of thermal overload or circuit breaker

3.3.7.1.4 Controls and indicators. Controls and indicators shall be readily visible when the unit is installed in a standard equipment rack conforming to MIL-STD-454, Requirement 55.

3.3.7.1.5 Connections. All electrical connections used in the antenna shall be located on the rear of the chassis. The primary power (120 V, 50 Hz or 60 Hz, or both, single-phase) input connector shall be a grounded receptacle. Interface connections to the external circuits (power and control) shall use plug-in connectors. A chassis ground stud shall be provided. Receptacles, plugs, and ground studs shall be in accordance with MIL-E-16400. All receptacles shall be provided with mating connectors.

3.3.8 Obstruction lighting kit. When specified in the contract (see 6.2), an obstruction lighting kit shall be provided, using double obstruction lights. Unless otherwise specified herein, the lights and hardware shall conform to FAA AC 70/7460-1. The lights shall be mounted in accordance with FAA AC 70/7460-1, to ensure unobstructed visibility of at least one of the lights from aircraft at any normal angle of approach. Slip rings shall not be used for delivery of power to the obstruction lights. A light-sensitive control device, adjustable in azimuth, shall be provided. The control device shall automatically turn the obstruction lights on whenever the natural light intensity falls below 35 footcandles (fc) and turn the lights off when the natural light intensity increases to 58 fc. Tolerances shall be ±2 fc. The control circuit shall be such that a failure within the control will turn the lights on. The obstruction lighting kit shall include cabling, conduit, and all associated hardware necessary for a complete installation on the antenna.

3.3.9 Raising and lowering assembly. All equipment, rigging, lines, components, and hardware items necessary for raising and lowering operations shall be provided with each antenna. All winches used in the erection and lowering of the antenna shall be electric with a remote control at least 50 ft from the winch. A circuit breaker and detachable power cables shall be provided for connecting the winch(es) to the junction box. The raising and lowering assembly shall be designed so that any support or tag line used to stabilize lateral movement is attached to a ground anchor point prior to raising or lowering. The raising and lowering assembly shall not:

a. Require critical alignment by the maintenance crew prior to or during raising and lowering operations. If the array must be locked in a certain position prior to raising or lowering, interlocks shall be provided to prevent the raising or lowering procedure from being initiated with the array improperly positioned.

b. Require complex rigging or attachment of lines or slings, or passing of winch line through or around the assembly to be lowered for final connection to another point on the support structure, or any rigging more complex than the attachment of the winch line to a single point on the assembly to be lowered after passing through a single block (if used) on supporting towers

c. Use personnel directly or on tag lines to stabilize any part of the antenna group when the structure is in motion

d. Require personnel to be stationed or walk under or near any part of the antenna group when the structure is in motion

e. Require personnel to ascend the support structure or any other part of the antenna group when the support structure is in motion

f. Cause damage to any part of the antenna group during operation

Factors of safety for guys used in the raising and lowering of the antenna shall be at least equal to those specified in 3.9.2.10 for permanent guys.

3.3.9.1 Winch requirements. The electric motor driven winch will be installed on a concrete foundation built by the Government in accordance with contractor-supplied specifications. The winch shall conform to the requirements specified in a through f:

a. The winch drum shall have a barrel diameter of at least 20 times the wire rope diameter. The drum shall have flange depth to stow the required length and size wire rope with a minimum of 2 in. of clear flange above the top layer when the winch line is completely wound onto the drum.

b. The winch shall be provided with wire rope installed on the drum. The wire rope shall conform to RR-W-410, Type 1, Class 2, preformed, zinc coated (galvanized) regular lay. The wire rope diameter shall have a safety factor of at least 5, based on the maximum working load and the nominal breaking strength specified in RR-W-410, Table IX. The mechanism used to attach the wire rope to the tower for raising and lowering operations shall have a safety factor of at least 5.

c. The winch shall be provided with all required attachments and hardware to ensure that the wire rope winds uniformly across the drum. This requirement shall apply for both the maximum load and normal load operating conditions.

d. Gear or chain drives shall be used throughout. Gearing shall be in accordance with American Gear Manufacturer's Association publications.

e. The winch shall be provided with a metal cover. The cover shall fully enclose the winch and motor assembly when mounted on the concrete foundation (all cable wound on drum). The cover shall be easily removable for winch operation.

f. The motor shall operate from a 120 V or 208 V, or both, ±10 percent, 47 Hz to 63 Hz, single-phase, alternating current power source and shall comply with CC-M-1807.

3.3.9.1.1 Winch safety features. Winch safety features shall be as specified in a through g:

a. The electric motor shall be provided with a switch or switches capable of being remoted up to a distance of 50 ft to allow operating personnel to stand clear of the winch during raising and lowering operations.

b. Gears and chains shall be covered or guarded.

c. The electric motor-driven winch shall contain an electric brake which shall automatically stop (within 2 ft of travel) and hold the maximum raised or lowered load when the power has failed or is disconnected, either accidentally or through normal operation of the power switch.

d. The cable length shall be designed to permit at least four full wrappings around the drum when in the maximum extended position.

e. The braking system shall be capable of braking, lowering, and safely holding a minimum of 150 percent of the rated load.

f. The winch shall be capable of handling a load equal to twice the maximum antenna and mast load (static plus dynamic load).

g. The motor shall be operated by a switch or switches which shall be depressed when the antenna is being raised or lowered. The switch or switches shall automatically return to the OFF position when released. The switch(es) shall be located so that the switch(es) cannot be easily locked, strapped, or blocked in the ON position to permit unattended operation. The switch or switches shall have a safety shield to prevent accidental activation. The shield shall be substantial so that the shield cannot be easily broken off, cut off, or otherwise removed.

3.3.9.2 Erection requirements. The radiating elements, horizontal boom, and rotator assembly shall be capable of being rigged and lowered to the ground as a unit without disassembly in 2 hours by a team of four men. The same structure shall be capable of being raised from ground level and ready for use in 4 hours by a team of four men. The time requirement shall be applicable over the temperature range of -29°Celsius(C) (-20°Fahrenheit (F)) to +49°C (+120°F). The time required to raise or lower the antenna, once rigged, and considering only the speed of the winch, shall be not greater than 15 minutes.

3.3.10 Installation kit. An installation kit for field assembly and erection of the antenna shall be provided. The kit shall include, but not be limited to, the items specified in 3.3.10.1 through 3.3.10.3.

3.3.10.1 Embedment hardware. The contents of the embedment hardware kit shall contain all anchor rods, foundation bolts, and all other items necessary for embedment in the ground during installation of the antenna and raising and lowering the assembly.

3.3.10.2 Additional hardware. In addition to the hardware provided for assembly and erection of the antenna, parts such as bolts, nuts, washers, clevises, pins, lugs, thimbles, insulators, and similar items subject to loss or breakage shall be supplied in excess quantity of 10 percent of each type. A minimum of one additional of each size and type shall be supplied. Standard length diagonal braces of the steel support tower and aluminum array booms shall be supplied in an excess quantity of two each per antenna. Special length braces shall be supplied in an excess quantity of each per antenna. Each different type of RF insulator shall be supplied in an excess quantity of two per antenna.

3.3.10.3 Coatings and treatments. Coatings and treatments shall be as specified in 3.6.4 through 3.6.7 for field application. A minimum of an 8-ounce supply of each coating and treatment specified in 3.6.5, 3.6.6, and 3.6.7 (in addition to that required for installation) as required to provide for loss, spillage, and maintenance shall be provided. A touch-up kit composed of primer, paint, and applicator shall be provided for touch-up of the coating specified in 3.6.4 following completion of field installation. A minimum of 4 fluid ounces of primer and paint shall be provided. A galvanized repair paint containing a high zinc dust content as specified in DoD-P-21035 shall be provided for application during installation.

3.3.11 RF performance. Unless otherwise specified in 3.3.11.1 through 3.3.11.10, the antenna shall provide the specified performance when installed over ground with characteristics specified in a through c:

a. Conductivities ranging from 0.1 milliohms (mΩ) to 4000 mΩ
b. Relative dielectric constants ranging from 4 to 80
c. Terrain roughness from 0 in. to ±18 in. from datum

Performance is referenced to the coaxial input flange of the antenna.

3.3.11.1 Frequency range. The antenna shall be capable of transmitting and receiving RF energy, without adjustment, at any frequency in the 4 megahertz (MHz) to 30 MHz frequency range.

3.3.11.2 Power handling. The antenna shall conform to all of the requirements of this specification with continuous RF input indicated by the type specified (see 1.2). Unless otherwise specified in the contract (see 6.2), Type II shall apply.

3.3.11.3 Input impedance. Input impedance of the antenna shall be 50 ohms within the voltage standing wave ratio (VSWR) specified in 3.3.11.4.

3.3.11.4 VSWR. The input VSWR of the antenna shall be no greater than 2 to 1 with respect to 50 ohms anywhere within the specified frequency range. The specified VSWR shall not be exceeded for any fixed antenna position or during antenna rotation over any azimuth position.

3.3.11.5 Polarization. The antenna shall be horizontally polarized.

3.3.11.6 Radiation pattern. The radiation pattern characteristics, when installed over average earth (Epsilon (dielectric constant) = 15, Sigma (conductivity) = 0.01 mhos per meter), shall be as specified in a and b:

a. Horizontal pattern: The beamwidth at the half-power points shall be not greater than 75 degrees nor less than 55 degrees.

b. Vertical pattern: The center line of the principal lobe shall be not greater than 36 degrees above the horizon at all frequencies within the specified range.

3.3.11.7 Gain. The gain shall be not less than 11 decibels (dB) over an isotropic radiator at all frequencies between 4 MHz to 6 MHz and 12 dB over an isotropic radiator at all frequencies between 6 MHz and 30 MHz.

3.3.11.8 Side lobes. The level of the largest side lobe relative to the main lobe shall be not greater than -13 dB.

3.3.11.9 Front-to-back ratio. The front-to-back ratio shall be not less than 10 dB for all frequencies between 4 MHz and 6 MHz and not less than 14 dB for all frequencies between 6 MHz and 30 MHz.

3.3.11.10 Efficiency. The efficiency of the antenna, excluding the effect of VSWR, shall be not less than 80 percent.

3.3.12 Dimensions and weight. The antenna, when packaged, shall not cause the maximum weights and sizes of the shipping containers to exceed the dimensions and weight specified in 5.3.

