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7 June 1976
SUPERSEDING
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MIL-A-6271A
27 May 1952

MILITARY SPECIFICATION

# ANTENNA SUBSYSTEM FOR VHF AIRBORNE COMMUNICATION EQUIPMENT GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 This specification covers the general design, performance, and flight test requirements for an antenna subsystem used with VHF communication equipment in the frequency range of 118 to 156 MHz.

## 2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

| | |
|---|---|
| MIL-B-5087 | -Bonding, Electrical, and Lightning Protection, For Aerospace Systems |
| MIL-E-5400 | -Electronic Equipment, Airborne, General Specification For |
| MIL-C-39012/16 | -Connector, Coaxial, Radio Frequency (Series BNC (Cabled) - Plug Male, Class II) |
| MIL-C-39012/17 | -Connector, Coaxial, Radio Frequency (Series BNC (Cabled) - Plug Female, Class II). |

STANDARDS

MILITARY

| | |
|---|---|
| MIL-STD-490 | -Specification Practices |
| MIL-STD-810 | -Environmental Test Methods |
| MIL-STD-831 | -Test Reports, Preparation of |
| MIL-STD-877 | -Antenna Subsystems, Airborne, Criteria For Design and Location of. |

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

## 3. REQUIREMENTS

3.1 First article inspection. When specified (see 6.2), the contractor shall furnish sample antenna subsystems for first article inspection and approval (see 4.4.1 and 6.2.1b.).

3.2 General documents. The requirements of MIL-STD-877 apply as requirements of this specification. The requirements of MIL-E-5400 apply to antenna components containing electronic circuitry. When the general documents conflict with this specification, this specification shall govern.

3.3 Design and construction. The antenna subsystem specified herein shall be designed to be compatible with the VHF communication requirements for the weapon system under consideration. The antenna subsystem may be a type that is installed external to aircraft skin or a zero drag design installed flush with the aircraft skin. The antenna subsystem may be in physical combination with other frequency range antenna subsystems, thus serving two or more equipments. If the VHF antenna subsystem is made in combination with other antenna subsystems, it shall be possible to operate the equipments simultaneously, and with no interference, one with another.

3.3.1 Antenna subsystem composition. The antenna subsystem shall include all components, such as radiating elements, transmission line, matching devices, filters, and switching devices, that are connected in the subsystem beyond the output connector of the VHF equipment.

3.3.1.1 Antenna radiating elements. The antenna radiating elements shall consist of a slot, cavity, loop, stub, dipole, array, or other elements suitable for installation in the aircraft weapon system consistent with the position in which it is to be installed.

3.3.1.2 Transmission line and connectors. The antenna subsystem shall be so designed and installed that connection can be readily made to the associated radio equipment through a minimum length of radio-frequency cable. R-f cable and associated connectors shall be subject to prior approval by the procuring activity. The method used in effecting electrical connection between the antenna element and the r-f cable shall satisfy the environmental requirements specified herein. The maximum allowable loss between transceiver and antenna element shall not exceed 2 dB. The use of standard cables and connectors shall in no way be construed as justification for exceeding the maximum allowable attenuation stated herein.

3.3.1.3 Selective isolating devices. The contractor shall provide selective isolating devices, as a part of the subsystem, that are necessary to assure compliance with the interference control requirements specified in MIL-STD-877.

3.3.1.3.1 Consideration shall be given to the fact that with multiple VHF transmitters and receivers operating in the same aircraft there is a greater requirement for independence of those subsystems to preclude the existence of interference from transmitter to receiver. A space attenuation between transmitting and receiving antennas of opposite subsystems shall be an absolute minimum of 35 dB, and preferable 45 dB or greater.

3.3.1.4 Structural plastic materials. Plastic materials used in the antenna design shall be in accordance with military specifications where possible. However, if electrical, environmental, and structural requirements can not be met with the use of these materials, other materials not covered by military specifications may be used subject to the approval of the procuring activity.