3.4 Definitions. The definitions of terms used in this specification shall be in accordance with MIL-E-16400, MIL-STD-188, and 6.4.

3.5 Human engineering. Human engineering operational and maintenance design criteria shall comply with MIL-STD-1472 and 3.5.1, except that the antenna shall be designed for use by the 5th percentile female to the 95th percentile male. The design of the antenna group shall minimize the number of personnel required for assembly, erection, maintenance, and disassembly.

3.5.1 Indicator lamps. Lamps used on front panels for indicators shall conform to the requirements of the Transilluminated display paragraph of MIL-STD-1472. A capability for remote indication of the status of the indicator lamps shall be provided. Legend lights shall be used in preference to simple indicator lights except where design considerations demand that simple indicators be used. Lamps used in legend switches shall conform to the requirements of the Legend switches paragraph of MIL-STD-1472. Legend switches shall be used in preference to toggle switches except where design considerations demand that toggle switches be used. Lamp testing shall be in accordance with the Lamp testing paragraph of MIL-STD-1472.

3.6 Parts, materials, and processes. Parts, materials, and processes shall be in accordance with 3.6.1 through 3.6.3.3.

3.6.1 Parts. All parts required and furnished shall be in accordance with MIL-E-16400, except that on structural items only, the nominal bolt projection shall be one bolt diameter with a minimum projection of one and one-half threads, and a maximum projection of two bolt diameters. Nonstandard parts approval is required only for electronic, electrical, and electromechanical parts and components which have not previously been approved by the procuring activity. Parts specified on Government-furnished drawings shall be assumed to have been approved.

3.6.1.1 Parts control. The parts to be incorporated in the antenna shall be controlled in accordance with MIL-STD-965, Procedure I.

3.6.2 Materials. Unless otherwise specified in 3.6.2.1 through 3.6.2.5, materials required and furnished shall be in accordance with MIL-E-16400. Aluminum or galvanized steel shall be used instead of ferrous alloys which are not corrosion-resistant. All materials used shall be fungus-inert. Unless otherwise specified in 3.6.2.1 through 3.6.2.5, dissimilar metal contacts shall be limited to those specified in MIL-E-16400. Metals which are not sheltered or do not conform to the enclosure requirement specified herein shall be considered under the condition for metal combinations subject to spray from sea water. When dissimilar metals other than those allowed by MIL-E-16400 are assembled in intimate contact with each other, those dissimilar metals shall be protected against electrolytic corrosion in accordance with Requirement 16 of MIL-STD-454, or in accordance with 3.6.6 if electrical considerations preclude such methods.

3.6.2.1 Aluminum. Structural aluminum members used in the antenna shall be alloy 6061-T6 conforming to QQ-A-200/8, except that cross braces for aluminum tower sections may be alloy 6063-T6 conforming to QQ-A-200/9. Aluminum castings used for structural purposes shall conform to MIL-A-21180. Aluminum parts that are essentially nonstructural in application may utilize alloy 6061-T6 conforming to QQ-A-200/16 or alloy 6063-T5 or T6 conforming to QQ-A-200/9.

3.6.2.1.1 Aluminum-to-aluminum structural connections. Aluminum-to-aluminum structural connections shall be made with hardware conforming to 3.6.3.1 and 3.6.3.2, aluminum clamps, or by shop welding.

3.6.2.1.2 Aluminum alloy sheet and plate. Aluminum alloy sheet and plate shall conform to QQ-A-250/11.

3.6.2.1.2.1 Aluminum wire or cable. Aluminum wire or cable shall be made from rod conforming to ASTM B233 or alloy 6201-T81 conforming to ASTM B398. Aluminum clad wire shall conform to ASTM B415. The preceding may be combined to form concentric-lay-stranded aluminum and aluminum-clad cable. Aluminum-clad cable shall conform to ASTM B416.

3.6.2.1.3 Aluminum alloy bars, rods, shapes, and extruded tubes. Aluminum alloy bars, rods, shapes, and extruded tubes shall conform to QQ-A-200/8.

3.6.2.1.4 Aluminum alloy brazing filler metal. Aluminum alloy brazing filler metal shall conform to ASTM B260.

3.6.2.1.5 Aluminum alloy and aluminum alloy welding rods and bare electrodes. Aluminum alloy and aluminum alloy welding rods and bare electrodes shall conform to ASTM B285.

3.6.2.2 Steel. All steel and steel hardware shall be galvanized except as specified in 3.6.2.2.1 through 3.6.2.2.3.

3.6.2.2.1 Structural steel. Structural steel shall conform to ASTM A36 or higher yield strength steels. All structural steels shall be galvanized in accordance with ASTM A123, except that anchor rods shall be galvanized to a minimum zinc coating of 4 ounces per square ft.

3.6.2.2.2 Steel wire strand. Steel wire strand shall conform to ASTM A475 and shall be Class C galvanized.

3.6.2.2.3 Sheet steel plate. Sheet steel plate shall conform to MIL-S-23196.

3.6.2.3 Fiberglass cable. If fiberglass cables are used, the material shall be in accordance with APPENDIX A. Deviations of ±0.0625 in. in diameter from the specified nominal diameters may be allowed if minimum breaking strengths are proportionally adjusted and the material conforms to the requirements of 3.9.11.

3.6.2.4 Insulating material. Insulating material for RF applications shall be selected in the descending order of preference specified in a through d:

a. Category A: Vitrified ceramics in accordance with MIL-I-10 in Grades L4, or better, of the materials specified in 1 through 3 only:
   1. Steatite
   2. Alumia
   3. Forsterite

b. Category B: Other vitrified ceramics conforming to MIL-I-10
c. Category C: Arc-resistant materials specified in MIL-STD-454, Requirement 26
d. Category D: Insulating materials in accordance with MIL-STD-454, Requirement 11

Ceramic insulators shall be glazed either white or brown. Insulators, other than ceramic, shall be adequately protected against tracking, erosion, ultraviolet radiation, fungus, and water absorption. Insulators selected from other than Category A and B of 3.6.2.4 shall be subject to successful completion of the inclined plane test of ASTM D2303 as specified in 4.5.7 and shall be subject to approval as nonstandard parts (see 3.6).

3.6.2.5 Polyethylene terephthalate and polyester rope and cable. Polyethylene terephthalate (mylar or equal) and polyester (dacron or equal) rope and cable, or other synthetic material which may creep under tension, shall not be used.

3.6.3 Processes. Unless otherwise specified in 3.6.3.1 through 3.6.3.3, processes shall be in accordance with MIL-E-16400.

3.6.3.1 Steel bolts, nuts, and washers. Steel bolts, nuts, and washers when used in contact with galvanized steel surfaces shall be galvanized in accordance with ASTM A153. Steel bolts, nuts, and washers when used in contact with aluminum surfaces shall be aluminum coated in accordance with MIL-A-40147. Steel nuts, bolts, and washers made of high strength ASTM-A325 steel shall be galvanized only.

3.6.3.2 Steel hardware other than bolts, nuts, and washers. Steel hardware other than bolts, nuts, and washers when used in contact with aluminum surfaces shall be galvanized in accordance with ASTM A153, aluminum coated in accordance with MIL-A-40147, or manufactured of corrosion-resistant steel. Where an assembly of galvanized steel hardware other than bolts, nuts, and washers is used in contact with an aluminum surface, an interposing coating shall be applied to the contact surface of the galvanized steel. This coating shall consist of a primer coat conforming to TT-P-641 (Type I, zinc dust-zinc oxide linseed oil primer). The primer may be omitted from the threaded portions if it interferes with threading action. All threaded members shall have their junctions and thread projections coated with environmental sealing compound in accordance with MIL-S-38228, Type I-2, after the members have been assembled.

3.6.3.3 Nonmetallic and nonceramic members. Nonmetallic and nonceramic members which are exposed to the environment shall be coated to resist ultraviolet radiation and moisture absorption.

3.6.4 Exposed surfaces. Exposed aluminum surfaces shall be treated as specified in 3.6.4.1 through 3.6.4.3, except for wire, cable, alloy 6061-T6 and 6063-T6, and the need to mask all interfacing surfaces where electrical contact is established when assembling the antenna.

3.6.4.1 Aluminum surfaces. Aluminum parts shall be degreased, rinsed, and thoroughly dried in air. If the surface is oxidized, an acid etch shall be used. All areas that could entrap liquid shall be inspected for dryness before proceeding.

3.6.4.2 Primer. After masking, one coat of phos-pho-neal (or equal) metal primer shall be applied. The primer shall conform to the requirements of DoD-P-15328 and MIL-C-8514.

3.6.4.3 Finish coat. Two coats of Magna-Laminar X-500 (or equal) shall be applied. This is a two-part polyurethane paint, gloss gray, color 16473, in accordance with FED-STD-595. The finish coats shall be applied in accordance with the manufacturer's recommendations.

3.6.5 Electrical connections. Electrical (including RF) connections to be made in the field and designed to be permanently connected and exposed to the environment shall be encapsulated with silicone rubber epoxy sealant conforming to MIL-A-46106.

3.6.6 Encapsulation. When encapsulation is chosen as the protective method to comply with 3.6.2, such encapsulation shall be accomplished by utilizing a compound conforming to MIL-C-16173.

3.6.7 Conductive adhesives and epoxies. Conductive adhesives and epoxies (such as Technit 72-0002, or equal), may be used for factory-made RF connections wherever appropriate, when compatible with the metals being joined, and where connections are to remain permanently bonded.

3.7 Safety. Safety shall be in accordance with the System safety criteria and considerations and the Safety criteria paragraphs of MIL-E-16400, and as specified in 3.7.1 through 3.7.3.

3.7.1 Tower climbing. The contractor shall provide adequate safety ladder(s) equipped with safety climb rail(s), to safely perform all installation, removal, maintenance, and inspection functions.

3.7.1.1 Safety ladder. The contractor shall provide a system of horizontal members on one face of the supporting structure designed for use as a ladder. The ladder(s) shall be constructed of the same material as the tower. The ladder(s) shall either consist of factory-assembled section of lengths consistent with the tower section sizes, or be integrated into the tower design. The inside dimensions between the vertical stringers shall be uniform and shall be not less than 16 in. The center-to-center spacing of the ladder rungs shall be uniform and shall be not less than 12 in. nor more than 18 in. The ladder shall be capable of supporting 500 pounds (lbs) of weight applied at the center of any of the ladder rungs.