3.3.1.5 Test point. If required by the detail specification (4.7.1), means shall be provided as an integral part of each antenna element for insertion of radio-frequency test signals. The decoupling between the test input and the antenna element or transmission line shall be not less than 16 db, nor more than 20 db. If the point of test signal input is inaccessible, an extension cable using Plug M39012/17-0001 shall be provided for easy access. The actual decoupling, including extension cable loss, shall be indicated on the permanent information plate at the point of access. The test signal connector shall be suitable for use with Plug M39012/16-0001.

3.3.2 Flush antenna designs. Flush antennas of special curvature to mate with the skin shall be designed for a given aircraft location only when standard curved shapes are not applicable.

3.3.2.1 Plastic cover plates, not an integral part of the flush antenna, shall not be used to obtain a mating surface with the aircraft skin.

3.3.3 Aerodynamics

3.3.3.1 The total aerodynamic drag, resulting from the protrusion of antenna elements into the airstream when installed on the aircraft, shall be minimized by proper shape design.

3.4 Performance

3.4.1 Electrical requirements

3.4.1.1 Frequency. The antenna subsystem shall be designed to cover the frequency range of 118 to 156 MHz.

3.4.1.2 Polarization. When properly installed on an aircraft, the antenna subsystem shall transmit or receive vertically polarized signals with a minimum transmission or reception of horizontally polarized signals. The antennas or antenna subsystems shall be so located and installed as not to physically deviate more tha 15° from the desired plane or axis of polarization when aircraft is in normal flight attitude.

3.4.1.3 Voltage standing wave ratio (VSWR). The design and installation of the antenna subsystem shall be such that the VSWR produced on any part of the connecting coaxial cable between the transmitter and the antenna shall not exceed 2.0:1 when the VHF equipment is transmitting at any frequency within the operating frequency range of the equipment.

3.4.1.4 Power handling capability. All components of the antenna subsystem shall be capable of handling an average r-f power of 100 watts during any combination of the environmental conditions specified herein.

3.4.1.5 Radiation pattern requirements

3.4.1.5.1 Pattern coverage and gain requirements. The pattern gain requirements specified herein shall apply to aircraft whose prime usage of VHF communication is air-to-ground and for communication with the control tower when the aircraft is parked on the runway. Normally a single bottom mounted fuselage antenna will meet these requirements. Where a requirement exists for additional coverage above the aircraft, dual antennas, top and bottom fuselage mounted, shall be required.

3.4.1.5.1.1 Pattern measurement parameters. The radiation patterns shall be essentially omnidirectional in azimuth, with the maximum null depth not to exceed 20 dB as a design goal, and with maximum radiation in the zone from the horizon to 45° below the aircraft for single antenna installations and ±45° from the horizon for a dual antenna installation (aircraft fuselage axis at the horizon).

a. Pattern coverage

(1) Coverage off the sides of the aircraft shall be as important as the coverage in the fore and aft directions.

(2) Bottom coverage shall take precedence over top coverage when a compromise is required.

b. Radiation pattern coordinates (see figure 1)

(1) Angles of elevation $\theta$ varying between 0° and 180°, with 0° directly above the aircraft and 90° directly ahead of the aircraft, shall be used.

(2) Angles of azimuth $\phi$ varying between 0° and 360°, with 0° directly ahead of the aircraft, shall be used.

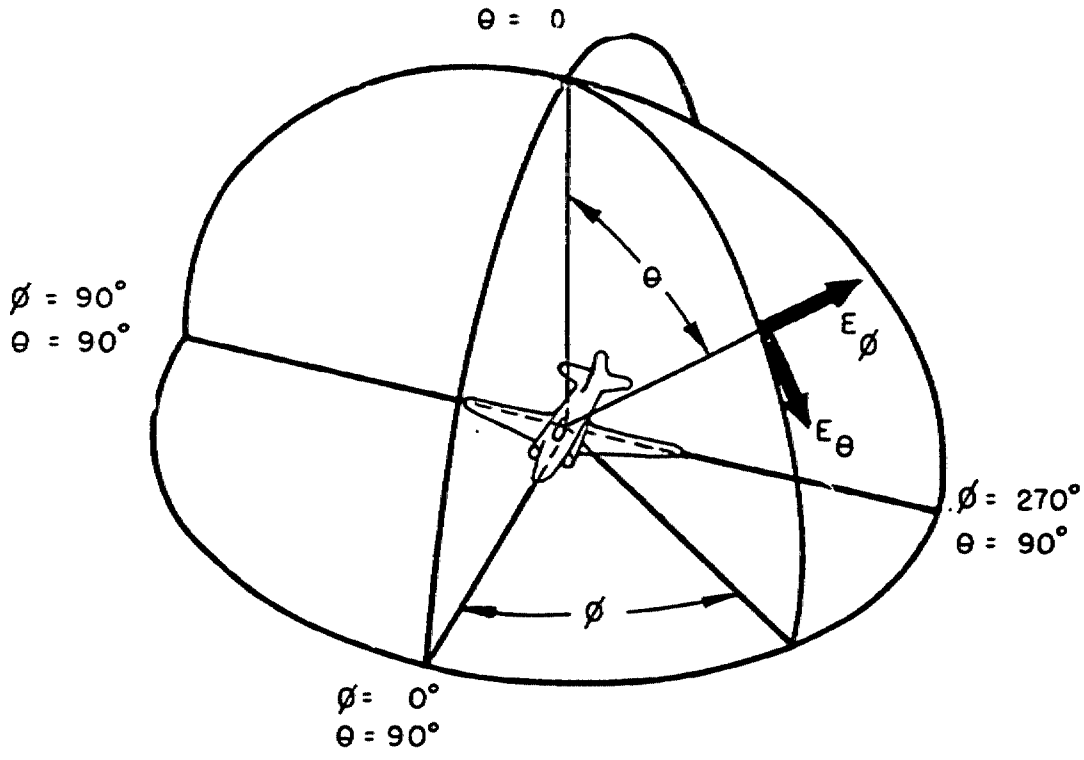


FIGURE 1. Radiation pattern coordinates.

3.4.1.5.1.2 Gain parameters. The minimum gain requirements for single and dual antenna installations shall be as follows:

a. Single antenna

(1) At any angle ∅in the planes defined by the angle θ equals $90^{o}$ to $110^{o}$ with the landing gear retracted, the gain over at least 90 percent of the area shall be equal to, or greater than, the computed isotropic gain.

(2) At any angle ∅ in the planes defined by the angle θ equals $110^{o}$ to $135^{o}$ with the landing gear retracted, the gain over at least 90 percent of the area shall be not more than 2 dB below the computed isotropic gain.

(3) With the landing gear extended, a 2-dB reduction in the gain specified in 3.4.1.5.1.2a.(1) shall be permitted in the region of ∅ equals $0^{o}$ $\pm 150^{o}$ and 3 dB shall be permitted in the region of ∅ equals $180^{o}$ $\pm 30^{o}$.

(4) A 1-dB additional reduction in the gain specified in 3.4.1.5.1.2a.(2) shall be permitted when the landing gear is extended.

b. Dual antennas

(1) At any angle ∅ in the planes defined by the angle θ equals $90^{o}$ $\pm 20^{o}$ with the landing gear retracted, the gain over at least 90 percent of the area shall be equal to, or greater than, the computed isotropic gain.

(2) At any angle ∅ in the planes defined by the angle θ equals $110^{o}$ to $135^{o}$ and $45^{o}$ to $70^{o}$ with the landing gear retracted, the gain over at least 90 percent of the area shall be not more than 2 dB below the computed isotropic gain.

(3) Allowable gain reduction due to the landing gear shall be as specified in 3.4.1.5.1.2a.(3) and 3.4.1.5.1.2a.(4) for the bottom antenna.

3.4.2 Environmental conditions. Unless otherwise specified for a particular weapon system, the antenna subsystem, including all components thereof, shall withstand the environmental test requirements defined under 4.4.3.3 without reducing the performance below the limits specified herein. In addition to the environmental conditions specified above, the antenna subsystem shall be designed and constructed to withstand the severest environmental conditions existing in the area of the aircraft in which it is installed. Vibration, shock, extreme temperatures, effects of gunfire or other armament originating within the aircraft or resulting from flight conditions shall be taken into consideration.