3.7.1.2 Safety rail and safety sleeve. The safety rail shall be constructed of galvanized steel or aluminum. Items made of aluminum shall be type 6061. The safety rail shall be provided in individual lengths not to exceed 20 ft. The safety rail shall be capable of being spliced to form one continuous straight smooth surface. The safety rail section length shall be consistent with tower and ladder section lengths. The safety rail shall consist of either a flat bar or T beam. The top and bottom of the safety rail shall be clamped to the tower structure at intervals not to exceed 7 ft. The safety rail shall start 2 ft from the base of the tower; the rail height shall equal, but not exceed, the height of the tower. The safety rail shall be equipped with a top stop to prevent the safety sleeve from being removed at the top of the rail. Two safety sleeves shall be provided with each antenna. The safety sleeve shall glide freely and shall not cause damage to the safety rail during normal ascent or descent of the tower. The sleeve shall be designed to stop within a maximum distance of 6 in. from the start of the fall of a 250 lb man to the locking position. The safety sleeve shall be provided with an integral single-latch safety-snap hook. The snap hook shall have an eye with a minimum inside diameter of 0.875 in. ±0.0625 in. The safety sleeve shall be clearly and permanently marked to indicate the correct direction of installation and shall be removable from the bottom of the safety rail.

3.7.1.2.1 Mounting hardware. Hot-dipped galvanized steel or aluminum mounting hardware shall be provided.

3.7.2 RF indicators. Red and green indicator lights and associated sensing devices shall be provided at the base of the antenna to indicate when RF operating power is, respectively, applied to the antenna and not applied to the antenna.

3.7.3 Safety ground. A safety ground shall be included in all power cable assemblies that utilize convenience outlets as a source for primary power. The safety ground shall be accomplished by utilizing three-pin connectors and three-conductor cables. The cable shall consist of one black, one white, and one green color-coded conductor. The green-coded wire shall be connected to the grounding blade or pin B, the black-coded wire connected to the brass terminal or pin C, and the white wire connected to terminal WH or pin A for the type connector used. Input power cable assemblies shall conform to MIL-C-28777.

3.8 Environmental conditions. The antenna shall be designed and constructed to conform to the minimum performance requirements during and after exposure to the environmental conditions specified in a through j without damage or degradation in performance:

a. Temperature range: The temperature range shall be as specified in 1 and 2:
1. Nonoperating: MIL-E-16400, Range 1: -62°C (80°F) to +71°C (+160°F)
2. Operating:
A. Exposed equipment: MIL-E-16400, Range 1: 54°C (129°F) to +65°C (149°F) except -30°C (-22°F) to +65°C (+149°F) for the winch only)
B. Sheltered equipment: MIL-E-16400, Range 4: 0°C (32°F) to +50°C (+122°F)

b. Seismic zone 3 as specified in NAVFAC DM-2.2

c. Humidity shall be as specified in the Humidity paragraph of MIL-E-16400.

d. Rain and snow: Operation and storage under rainfall as specified in MIL-STD-810C, Method 506.1, Procedure I, or snowfall of 2 in. per hour with windblown snow

e. Wind and ice: Operation and storage in winds of 150 miles per hour (mph) from any horizontal direction without ice loading or winds of 90 mph from any horizontal direction with 0.50 in. of radial ice. Tower erection and antenna raising in winds of 25 mph, no ice, and antenna lowering in winds of 50 mph, no ice.

f. Salt atmosphere: Operation and storage in salt fog atmosphere as specified in MIL-STD-810C, Method 509.1, Procedure I.

g. Sand and dust: Operation and storage under conditions of blowing sand and dust as specified in MIL-STD-810C, Method 510.1, Procedure I.

h. Altitude: Operation at high altitudes up to 10,000 ft above sea level, and non-operating transport by air at altitudes up to 30,000 ft above sea level as specified in MIL-STD-810C, Method 500.1, Procedure I.

i. Fungus: Operation and storage in the presence of the fungi identified in MIL-STD-810C, Method 508.1.

j. Sunshine: Operation and storage in the presence of sunshine as specified in MIL-STD-810C, Method 505.1, Procedure I.

3.9 Design. The design of the antenna shall be in accordance with MIL-E-16400 to the extent specified herein. Items or parts necessary for proper operation shall be incorporated even though the items or parts may not be specifically provided for or described herein.

3.9.1 Service life. The antenna shall be designed and constructed to provide continuous service for long periods of time. Mechanical and electrical integrity shall be retained for a period of not less than 10 years without replacement of major components or assemblies. Major overhaul and adjustment, including lowering of the radiating elements, horizontal boom, and rotator assembly shall not be required at intervals of less than 5 years. The design, choice of materials, parts selection, construction methods, surface protection, and other factors which determine durability and performance reliability shall be consistent with requirements specified herein.

3.9.2 Electrical design. The electrical design shall be in accordance with the Electrical overload protection, Bonding and grounding, Internal wiring and cabling, and Mounting of parts paragraphs of MIL-E-16400, and as specified in 3.9.2.1 through 3.9.2.10.

3.9.2.1 Primary power. The antenna shall be designed to operate from a 120 volts alternating current (VAC) or 208 VAC, or both, ±10 percent, 47 Hz to 63 Hz, single-phase, 3-wire power source. The power circuits shall be designed so that incoming power is supplied through the antenna's local control unit. Circuit breakers only (no fuses) equipped with manual reset controls shall be used for individual protection of the motor and lighting circuits and shall be located at the local control unit. All power conductors and protective devices shall be sized and installed in accordance with the National Electrical Code (NFPA 70-1983). Circuit breakers shall conform to the requirements of W-C-375.

3.9.2.2 Electrical connections. Electrical (including RF) connections to be made in the field shall be clamped or bolted. Self-tapping screws shall not be used. Field connections of dissimilar metals shall not be required.

3.9.2.3 RF connections. RF electrical connections shall be constructed and protected so that the antenna shall not gradually degrade below the requirements of this specification over its service life due to deterioration of the connections. To eliminate the possibility of poor RF connections in tubular type radiating elements, if used, all elements 28 ft or less shall be constructed in a continuous length. Elements between 28 ft and 56 ft shall consist of two continuous lengths; elements 56 ft to 84 ft shall consist of three continuous lengths. Elements in lengths greater than 28 ft shall be connected by splice clamps as shown in FIGURE 1. In addition, provisions shall be included to permit field welding the continuous lengths together to ensure electrical continuity for the service life of the antenna group. The welding need only be sufficient to ensure electrical continuity and shall not be required to ensure mechanical strength of the radiating element. Provision shall also be included to allow for field welding the feedline to radiator element connections during installation. Each wire type radiator, if used, shall be constructed in a continuous length. Swaged fittings may be used on wire type radiators to ensure electrical reliability.

3.9.2.4 Corona. Corona and electrical breakdown protection shall be in accordance with the Corona and electrical breakdown prevention paragraph of MIL-E-16400. There shall be no evidence of corona, voltage breakdown, or overheating when operated at the RF powers specified in 3.3.11.2. Exposed edges and surfaces of the radiating elements shall be rounded to reduce the probability of corona.

3.9.2.5 Electromagnetic interference (EMI). All primary power, control, and lighting circuitry of the antenna shall be self-compatible and shall comply with the requirements of MIL-STD-461 for CE03 and RS03 at 194 V per meter from 0.2 MHz to 30 MHz for units other than the remote control, and 40 V per meter for the remote control unit.

3.9.2.6 Impedance matching. The drive point impedance of the radiating elements shall be matched to the 50 ohms nominal input impedance of the antenna. If an impedance matching transformer (balun) is required to conform to this requirement, the transformer (balun) shall be in accordance with MIL-T-28732, except that the maintainability requirements and oil level indicator are not required.

3.9.2.6.1 Nominal secondary impedance. The impedance interface between the balance terminals of the transformer (balun) and the antenna feedline shall be one of the following nominal impedances only: 200 ohms, 300 ohms, and 600 ohms. Transformer (balun) impedances shall not be complementary to the antenna feedline impedance so that special selection procedures for replacement transformers (balun) are required. The feedline and transformer (balun) impedance characteristics shall be such that the transformer (balun) can be replaced with any transformer (balun) conforming to MIL-T-28732 with the same nominal impedance.

3.9.2.7 Protective devices. Protective devices shall be in accordance with 3.9.2.7.1 through 3.9.2.7.4.

3.9.2.7.1 Lightning protection. Lightning protection, in addition to the ground rod specified in 3.9.2.9, shall be incorporated in the antenna to bypass the equipment and incoming lines as well as to act to minimize damage to the structure if a direct lightning strike occurs. The lightning protection device shall survive direct strikes and shall be capable of adjustment to allow for continuing protection. The lightning protection required by MIL-T-28732 shall be used to conform to this requirement.

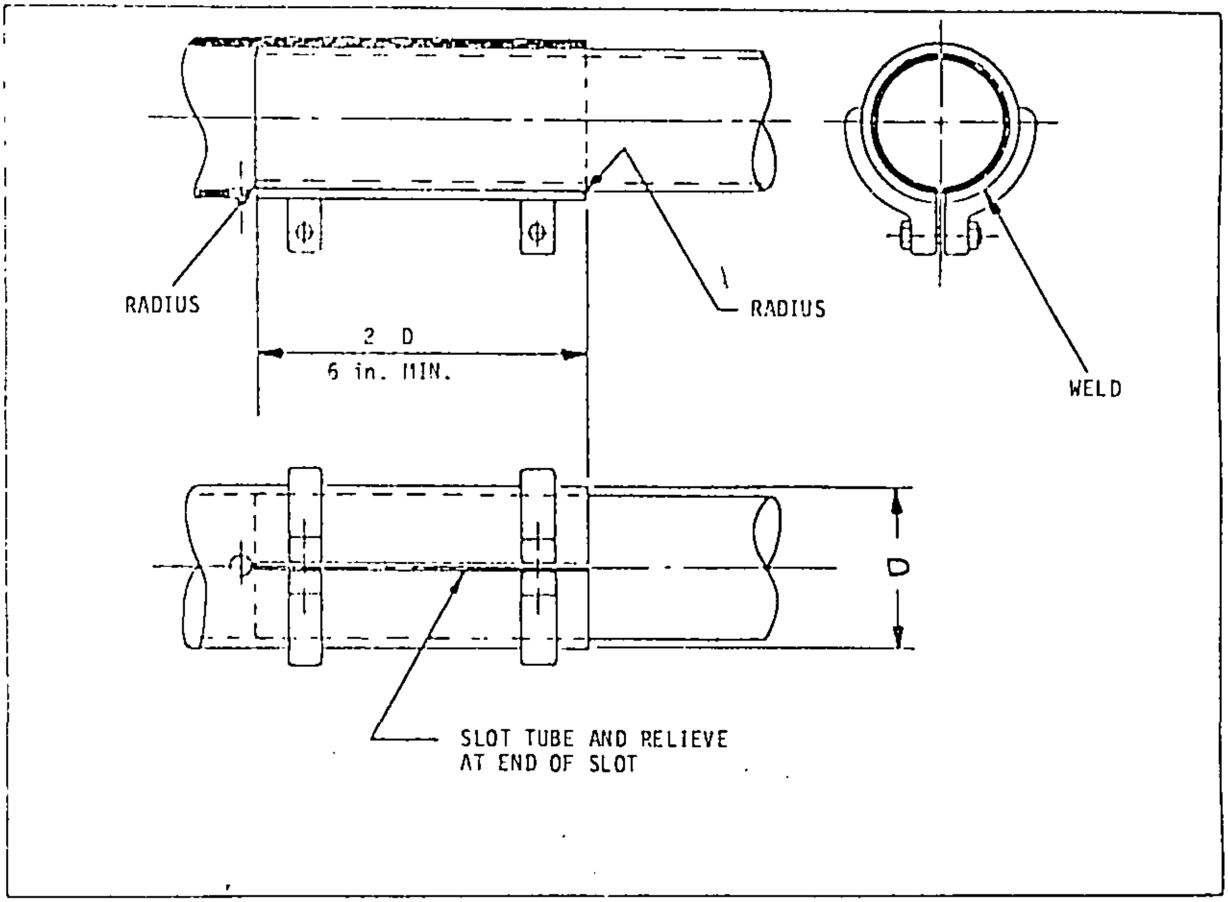


FIGURE 1. Splice clamp, typical.

3.9.2.7.2 Transient electromagnetic pulse (EMP). EMP and lightning protection shall be incorporated into the antenna group to prevent equipment damage as a result of transients that may be conducted into the equipment through power, communications, or control lines after having been induced onto the lines by man-made sources such as heavy switching transients or by natural phenomena such as lightning. Transient protection shall protect against pulses having the characteristics in TABLE I.

TABLE I. Transient EMP.

| Peak voltage | Pulsewidth | Rise time | Decay time | Approximate energy |
|---|---|---|---|---|
| 1000 | 1000 microseconds (μs) | 10 μs | 1000 μs | 33 joules |
| 1000 | 100 μs at 100-Hz rate | 1 μs | 100 μs | 3.3 joules |

Maximum use shall be made of no-fault devices to shunt transients to ground without causing failure of equipment or the protective device. The device shall be of the automatic reclosure type. Circuit design and protective devices shall be selected assuming a maximum 25-ohm ground condition.

3.9.2.7.3 Thermal overload. The rotator motor shall be protected against thermal overload. The thermal overload shall automatically reset after sufficient cooling of the motor.

3.9.2.7.4 Rotary switches. Rotary switches shall not be used.

3.9.2.8 Antenna control and power cables. The control cable shall contain a twisted pair for use as a voice telephone circuit in addition to antenna control wires with 50 percent extra conductors. The power cable shall be a 3-wire with ground return, and the conductor size shall be adequate to limit the voltage drop across given cable lengths to 2 percent of the applied voltage when running the motor under maximum wind loading conditions as specified herein. Requirements shall be specifically differentiated for 300-ft lengths up to 3500-ft lengths in increments of 300 ft. Cable shall be suitable for direct ground burial.

3.9.2.9 Ground rod. A ground rod, ground straps, and connectors required for grounding the antenna support structure shall be provided as specified in a through c:

a. The rod shall be a minimum 10 ft long and shall be copper-clad steel. The copper thickness shall be a minimum of 0.03125 in.
b. The diameter of the rod electrode shall be approximately 0.75 in.
c. Ground straps shall be solid copper straps not less than 2 in. wide by 0.0625 in. thick, tinned at the tower end over one-half the length of the straps.

3.9.2.9.1 Transmission lines. Transmission lines for RF power shall be capable of continuously carrying 1.25 times the power indicated in 1.2 without damage, except that rotary joints, if used, shall be capable of 1.5 times that power. If coaxial lines are used, minimum sizes shall be as specified in TABLE II throughout the antenna:

TABLE II. Minimum sizes of coaxial lines.

| Type (see 1.2) | Coaxial size |
|---|---|
| Type I | 0.875 in. |
| Type II | 3.125 in. |

Input connectors shall be of the same corresponding minimum sizes specified in TABLE II for the specific Type and shall conform to MIL-F-24044.

3.9.2.10 Guys and guy anchors. The guy wires shall be suitably segmented with fail-safe ceramic strain insulators to prevent resonance at any frequency within the specified operating range and to reduce pattern distortion to collocated HF antennas. If a guy requires more than three insulators to conform to this requirement, the guys shall be pre-assembled.

3.9.3 Mechanical and structural design and construction. Mechanical design shall be as specified in 3.9.3.1. Structural design shall be in accordance with the criteria specified in APPENDIX B.

3.9.3.1 Construction. Construction of the antenna shall be in accordance with AISC Specification for Design, Fabrication, and Erection of Structural Steel for Buildings, NAVFAC DM-2.2, NAVFAC DM-4, EIA RS-222C, and as specified in 3.9.3.1.1.

3.9.3.1.1 Templates. If tolerances on the horizontal location of hardware to be embedded in concrete during installation are held to ±0.50 in. or less, templates shall be supplied to guide the accurate placement of the hardware.

3.9.4 Surface area. Geometric configuration of structural elements, subassemblies, and assemblies shall be designed to minimize wind loading and to present minimum surface area for accumulation of ice.

3.9.5 Discontinuities. Structural discontinuities and stress risers (concentrations) shall be located so as to have minimum effect on the overall structural integrity.

3.9.6 Damping. Means shall be provided for damping vibration of the radiating elements and horizontal boom.

3.9.7 Stress. Joints and connections in structural members shall be designed for maximum shear, moment, and axial load existing at the joint and for a stress reversal equal to at least 50 percent of the design load. Field splices, connections, and joints shall be located at least 5 ft from points of maximum moment or points where a change of direction occurs in the moment diagram for the individual structural members of the assembly. Where structural members are subject to combined stress, the members shall be designed to withstand the effect of combined stress. All fasteners, including U-bolts, used on aluminum or nonmetallic components shall incorporate appropriate fittings to provide for uniform distribution of force under the U-bolt or other clamping surface. Strap type hose clamps shall not be used.

3.9.8 Electrical connections. All electrical connections to structural members made with bolts, clamps, or other screw type fasteners, shall use a minimum of two fasteners.

3.9.9 Threaded connections. All threaded connections shall have a locking method. All bolts used in the rotator assembly, including motor, clutch, housings, and drive train, shall have locknuts or shall be safety wired to prevent loosening due to vibration under normal antenna operation.

3.9.10 Aluminum. At load of 90 mph wind with 0.50 in. of radial ice, stresses in aluminum members shall not exceed the allowable stresses calculated in accordance with ASCE Proceedings Papers, Numbers 3341 and 3342. At load of 150 mph wind and for seismic loading, stresses shall not exceed the allowable stresses calculated in accordance with ASCE Proceedings Papers, Numbers 3341 and 3342, for bridges.

3.9.11 Insulators and nonmetallic structural parts. The minimum thickness of any fiberglass reinforced plastic, or any other nonmetallic structural part, shall be 0.375 in. regardless of calculated strength or stress. At 90 mph wind load with 0.50 in. of radial ice, stresses shall not exceed 30 percent of ultimate strength of the material, in the configuration in which the material is utilized. At 150 mph wind, load stresses on nonmetallic parts shall not exceed 30 percent of ultimate strength of the material in the configuration in which the material is utilized. Stresses on ceramic parts shall not exceed 30 percent of ultimate strength for either wind load condition.

3.9.12 Steel. At 90 mph wind load with 0.50 in. of radial ice, stresses shall not exceed the allowable stresses calculated in accordance with AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. At 150 mph wind load, stresses shall not exceed the allowable stresses calculated in accordance with AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

3.9.12.1 Cables. Steel and steel-clad cable tensions shall not exceed 50 percent of the ultimate strength of the material.

3.9.13 Structure. The structure shall be designed for winds normal to the radiating elements and normal to the horizontal boom, and wind directions shown in FIGURE 2 of APPENDIX B. The ratio of length to radius of gyration for the supporting structure shall not exceed 80:1.

3.9.14 Shock and vibration. The antenna shall be designed and constructed to conform to the minimum performance requirements upon completion of the vibration and shock conditions specified in 4.5.4 and 4.5.5. The shock and vibration tests shall determine the capability of the equipment to withstand the shock and vibration encountered during transportation and handling.

3.9.15 Moisture pockets and closure. The equipment shall be constructed so that there are no moisture pockets, wells, traps, or similar apertures in which water and condensed moisture can collect when the equipment is in the normal operating position. Means shall be provided for draining the water or condensed moisture from low spots. Ends of tubes shall be closed to prevent access by insects and birds; drainage shall be provided. The outer edge of the radiating elements shall be rounded to a minimum radius of 0.50 in. or to a spherical tip for elements less than 1 in. in diameter. If the inner edges of the radiating elements are enclosed, the entire radiating element shall conform to the watertight requirements of MIL-STD-108.

3.9.16 Insulation. Insulating elements utilized to support or, in any case, making contact with exposed portions of the transmission line or radiating elements shall be appropriately designed to minimize the possibility of arcing, creation of water drip paths, carbon tracking, or other deleterious condition. Positive means shall be provided to limit vibration or motion of conductors at different potentials to ensure proper electrical performance. The outer conductor of all coaxial lines shall be fabricated from aluminum and shall be supported to prevent physical or electrical contact with steel structural members.

3.9.17 Welding. Welding shall be in accordance with Requirement 13 of MIL-STD-454. Welding of aluminum shall be by the inert gas shielded tungsten arc (heliarc, argonarc) process.