3.4.2.1 Lightning protection for external antennas. External antennas shall be designed to avoid lightning currents entering the vehicle and causing damage to the vehicle or equipment installed as required by MIL-B-5087. External

antennas shall be metallic in design to carry lightning currents to the air vehicle skin, or shall be designed with shunt matching devices which will provide a path for lightning current to the air vehicle skin.

3.4.3 Flight performance. When installed on the aircraft, the antenna subsystem shall provide satisfactory VHF communication performance when flight tested as specified in section 4 herein.

3.5 Size and weight. The size and weight of all components required for the antenna subsystem shall be a minimum consistent with the requirements of this specification and the detail specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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.

4.2 Classification of inspections. The inspection requirements specified herein shall be classified as follows:

a. First article inspections (see 4.4)

b. Quality conformance inspections (see 4.5).

4.3 Pre-testing requirements

4.3.1 Bench and preflight tests. The VHF equipment shall be tested in accordance with the bench and preflight procedures specified in the applicable bench, preflight, and flight test specification to be furnished by the procuring activity. Preflight procedures shall be conducted after the installation test of 4.3.2.

4.3.2 Aircraft installation test. The VHF equipment shall be properly installed in the aircraft and connected in accordance with the installation wiring diagram and installation specification to be furnished by the procuring activity. An operational installation test shall be performed on the VHF communication system, including all components of the antenna subsystem, by establishing communication with at least three existing ground communication stations operating in the lower, upper, and intermediate portions of the 118- to 156-MHz frequency range.

4.4 First article inspections

4.4.1 First article samples. The first article samples shall consist of models of all major components of the antenna subsystem representative of the production equipment and covered by the antenna subsystem component specification required in 4.7.1. The first article samples shall be tested under the test conditions specified herein and at the point designated by the contract.

4.4.1.1 Testing instructions. Unless otherwise specified in the contract, a minimum of three first article samples shall be required and testing shall be as follows:

a. One first article sample shall be subjected to the environmental tests specified under 4.4.3.3.

b. One first article antenna subsystem shall be installed on the test aircraft and subjected to the flight tests specified in 4.4.3.4.

c. One first article sample shall be subjected to the electrical tests specified in 4.4.3.2.

4.4.2 Scale models. A scale model of the antenna or antenna subsystem installed on a scale model of the aircraft involved shall be used for radiation pattern measurements (see 4.4.3.1). Modeling details such as external stores, canopy constructions, flaps, wheel doors, et cetera shall be similar enough to full-scale details to permit reasonably accurate radiation patterns to be measured. The type of construction and metallic surfacing used shall permit maximum versatility for testing new locations for antennas. Reduced scale dimensions of the model shall not differ by more than 2 percent from the correct dimension, or one-sixteenth inch, whichever is greater.

4.4.3 First article tests

4.4.3.1 Radiation pattern measurement tests. Radiation patterns (see 3.4.1.5) of the antenna or antenna subsystem in the locations proposed by the contractor shall be obtained by scale model techniques. A complete integral set of patterns (voltage) shall be submitted for each antenna element used separately, and for an antenna subsystem utilizing two or more antenna elements. The isotropic gain shall be computed and plotted on each pattern chart for each separate antenna element or antenna subsystem measured.

4.4.3.1.1 When two or more antennas are used to form one antenna subsystem, the patterns of each shall be measured using the same gain setting of the pattern measuring equipment, or shall be corrected to the same gain level. The combined measured pattern of the antennas shall conform to the over-all pattern coverage requirements specified herein.

4.3.1.2 In combining the patterns in an antenna subsystem, the method of coupling the indicidual antenna elements to the equipment shall be chosen considering the effect on the resultant pattern coverage and the net gain of the antenna subsystem, including all components such as filters, isolating devices, cables, connectors, and coupling devices. The method of coupling proposed shall be subject to the approval of the procuring activity.

4.4.3.1.3 The model frequencies shall be chosen to simulate both the upper and lower frequencies and at least one intermediate frequency in the 118- to 156-MHz band.

4.4.3.1.4 All other antennas in the immediate vicinity of the model antenna under test shall be installed and properly terminated to insure that normal coupling effects will be reflected in the pattern data.