3.9.18 Edges. All raw or cut edges, including bolt holes, in nonmetallic materials shall be sealed to prevent exposure to the atmosphere of filler, voids, or reinforcement.

3.9.19 Guy hardware. Appropriate size turnbuckles and automatic jaw or preformed grip type dead ends shall be used on all guy lines. All turnbuckles used shall be provided with locking nuts or other positive locking devices.

3.9.20 Jumpers. Removable jumpers for electrical connections between dissimilar metals shall be fabricated so that field connections between dissimilar metals shall not be required.

3.9.21 Assembly. The supporting structure and horizontal boom shall be designed to permit assembly and erection free from bows or other deformations. No cutting, drilling, or reaming operations shall be required during the assembly of the antenna. All connections, whether field or factory made, shall have identification on each cable extending from the connections so that verification that the proper cables are connected can be made by visual inspection of the connection.

3.9.22 Lifting attachments. Lifting attachments for sections shall be permanently attached to the structure and shall be designed for a safety factor of not less than 4. Lifting attachments shall be provided as required so that the attachments will provide a point of attachment for every guy or cable used during the antenna installation or in a normal maintenance procedure.

3.9.23 Brazing. Brazing shall conform to Requirement 59 of MIL-STD-454.

3.9.24 Cable manufacturing tolerances. Tolerances on cable elements of the antenna, both for the lengths of the cables and the locations of fittings and connections along the cables, shall not exceed the values specified in TABLE III, but may be less if required for the dimensional stability of the antenna. Cable dimensions shall be based upon the cable end-points, shall be noncumulative, and shall be measured under a minimum of 10 percent prestress (of design load).

TABLE III. Cable tolerances.

| Total length of cable (ft) | Maximum tolerance (in.) |
|---|---|
| Over 100 | 0.25 |
| 10 to 100 | 0.125 |
| Under 10 | 0.0625 |

Tolerances do not apply to overall lengths of a cable containing a turnbuckle or other positive length adjusting device, or to the structural guy insulator locations.

3.9.25 Gears. Gear applications shall be in accordance with Requirement 48 of MIL-STD-454.

3.10 Thermal design. The thermal design shall be in accordance with the Thermal design paragraph of MIL-E-16400. Water cooling and forced air cooling shall not be used.

3.11 Controls, indicators, and panel layouts. The design of controls and indicators, and arrangement on operator and maintainer panels, shall conform to the criteria of MIL-STD-1472 and shall be in accordance with the Controls, indicators and panel layout paragraph of MIL-E-16400, except as otherwise specified herein. The color coding and marking of pin jacks and other test points shall be in accordance with MIL-STD-415. Abbreviations used on panels shall be in accordance with MIL-STD-12. Time meters are not required.

3.12 Reliability. Reliability requirements shall be as specified in 3.12.1 through 3.12.3.

3.12.1 Quantitative reliability requirements. The upper test mean-time-between-failure (MTBF) ($\theta_0$ as defined by MIL-STD-781) shall be 8000 hours. The lower test MTBF ($\theta_1$ as defined by MIL-STD-781) shall be 4000 hours.

3.12.2 Failure. Any degradation of the performance parameters of this specification, or degradation as specified in the Failure categories paragraph of MIL-STD-781 shall be deemed a failure. Nonchargeable, chargeable, relevant, and nonrelevant failures shall be as defined in MIL-STD-781.

3.12.3 Mean-cycles-between-failure (MCBF). The MCBF for the antenna shall be the total number of cycles divided by the total number of chargeable failures. In an operational scenario, a cycle shall be an intentional rotational movement of the antenna. See 4.7 for reliability test and demonstration.

3.13 Maintainability. The equipment mean-preventive-maintenance-time ($M_{pt}$) shall not exceed 2 hours. Routine inspection and adjustments shall not be required at intervals of less than 6 months and shall not require a downtime of more than 3 hours. Routine inspection shall not require lowering the antenna. Ease of maintenance shall be considered in the design, choice of materials, parts selection, construction methods, and surface protection.

3.13.1 Technical standards. In order to ensure compatibility with other communications equipment employed by the Military services, the antenna shall conform to all applicable communication system technical standards of MIL-STD-188.

3.13.2 Maintenance design. The maintenance design shall be in accordance with MIL-E-16400, except that two 15-A fused duplex convenience receptacles shall be provided on the front panel of the antenna local control unit.

3.13.2.1 Lowering. The radiating elements, horizontal boom, and rotator assembly shall be capable of being rigged and lowered to ground level as a unit, without disassembly, in 2 hours, by a team of four men. The same structures shall be capable of being raised from ground level and the antenna ready for use, in 4 hours, by a team of four men.

3.13.3 General purpose test equipment (GPTE). GPTE shall be selected from MIL-STD-1364, unless permission is granted by the procuring activity to select other equipment based upon receipt of adequate justification.

3.14 Identification and marking. Identification and marking shall be in accordance with the Identification and marking paragraph of MIL-E-16400. Clear, concise, and durable markings shall be provided for all components to facilitate installation, operation, and maintenance.

3.14.1 Marking of electronic items. Electronic items shall be marked in accordance with MIL-M-13231.

3.15 Workmanship. Workmanship shall be in accordance with the Workmanship paragraph of MIL-E-16400.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Government verification. All quality assurance operations performed by the contractor will be subject to Government verification at any time. Verification will consist of, but is not limited to, a) surveillance of the operations to determine that practices, methods, and procedures of the written quality program are being properly applied, b) Government product inspection to measure quality of the product to be offered for acceptance, c) Government inspection of delivered products to assure compliance with all inspection requirements of this specification. Failure of the contractor to promptly correct deficiencies discovered by him or of which he is notified shall be cause for suspension of acceptance until corrective action has been taken or until conformance of the product to prescribed criteria has been demonstrated.

4.1.2 Quality assurance terms and definitions. Quality assurance terms used in this specification shall be as defined in MIL-STD-109.

4.2 Classification of inspections. The inspection requirements specified herein are classified as specified in a through c:

a. First article inspection (see 4.3)
b. Quality conformance inspection
   1. Production inspection (see 4.4.1)
c. Inspection of preparation for delivery (see 4.9)

4.3 First article inspection. Unless otherwise specified (see 6.2), one antenna shall be required for first article inspection. First article inspection shall consist of all examination and testing necessary to determine compliance with the requirements of this specification. First article inspection shall include the tests specified in TABLE IV.

TABLE IV. Examinations and tests.

| Examination or test | Requirement paragraph | Test paragraph | First article inspection | Production inspection |
|---|---|---|---|---|
| Surface examination | 3.1, 3.3 through 3.3.10, 3.3.12, 3.5, 3.6.1, 3.6.2, 3.6.3, 3.7, 3.9.2, 3.9.3, 3.11, 3.14, 3.15 | 4.5, 4.5.10 | X | X |
| Performance | 3.3.3, 3.3.6, 3.3.7, 3.3.8, 3.3.9.1, 3.3.11.1, 3.3.11.3, 3.5.1, 3.7.2, 3.9.2.1 | 4.5, 4.5.11 | X | X |
| VSWR | 3.3.11.4 | 4.5.12 | X | |
| Inclined plane | 3.6.2.4 | 4.5.7 | X | |
| Humidity | 3.8 | 4.5.13 | X | |
| Salt atmosphere | 3.8 | 4.5.14 | X | |

TABLE IV. Examinations and tests. (continued)

| Examination or test | Requirement paragraph | Test paragraph | First article inspection | Production inspection |
|---|---|---|---|---|
| Weld | 3.1, 3.9.17 | 4.5.3 | X | X |
| Reliability | 3.12 | 4.7 | X | |
| Fungus | 3.8 | 4.5.15 | X | |
| Sand and dust | 3.8 | 4.5.16 | X | |
| Rain | 3.8 | 4.5.17 | X | |
| Corona | 3.9.2.4 | 4.5 | X | |
| Wind and ice | 3.8 | 4.5.1 | X | |
| Power and power factor | 3.9.2.1 | 4.5 | X | |
| Pressurization | 3.3.4.2 | 4.5.2 | X | |
| Shock | 3.9.14 | 4.5.4 | X | |
| Vibration | 3.9.14 | 4.5.5 | X | |
| Proof load | 3.3.9, 3.3.9.2, 3.7.1.1, 3.7.1.2, 3.9.11, 3.9.12.1, 30.8 of APPENDIX A | 4.5.6, 40.1.1 of APPENDIX A | X | |
| Fiberglass cable | APPENDIX A | 40.1 of APPENDIX A | X | |
| EMP | 3.9.2.7.2 | 4.5.9 | X | |
| EMI | 3.9.2.5 | 4.5.9 | X | |
| Installability | 3.1, 3.3.9, 3.3.10 | 4.6 | X | |
| Maintainability demonstration | 3.3.9.2, 3.13 | 4.8 | X | |
| Human engineering | 3.5 | 4.5.8 | X | |

4.4 Quality conformance inspection. Quality conformance inspection shall be as specified in 4.4.1.

4.4.1 Production inspection. Production inspection shall be made on every antenna offered for delivery. Production inspection shall comprise such examination and testing which will prove the workmanship and reveal the omissions and errors of the production process such as functional and performance tests at a limited number of points in the required range, tests which detect deviations from design, tests of adjustment, and tests which detect hidden defects of materials. Production inspection shall include the examinations and tests specified in TABLE IV.

4.5 Test methods. The applicable test methods shall be as specified in MIL-E-16400, except as specified in 4.5.1 through 4.5.17.

4.5.1 Wind and ice loading. Static simulated wind and ice loading tests shall be performed in order to demonstrate the structural integrity of the antenna to withstand the wind and ice loading specified in 3.8. The antenna shall not take a permanent set or be deformed after wind and ice loading have been removed.

4.5.2 Pressurization test. The transmission line cable, with ends properly terminated, shall be pressurized to an internal pressure of 10 psig, and shall not leak in excess of 35 percent pressure drop over a 24-hour period.

4.5.3 Weld test. Ten percent of the steel welds of each antenna shall be magnafluxed to detect discontinuities. If a defect is found in the 10 percent welds, all of the welds in the affected antenna shall be magnafluxed.

4.5.4 Shock test. The remote control unit, junction box (with contents), local control unit, rotator assembly, winch(es), obstruction lighting hardware, radiating elements, and boom and tower sections packaged for shipment shall be subjected to the rough handling test of MIL-P-116.

4.5.5 Vibration test. The remote control unit, local control unit, rotator assembly, winch(es), and obstruction lighting hardware assembled for shipment shall be subjected to the vibration test of MIL-STD-810C, Method 5142, Procedure X, Curve AX.

4.5.6 Proof load tests. Proof load tests shall be accomplished on fiberglass and steel cable assemblies with insulators and attachment hardware, safety ladder, safety rail and sleeve safety locking device, and installation and erection kit components.

4.5.7 Inclined plane test. When required by 3.6.2.4 (that is, use of Category C or D material in transmitting applications), test samples of each material shall successfully complete the initial tracking voltage test of ASTM D2303, as specified in 4.5.7.1 and 4.5.7.2. If the insulating material is to be coated in final use, the test shall be performed on the coated material.

4.5.7.1 Power supply frequency. The frequency of the power supply used in the test shall be 30 MHz.

4.5.7.2 Limits. The test sample shall not be considered to have passed the test unless the sample complies with a and b:

a. The initial tracking voltage is at least double that which would be encountered under full specified power operation of the antenna

b. Insulating material or coating does not melt

4.5.8 Human engineering testing. The contractor shall test the antenna for human engineering characteristics in accordance with the Human engineering in test and evaluation paragraph of MIL-H-46855 and the approved human engineering test plan.

4.5.9 EMP/EMI tests. Conformance to the requirements of 3.9.2.7.2 and 3.9.5 shall be verified by tests performed in accordance with MIL-STD-462.

4.5.10 Cable inspection. Each cable shall be measured in a prestressed condition to determine compliance with 3.9.24 and shall be visually inspected for proper assembly and compliance with 3.9.21.

4.5.11 Drive system test. The drive system shall be inspected for backlash, torque, acceleration, deceleration, and the ability to hold the antenna from rotating by forces external to the antenna. If a clutch is part of the system, the clutch shall be tested for proper operation.

4.5.12 VSWR. VSWR measurements shall be made across the entire frequency range of the antenna utilizing swept frequency techniques.

4.5.13 Humidity test. The humidity test shall be in accordance with MIL-E-16400. The test shall be performed on the completely assembled and functional rotator assembly, load control unit, junction box (with contents), obstruction lighting kit, and winch(es).

4.5.14 Salt fog test. The salt fog test shall be in accordance with MIL-STD-810C, Method 509.1, Procedure I and shall conform to the following: The test shall be performed on samples of all materials exposed to the environment. Every type of material, every process (coating and treatment), every type of dissimilar metal junction, and every type of bolted connection which must be disconnected for maintenance shall be included in the test. Corrosion of bolts and nuts which results in the inability to remove the bolt and nut without destroying them shall be cause for rejection. Corrosion of dissimilar metal junctions, corrosion of the base metal under or through processes (coatings and treatments), and the inability of the coatings to prevent corrosion shall be causes for rejection.

4.5.15 Fungus test. The fungus test shall be in accordance with MIL-STD-810C, Method 508.1.

4.5.16 Sand and dust test. The sand and dust test shall be in accordance with MIL-STD-810C, Method 510.1, Procedure I.

4.5.17 Rain test. The rain test shall be in accordance with MIL-STD-810C, Method 506.1, Procedure I. The test shall be performed on the completely assembled and functional rotator assembly, local control unit, junction box (with contents), obstruction lighting kit, and winch(es).

4.6 Installation verification. The installation instructions shall be completely verified as part of the first article test on a step-by-step basis, from start to finish (with the exception of the concrete foundation) while being witnessed by a Government representative.

4.7 Reliability test and demonstration. An accelerated reliability test shall be conducted in the following manner: The antenna shall be operated a total of 4000 cycles, one cycle consisting of a rotation in a given direction of no less than 330 degrees. Each consecutive cycle shall be in the opposite rotational direction. Acceptance of the antenna shall require completion of this test with no more than one failure (see 3.12.2).

4.8 Maintainability demonstration. The contractor shall demonstrate the $M_{pt}$ time requirement specified in 3.13 in accordance with Method 11 of MIL-STD-471. Compliance with the erection requirements of 3.3.9.2 shall also be demonstrated.

4.9 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation and packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of Section 5. First article packs which contain Level A packages shall be subjected to rough handling tests in accordance with MIL-P-116.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in the contract. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order.)

5.1 Preservation, packaging, packing, and marking. Unless otherwise specified herein, preparation for delivery shall be in accordance with the applicable levels of preservation, packaging, packing, and marking specified in MIL-E-17555 (see 6.2).

5.2 Fiberglass cables. Fiberglass cables shall be packaged in accordance with APPENDIX A.

5.3 Weight and size limitation. The weight and size of individual shipping containers shall not exceed the values in a through d without approval of the procuring activity prior to packing and packaging:

a. Length 32 ft
b. Width 8 ft
c. Height 8 ft
d. Weight 11,200 lbs

6. NOTES

6.1 Intended use. The antenna covered by this specification is intended for communications use in shore based Naval stations at worldwide locations. The antenna is expected to withstand continuous use for long periods under Military service conditions, without benefit of overhaul. The antenna is a vital communications instrument for important use by the forces concerned. Failure at a critical moment invariably results in serious reduction in the efficiency and effectiveness of the Naval Communications System. Emergency repairs at distant stations can seldom be made with sufficient celerity to avoid having the antenna out of service during a critical period.

6.2 Ordering data. Procurement documents should specify:

a. Title, number and date of this specification
b. Type of equipment, if other than Type II is required (see 1.2 and 3.3.11.2)
c. Obstruction lighting kit, if required (see 3.3.8)
d. Number of first article samples to be submitted if other than specified in 4.3
e. Applicable levels of preservation, packaging, packing, and marking (see 5.1 and 5.2)

6.3 First article. When a first article is required, it shall be tested and approved under the appropriate provisions of 52.209-3 of the Federal Acquisition Regulation. The first article should be a first production item. The first article should consist of one unit. The contracting officer should include specific instructions in all procurement instruments, regarding arrangements for examinations, tests, and approval of the first article.

6.4 Definition. Definition of gain as used in this specification is:

$$10 \log \frac{\text{maximum radiation intensity from RLPA}}{\text{radiation intensity from (lossless) isotropic source with the same power input}}$$

6.5 Changes from previous issues. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
NAVY-EC



(Project No. 5985-N505)

APPENDIX A
FIBERGLASS CABLES

10. SCOPE

10.1 Scope. This APPENDIX covers the design, construction, and performance of fiberglass guys and other cable elements (collectively referred to as cables) for structural use with antenna supporting structures. Unless otherwise specified herein, requirements apply to both the guys and the cable elements. This APPENDIX is a mandatory part of this specification. The information contained herein is intended for compliance.

20.1 Government documents.

20.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

| | |
|---|---|
| QQ-S-763 | Steel Bars, Wire Shapes, And Forgings, Corrosion Resisting |
| RR-S-550 | Sockets, Wire Rope |

MILITARY

| | |
|---|---|
| MIL-R-7575 | Resin, Polyester, Low-Pressure Laminating |
| MIL-R-9300 | Resin, Epoxy, Low-Pressure Laminating |

STANDARD

FEDERAL

| | |
|---|---|
| FED-STD-406 | Plastics: Methods of Testing |

(Copies of specifications and standards required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

30. REQUIREMENTS

30.1 General. Fiberglass cables shall consist of glass reinforced plastic rods and galvanized steel end socket fittings. The reinforcement shall be fiberglass roving laid up unidirectionally and shall be impregnated with an epoxy laminating resin conforming to MIL-R-9300 or polyester laminating resin conforming to MIL-R-7575. The plastic rods shall have a protective coating for weather protection.

30.2 Dimensions. The diameter of the rods shall be as specified by the designer with a tolerance of +0.03125 in. and -0 in. exclusive of coatings but in no case shall the diameter of the rods be less than 0.375 in.

30.2.1 Guy lengths. Guys shall be furnished in sections of assembled standard rod lengths. The manufacturer may choose any length up to 30 ft including the end fittings and establish this length as a standard length; then the complete guy assembly shall be made up of standard lengths, plus the minimum number of other lengths not less than 10 ft in length plus a metal guy section as specified in 30.2.1.1. Each guy assembly shall be made up of lengths of rod of the same diameter.

30.2.1.1 Assembly length. Assembly length shall be variable ±10 percent of the nominal length. To accomplish this, a suitable length or lengths of metal guy section shall be furnished as part of the assembly and shall conform to the metal guy section requirements specified herein.

30.2.2 Cable assemblies. Cable assemblies other than structural guys may be fiberglass rod sections or continuous lengths of fiberglass rod. Continuous length fiberglass rods shall be not greater than 0.50 in. diameter.

30.3 Glass and resin content. The glass and resin content shall be determined on five samples cut from uncoated rods of each size in accordance with Method 7061 of FED-STD-406, except that the temperature shall be 593°C (1100°F) ±38°C (100°F) and the exposure time shall be the time necessary to remove all the resin, or a minimum of 4 hours, whichever is greater, at the exposure temperature. Care shall be taken to ensure that the glass does not melt and entrap resin or carbon. The resin mixture shall contain no fillers. The samples removed from the furnace shall be clean and white. The glass and resin content of the rods shall be within ±3 percent of the percentages specified in TABLE V.

TABLE V. Glass and resin content packages.

| Size (in.) | Glass content (percent) | Resin content (percent) |
|---|---|---|
| 0.50 | 78 | 22 |
| 0.50 | 77 | 23 |
| 0.625 | 76 | 24 |
| 0.75 | 75 | 25 |
| 1.00 | 74 | 26 |

30.4 Specific gravity. The specific gravity shall be determined on five samples cut from uncoated guy rods of each size in accordance with Method 5011 of FED-STD-406. The specific gravity shall be within the limits specified in TABLE VI.

TABLE VI. Specific gravity.

| Size (in.) | Specific gravity |
|---|---|
| 0.375 | 2.05 ±0.15 |
| 0.50 | 2.00 ±0.15 |
| 0.625 | 1.94 ±0.15 |
| 0.75 | 1.89 ±0.15 |
| 1.00 | 1.84 ±0.15 |

30.5 Coatings and treatments. Fiberglass cables shall be coated to prevent deterioration from ultraviolet radiation and weathering. The coating shall be either an epoxy or polyester laminating resin mixture matching the resin used in the rod and containing a nonchalking titanium dioxide pigment. An epoxy coating in lieu of a laminating resin may be used on either type of rod. The thickness of the coating shall be a minimum of 5 mils and a maximum of 30 mils. However, the maximum and minimum thickness on any rod shall not vary more than 7 mils. The coating may contain a thixotropic filler in order to help provide the proper thickness.