4.4.3.2 Electrical tests. The procedures and application of electrical tests to determine proper performance and compliance with the electrical requirements (3.4.1) of this specification shall be prepared by the contractor and subject to approval by the procuring activity.

4.4.3.3 Environmental tests

4.4.3.3.1 The following environmental testing shall be conducted in accordance with the indicated methods of MIL-STD-810. The procedures may be modified as necessary to be compatible with any expected extreme conditions:

a. Temperature shock, method 503, procedure I

b. Temperature-altitude, method 504, procedure I, table 504-I, equipment class of applicable detail specification

c. Rain, method 506, procedure I

d. Humidity, method 507, procedure I

e. Fungus, method 508, procedure I

f. Salt fog, method 509, procedure I

g. Dust, method 510, procedure I

h. Explosive atmosphere, method 511, procedure I for equipment not hermetically sealed; procedure II for equipment with cases designed to prevent flame and explosion progagation.

j. Vibration, method 514.1, equipment category and specific requirements of the applicable detail specification.

k. Shock, method 516.1, procedure I and II, figure 516.1-2, shock, parameters (a) and (c).

l. Gunfire vibration, method 519.1, procedure as applicable.

4.4.3.3.2 Immersion (leakage) tests. The equipment shall be immersed in a suitable liquid such as boiled ethylene glycol or water. The water temperature shall be uncontrolled if the supply temperature is between 11°C and 20°C (51.8°F to 68°F). The absolute pressure of the air above the liquid shall then be reduced to approximately 1 inch of mercury and maintained for 1 minute, or until air bubbles substantially cease to be given off by the liquid, whichever is the longer. The absolute pressure shall then be increased to 2-1/2 inches of mercury. Any bubbles coming from within the equipment case shall be considered as leakage. Bubbles which are the result of entrapped air on the various exterior parts of the case shall not be considered as leaks. A helium leak detector or other means of test, equal or superior in sensitivity to the immersion test method described above, may be used upon approval by the procuring activity.

4.4.3.3.2.1 The test specified in 4.4.3.3.2 shall apply to all components of the antenna subsystem that are gasket sealed, pressurized, or fusion sealed. Components that are not sealed or pressurized shall be subjected to a rain test (4.4.3.3.1c.) and humidity test (4.4.3.3.1d.) in lieu of the immersion test.

4.4.3.4 Flight test. Flight test of the antenna subsystem shall be performed in the designated avionics flight test aircraft as a qualitative evaluation of the communication capability of the over-all VHF communication system as required by the weapon system under consideration. Flight test procedures shall be as specified in 4.7.4.3.1.

4.5 Quality conformance inspections. Quality conformance inspections shall consist of individual tests and a sampling plan and tests.

4.5.1 Individual tests. Each antenna subsystem shall be subjected to the following tests:

a. Antenna subsystem component tests. The individual tests for each component used in the antenna subsystem shall be those specified in the component specifications (see 4.7.1).

b. Complete antenna subsystem tests. The individual tests for the complete antenna subsystem shall be limited to the functional testing of the VHF communication system and shall be specified in the basic weapon system specification.

4.5.2 Sampling plan and tests. Unless otherwise specified in the weapon system contract, 1 production aircraft, equipped with VHF communication equipment, cables and antenna subsystem, from each group of 50 shall be subjected to the flight tests specified in 4.4.3.4.

4.6 Rejection and retest. The procuring activity shall have the option of rejecting the VHF antenna subsystem covered by this specification on the basis of unsatisfactory radiation patterns or flight test results. Rejected antenna subsystems shall not be retested and resubmitted for approval without furnishing full particulars concerning the previous rejection and the measures taken to overcome the defects.

4.7 Data requirements. When specified in the contract, the data specified herein shall be prepared and submitted to the procuring activity for approval.

4.7.1 Antenna subsystem components specifications. The contractor shall prepare for each contractor-furnished equipment (CFE) nonstandard antenna or antenna subsystem component a proposed procurement specification in accordance with MIL-STD-490, outlining in detail the method for quality control. The foregoing requirement shall also apply to procurement of previously qualified standard types, including those types previously contractor-furnished aircraft equipment (CFAE). The contractor shall prepare detail specifications on all components of the antenna subsystem that are nonstandard or not previously approved; standard types not supplied from Government stock shall be included in this category.