30.6 Electrical resistance. The coated rods shall have a minimum resistance of 10 megohms per ft of length measured by a 500-V megger under standard room conditions.

30.7 Fittings and fitting attachments. Fittings and fitting attachments shall be steel. Steel fittings shall be wire rope sockets conforming to Types A and B, Finish 2 of RR-S-550, using an appropriate size for the corresponding rod size. Cotter pins used with steel fittings shall be Class 302 or 304 corrosion-resistant conforming to QQ-S-763. Each rod shall have attached a Type A fitting on one end and a Type B fitting on the other end. Fittings on each rod shall be positioned so that the eye of the loop of the closed socket is on an axis parallel to that of the pin of the open socket. Each rod end shall be expanded by a plug shaped to suit the socket fitting. The minimum length of the plug shall be 50 percent of the length of the basket.

In no case shall the end of the plug extend beyond the end of the basket. Epoxy compound shall be used to cement the plug to the rod and the rod to the fitting. The exposed rod end and plug shall be completely covered with epoxy compound. Where the rod enters the fitting, a weather seal shall be provided to prevent moisture penetration using a silicone rubber sealer such as Dow Corning Silastic RTV 731, or equal.

30.8 Breaking strength in tension. The minimum breaking strength in tension of the rods with end fittings attached shall be as specified in TABLE VII.

TABLE VII. Breaking strength in tension.

| Size (in. diameter) | Minimum breaking strength (lbs) |
|---|---|
| 0.375 | 12,000 |
| 0.50 | 20,000 |
| 0.625 | 30,000 |
| 0.75 | 40,000 |
| 1.00 | 65,000 |

The actual breaking strength shall be determined on samples at least 4 ft in length, including fittings. The sample shall be pulled in tension at the rate of 0.2 in. per minute. The test shall be performed in a room maintained at 21°C (70°F) to 24°C (75°F) and a relative humidity no higher than 65 percent. A minimum of five samples of each size shall be tested, and no sample shall have a breaking strength lower than the minimum strength specified herein.

30.8.1 Elongation. The maximum elongation at one-third the minimum breaking strength for each of the rods shall be 1 percent of the length of the rod. The maximum elongation at break for each of the rods shall be 2 percent of the length of the rod. The elongation shall be determined during the breaking strength in tension test in the following manner unless the testing machine is equipped with an automatic measuring device: Gage marks 30 in. apart shall be made on the sample with a grease pencil. A tape measure, graduated in 0.0625 in. increments, shall be taped to the sample at one gage mark. The other end of the tape shall be attached to a paper clip or similar wire and attached by the clip at the opposite end of the rod and readings shall be made on the tape at the specified loads.

30.8.2 Wet strength. The wet strength of the rod shall be not less than 90 percent of the average breaking strength determined as specified in 30.8. Wet strength shall be determined by immersing the sample in boiling water for 3 hours ±10 minutes. The sample shall be allowed to return to room temperature by immediately immersing it in water at room temperature or allowing the boiling water to cool to room temperature. The sample shall be tested immediately upon removal from the water. Sample size, number of samples, and test method shall be as specified in 30.8. Samples used for this test shall have been fabricated at least 2 weeks prior to immersion in the boiling water.

30.9 Creep-set. The rod shall fully recover its original length and show no permanent set when tested as follows: A sample 4 ft in length, including fittings, shall be subjected to a tensile load of one-third the minimum breaking strength of the rod as specified in 30.8. The length between the fittings shall be measured before and immediately after applying the load. Measurements to the nearest 0.0625 in. shall be made every hour for the first 8 hours and every day thereafter until no further elongation is measured for 6 successive days. If this equilibrium is not attained within a period of 30 days, the sample shall be considered to have failed the test. Upon reaching equilibrium, the load shall be removed. Measurements shall be made immediately after removing the load and 24 hours later. At the end of the 24-hour period, the length shall be fully recovered.

30.10 Fatigue strength. The fatigue strength shall be not less than 80 percent of the average breaking strength of that size as determined in 30.8. The fatigue strength shall be determined by holding one end of a rod with end fitting installed rigid and pushing the other end horizontally from the side with a pusher arm. The deflection (distance pushed) at the free end of the rod shall be 1 in. per foot length of sample. The sample shall be subjected to 100,000 cycles of pushing and recovery and then the breaking strength in tension shall be determined. Sample size, number of samples, and breaking strength test method shall be as specified in 30.8.

40. QUALITY ASSURANCE PROVISIONS

40.1 Quality assurance tests. Quality assurance tests shall be as specified in 40.1.1 and 40.1.2.

40.1.1 Proof test. Each assembled section or continuous length, with fittings attached, shall be proof tested to 50 percent of the breaking strength of the rod as specified in 30.8 to ensure proper assembly. Rods failing to pass the proof test shall be discarded.

40.1.2 Production tests. The contractor shall take, for every 1000 ft of rod being produced, a random sample of sufficient size, and test the sample for conformance to the requirements for diameter, glass and resin content, electrical resistance, and specific gravity. The contractor shall also perform tests on random samples, selected by the Government quality assurance representative (QAR), from each lot in accordance with the procedure specified in a through c:

a. The breaking strength, elongation, wet strength, creep-set, and fatigue strength tests shall be performed under the observation of the Government QAR, by the contractor or the contractor's commercial laboratory acceptable to the Government. If a sample fails, the lot shall be considered to have failed.

b. The first 40 assembled sections, or each 1000 ft of one size produced, shall constitute the first lot. If the results of the tests are above minimum requirements, the first lot is acceptable and the next lot shall be the next 80 (or 2000 ft) pieces of that size produced. If that lot is acceptable, the next lot shall be the next 160 (400 ft) produced, then the next 320 (9000 ft), 640, and so forth.

c. If a lot fails, the lot shall then be divided into two sub-lots and each sub-lot tested. If a sub-lot fails, the sub-lot shall be rejected and the next regular lot shall be the same size as the previous lot which has passed the test.

50. PACKAGING

50.1 Marking and packaging. Fiberglass rod in sections shall not be coiled at any time during or after manufacture. Sections shall be physically marked to correspond with the installation drawings. Packaging for shipment shall be as follows: Sections shall be assembled in bundles, wrapped, and banded, with the bundle end boxed. The wrapping material shall be reinforced waterproofed kraft paper. Cushioning material shall be placed under all banding to prevent damage to the sections. Each bundle shall be provided with a sufficient number of lifting attachments, so positioned and cushioned to prevent damage to the sections during shipment, handling, and lifting. Continuous length fiberglass rods may be packaged in coils provided that the coil diameter is not less than 250 times the diameter of the rod. Verification that this packaging will not be detrimental to the rod shall be made by subjecting a sample coil to a temperature of 75°C (167°F) and a relative humidity of not less than 85 percent for a continuous period of not less than 170 hours, at the end of which time the sample shall be pull-tested to show a breaking strength equal to that obtained prior to heating.

APPENDIX B
BASIC STRUCTURAL DESIGN CRITERIA

10. SCOPE

10.1 Scope. This APPENDIX covers the basic design of guyed antenna support structures, towers, and antennas. This APPENDIX is a mandatory part of this specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this APPENDIX.

30. REQUIREMENTS

30.1 General. The general requirements shall be as specified in 30.1.1 through 30.1.8.

30.1.1 Guyed towers. Guyed towers shall be designed as beam columns on elastic supports. Elastic actions resulting from guy behavior should be analyzed and included in the design.

30.1.2 Moment of inertia. Moment of inertia shall be assumed to be constant within a tower span.

30.1.3 Axial load. Axial load shall be assumed constant in a tower span.

30.1.4 Uniform variation of wind pressure on towers. Uniform variation of wind pressure on towers shall be replaced by a step function that makes the wind load constant in a span.

30.1.5 Wind velocity. Wind velocity to be used for computing wind loads on guys shall be assumed as the wind acting at mid-height of the guys.

30.1.6 Torsional moment. Torsional moment at each guy level introduced by the eccentricity resultant of the guy forces with respect to the centroid of the tower shaft shall not be neglected.

30.1.7 Increase in flexture. Increase in flexture due to tower distortion, caused by noncollinear deflections of the tower at each guy level, may be disregarded.

30.1.8 Wind directions. Wind directions assumed to be acting on the structure shall be as shown in FIGURE 2 and such other wind directions as may induce critical stresses in structural members.

30.2 Design criteria. The design criteria shall be as specified in 30.2.1 through 30.2.8.

30.2.1 Wind, wind and ice, and seismic zone. Wind, wind and ice, and seismic zone shall be as specified in 3.8e and 3.8b. The symbols used shall be as shown in FIGURE 3.

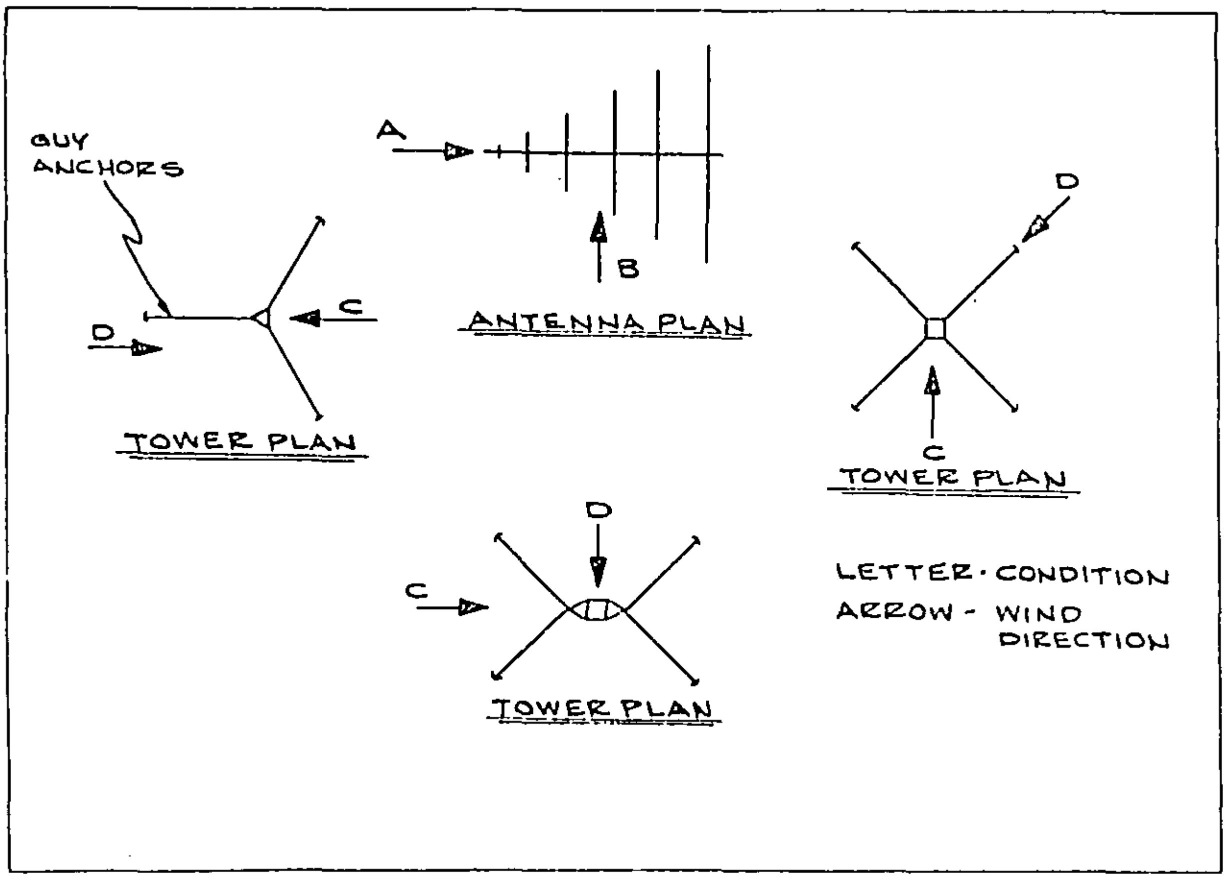


FIGURE 2. Wind direction.

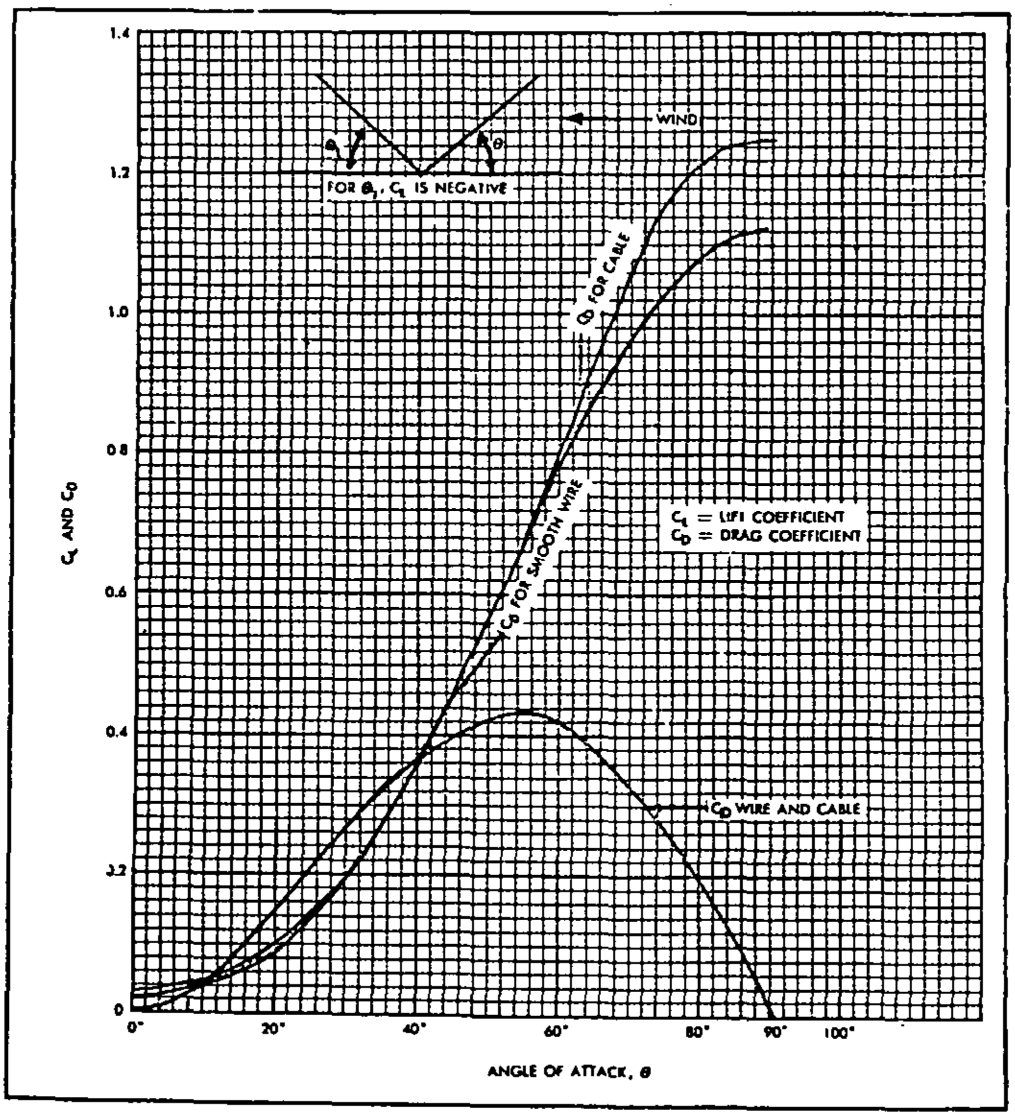


FIGURE 3. Wind coefficient chart for guy cables.

30.2.2 Wind loading on antennas and towers. The wind pressures on antennas and towers shall be computed by the relation:

$$w = C_d A\ Q\ C_h$$

Where:

w = Load in lbs per unit of structural length at a given height above ground level

$C_h$ = Wind pressure coefficient to be applied for all heights above 30 ft only

= $\frac{h}{30}$ 2/7, where h is the given height in ft

Q = Wind pressure is pounds per square ft

= $0.00256\ V^2$, where V is the wind velocity in mph

A = Projected area of the face of the structure in square ft per unit of structural length at the given height

$C_d$ = Wind drag coefficient to be applied as specified for the conditions specified in a through c:

a. For open-faced (latticed) structures fabricated with flat-surfaced members

$C_d$ = 1.75 for towers of square cross-section

$C_d$ = 1.50 for towers of triangular cross-section

b. For open-faced (latticed) structures fabricated with cylindrical members

$C_d$ = 2/3 of the applicable coefficients in a

c. For close-faced (solid) structural or antenna elements (poles, tubing)

$C_d$ = 1.5 for elements of rectangular cross-section

$C_d$ = 1.0 for elements of cylindrical cross-section

30.2.3 Wind loading. No increase in design stress shall be permitted for wind loading since wind is the principal load, except as specified herein. If design wind on the structure equals or exceeds 40 percent of the weight of the structure, investigation of seismic loading shall not be required.

30.2.4 Wind loading on guys. Wind, drag, and lift on the guy cables shall be computed as shown in FIGURE 3.

30.2.5 Existing antenna design. When a manufacturer is offering an antenna of existing commercial design, the structural adequacy of the antenna and the supporting tower shall be investigated and verified in accordance with requirements specified herein.

30.2.6 Allowable stresses. Allowable stresses for aluminum alloys shall be in accordance with ASCE Proceedings, Paper Numbers 3341 and 3342, except as modified herein.

30.2.7 Allowable stresses. Allowable stresses for structural steel shall be in accordance with Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings of the American Institute of Steel Construction, except as modified herein.

30.2.8 Foundations and anchors. Foundations and guy anchor design shall be in accordance with the applicable portions of NAVFAC DM-2.2, Chapter 9, Section 3, Subpart 13, Steel Towers.

30.3 Additional design criteria and construction details. Additional design criteria and construction details shall be as specified in a through k:

a. Initial structural guy tensions shall be limited to 20 percent of the guaranteed minimum breaking strength of the cable.

b. Maximum guy stresses shall not exceed 0.4 of the guaranteed minimum breaking strength of the cable, except as modified herein.

c. The design of the antenna shall preclude the possibility of detrimental oscillation in any element through wind loading.

d. Care shall be exercised to ensure that detailed investigation of horizontal and vertical shear stresses is not overlooked in the design analysis.

e. Effects of holes, notches, re-entrant corners, and other points of stress concentration shall be evaluated in the design analysis when such cannot be eliminated.

f. Longtime stress (cold flow, fatigue, and any other time-related characteristics of metallic and nonmetallic structural components) shall be evaluated and the effect on the life of the structure explained in the design analysis.

g. The supporting mast structure shall be analyzed to ensure that allowable stresses are not exceeded during the field erection and lowering process. In addition, the supporting mast structure shall be analyzed for stresses and reversal of stresses due to inertial forces generated by start and stop operations

h. The vertical rotating mast shall be analyzed for deflection and stresses under maximum wind loading as well as torque loading

i. The rotating load on the drive mechanism shall be analyzed at maximum wind and ice loadings as specified in 3.8e.

j. The antenna shall be designed to resist the effect of the failure of any guy. The antenna loading and allowable stress criteria for this condition shall be one-quarter maximum wind load plus all dead load with an increase in allowable stress specified in 30.2.6 and 30.2.7 of 33 percent but not exceeding the yield strength of the material.

k. The design of the antenna, and the erection and lowering shall include a temporary backup system of redundant components as necessary to prevent the possibility of a catastrophic collapse resulting from the failure of any of the major components during erection and lowering operations.

40. Definitions. Definitions of terms used in this APPENDIX are given in 40.1 through 40.3.

40.1 Factor of safety of guys and their connections. Factor of safety of guys and their connections are defined as the ratio of the guaranteed minimum breaking strength of the guy to the working stress at the design load.

40.2 Prestressing of guys. Prestressing of guys is defined as the removal of the inherent constructional looseness of the guys.

40.3 Initial guy tension. Initial guy tension is defined as the specified guy tension at the low end of the guy under no-load conditions.

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