4.7.2 Component drawings. Construction drawings, of sufficient detail to facilitate complete evaluation of any contractor-furnished antenna subsystem, including all nonstandard components, shall be submitted prior to delivery of the first production aircraft on which the antenna subsystem is mounted. The minimum acceptable drawings shall include general arrangements, outline dimensions, mounting provisions, power connections, and r-f cable lengths. Photographs shall also be considered acceptable if the object size can be closely approximated. The construction drawings may be included as part of another report due in the same time phase.

4.7.3 Installation data. Complete information regarding the installation of the antenna subsystem in the actual aircraft shall be furnished. Information supplied shall include the type and quantity of r-f cable, connectors, relays, filters, adapters, or other miscellaneous items that form a part of the actual antenna subsystem installation.

4.7.4 Test reports. All test reports shall be prepared in accordance with MIL-STD-831.

4.7.4.1 Radiation pattern report. A detailed report covering the results of the scale model test of the recommended location shall be prepared. In addition, the contractor shall include sufficient data, both electrical and mechanical, on all other locations investigated to substantiate his choice of locations and as evidence that a thorough study has been made. These data shall be submitted as soon as possible after the first prototype structural configuration of the aircraft is completed. Additional data shall be required for each major revision of the aircraft configuration affecting the performance of the antenna subsystem.

4.7.4.2 Electrical, mechanical, and environmental test data. The contractor shall submit a detailed test report covering the electrical, mechanical, and environmental tests in accordance with the specification required in 4.7.1.

4.7.4.2.1 Submission of new electrical, mechanical, and environmental test data on components that have previously been approved and the application is similar shall not be required. However, the contractor shall submit previous test data and shall certify that the component(s) is capable of meeting the electrical, mechanical, and environmental performance requirements for the weapon system in which it is to be installed. Any changes affecting the electrical, mechanical, or environmental performance of the component shall render any previous approval void.

4.7.4.3 Flight testing data

4.7.4.3.1 Flight test program plan. The contractor shall prepare a detailed flight test program plan in accordance with the test requirements specified herein. When more than one antenna subsystem is being tested concurrently, this program may be combined with other flight programs. The report shall be submitted prior to beginning any flight tests on the antenna subsystem.

4.7.4.3.2 Flight test report. A final flight test report shall be submitted analyzing and summarizing the results of all flight tests conducted by the contractor on the antenna subsystem.

4.7.4.4 Interim engineering reports. Interim reports shall be submitted on the antenna subsystem development, first article inspections, quality conformance inspections, et cetera, describing in detail the progress made, including unsatisfactory results and comments on modifications required.

4.7.4.5 Final engineering reports. The contractor shall prepare final engineering reports consisting of pictorial, graphic, and written material necessary to completely describe the location, installation and performance of CFE or Government-furnished equipment (GFE) antenna subsystems installed in the weapon system under consideration. The contractor's identification numbers of each component of the over-all subsystem shall be included.

5. PACKAGING

5.1 The VHF antenna subsystem shall be prepared for delivery in accordance with the instructions of the procuring activity.

6. NOTES

6.1 Intended use. The VHF antenna subsystem covered by this specification is intended for use with VHF communication equipments.

6.2 Ordering data. Procurement documents should specify the requirements herein.

6.2.1 Procurement requirements.

a. Title, number, and date of this specification

b. First article samples and tests

(1) Number of first article samples

(2) Point of inspection

(3) Point of delivery for samples (samples to be submitted for approval should be shipped at least 60 days prior to production installation).

c. Selection of applicable levels of preservation and packaging, and packing.

6.2.2 Contract data requirements. When required, the data specified under 4.7 will be listed directly on a DD Form 1423 incorporated into the contract.

6.3 Typical design information. The contractor may obtain design and installation data for a typical VHF communication antenna upon request to the procuring activity.

Custodians:
Army - EL
Navy - EC
Air Force - 11

Reviewer:
Army - EL, SC
Navy - EC
Air Force - 85
DSA - ES

Preparing activity:
Air Force - 11

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