

MIL-A-5999B(USAF)
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SUPERSEDING
MIL-A-5999A(USAF)
30 April 1958

MILITARY SPECIFICATION

ANTENNA SUBSYSTEM FOR AIRCRAFT MARKER BEACON EQUIPMENT
GENERAL SPECIFICATION FOR

1. SCOPE

1.1 This specification covers the general design, performance, and flight test requirements for an antenna subsystem used with VHF marker beacon equipment in the spot frequency of 75 MHz.

2. APPLICABLE DOCUMENTS

2.1 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

Federal

L-P-383 Plastic Material, Polyester Resin, Glass Fiber Base,
Low Pressure Laminated

Military

MIL-E-5400 Electronic Equipment, Airborne, General Specification For
MIL-E-6051 Electromagnetic Compatibility Requirements, Systems
MIL-C-45662 Calibration System Requirements

FSC 5826

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STANDARDSMilitary

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 suppliers 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. This specification makes provisions for first article inspection.

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 marker beacon requirements for the weapon system under consideration. The antenna subsystem may be a separate item or may be installed as an integral part of the aircraft. The antenna subsystem may be in physical combination with other frequency range antenna subsystems, thus serving two or more equipments. If the 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 receiving elements, transmission line, matching devices, filters, and switching devices, that are connected in the system beyond the output connector of the associated equipment.

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

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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 the receiver 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 Structural plastic materials. The requirements for type II materials of L-P-383 shall apply for all structural plastic materials used in the antenna subsystem covered by this specification.

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 spot frequency of 75 MHz.

3.4.1.2 Polarization. When properly installed on an aircraft, the antenna subsystem shall receive signals from directly beneath the aircraft that are polarized parallel to the fore and aft axis of the aircraft.

3.4.1.3 Voltage standing wave ratio (VSWR). The antenna subsystem shall be so designed and installed that the VSWR produced on any part of the interconnecting radio frequency transmission line shall not exceed 1.5 : 1 at 75 MHz with reference to a nominal 50-ohm level. A bandwidth of 300 kHz shall be maintained within a 5:1 VSWR circle with the antenna fixed tuned. When subjected to extreme service conditions, the antenna subsystem shall not go beyond 2.5:1 VSWR at 75 MHz.

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3.4.1.4 Efficiency. The minimum acceptable sensitivity in voltage of the antenna subsystem shall be within 10.5 dB of that of a half-wave dipole at a frequency of 75 MHz.

3.4.1.5 Radiation pattern requirements. The radiation pattern shall be essentially a lobe without deep nulls so that the maximum gain of the antenna subsystem is downward from the aircraft and in a direction not more than 10 degrees from a vertical line through the antenna subsystem. All external store configurations that are proposed or normally carried operationally shall be considered separately.

3.4.1.6 Interference acceptability level. The interference of other electronic equipment with the antenna subsystem operating with the marker beacon receiving set shall be considered to be at an acceptable low level when the operation of other electronic equipment in the aircraft does not give erroneous marker indication throughout the flight profiles specified in section 4 herein.

3.4.2 Environmental conditions. Unless otherwise specified for a particular weapon system, the antenna subsystem, including all components thereof, shall withstand the environmental 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.

3.4.3 Flight profile performance. When installed on the aircraft, the antenna subsystem shall satisfactorily perform the flight profile executions specified in section 4 herein.

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3.4.3.1 Range. In a horizontal flight of the aircraft over the ground station cone of silence marker at 10,000 and 30,000 feet altitude (ground clearance), a position marker beacon indication shall be received for a distance of not less than 1 mile.

3.4.3.2 Pattern symmetry. In horizontal flight over the ground station at any altitude, the duration in miles of marker indication, when approaching a point directly over the ground station, shall not be more than 50 percent greater than the duration in miles of marker beacon indication when leaving the point directly over the ground station, and vice versa. (Mathematically this may be expressed as $0.67 < \frac{A + A'}{B + B'} < 1.5$ when referred to figure 1 (section 4)).

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 or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 examining and testing of the antenna subsystem shall be classified as follows:

- a. First article inspections
- b. Quality conformance inspections.

4.3 Pretesting requirements

4.3.1 Calibration of marker beacon equipment. Prior to beginning any tests the supplier shall perform calibration tests on all VHF marker beacon equipment in accordance with the supplier-prepared test plan conforming to the requirements of MIL-C-45662. Records of all test results shall be maintained.

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4.3.2 Marker beacon receiver bench and preflight tests. The marker beacon receiver shall be tested and adjusted within the limits of the bench and preflight procedures specified in the applicable bench, preflight, and flight test specification to be furnished by the procuring activity. The receiver sensitivity shall be measured and recorded before each series of tests. The preflight procedures shall be conducted after the installation test of 4.3.3.

4.3.3 Aircraft installation test. The VHF marker beacon 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 marker beacon system, including cables and antennas.

4.3.4 Ground test station. The ground equipment shall consist of a standard Federal Aviation Administration (FAA) cone of silence transmitter as maintained and operated by the FAA of the Department of Transportation. The ground test station for flight testing under the marker beacon antenna subsystem shall be similar to the station used under operational conditions.

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 or purchase order, 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 under 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 measurement(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 supplier shall be obtained by scale model techniques. A complete integral set of patterns shall be submitted for each selected antenna location. The isotropic gain shall be computed and plotted on each pattern chart for each antenna subsystem measured. The model frequency shall be chosen to simulate 75 MHz. 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 into the pattern data.

4.4.3.2 Electrical tests. The procedures and application of electrical tests to determine proper performance and compliance with the requirements of this specification shall be prepared by the supplier 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 the expected extreme conditions:

- a. Temperature shock, method 503, procedure I
- b. Temperature-altitude, method 504, procedure I, table 504-1, equipment class of applicable detail specification
- c. Humidity, method 507, procedure I

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- d. Salt fog, method 509, procedure I
- e. Vibration, method 514.1, equipment category and specific requirements of the applicable detail specification.
- f. Shock, method 516.1, procedure I, figure 516.1-2, shock parameters (a) and (c).
- g. 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 bubbles substantially cease to be given off by the liquid, whichever is the longer. The absolute pressure shall then be increased to 2-½ 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 humidity test (4.4.3.3.1c.) in lieu of the immersion test.

4.4.3.4 Flight tests

4.4.3.4.1 Test setup

- a. The VHF marker beacon flight test aircraft shall be one of the first 10 assembled models of the weapon system under test.

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b. The installation of the VHF marker beacon equipment, cables, and antenna subsystem shall be an exact duplicate of the installation proposed for production aircraft.

c. The extent of flight testing shall depend on the results of the model radiation pattern measurements. If the radiation patterns are inconclusive, all or part of the flight tests specified herein may be required as directed by the procuring activity.

d. The antenna subsystem shall be evaluated with all normally carried stores in place and with both landing gear and flaps or air brakes in extended and retracted positions.

4.4.3.4.2 Procedures. Unless otherwise specified by the procuring activity, flight tests shall be conducted in accordance with figures 1 and 2.

4.5 Quality conformance inspections. Quality conformance inspections shall consist of individual tests.

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

a. Immersion (leakage) tests, 4.4.3.3.2

b. 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).

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

4.6 Rejection and retest. The procuring activity shall have the option of rejecting the 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.

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PROCEDURES:

- a. Six flight "passes" shall be required to complete the figure.
- b. All passes shall be directly over the marker beacon.
- c. 5000-foot "passes" shall be made with normal stores and landing gear extended.

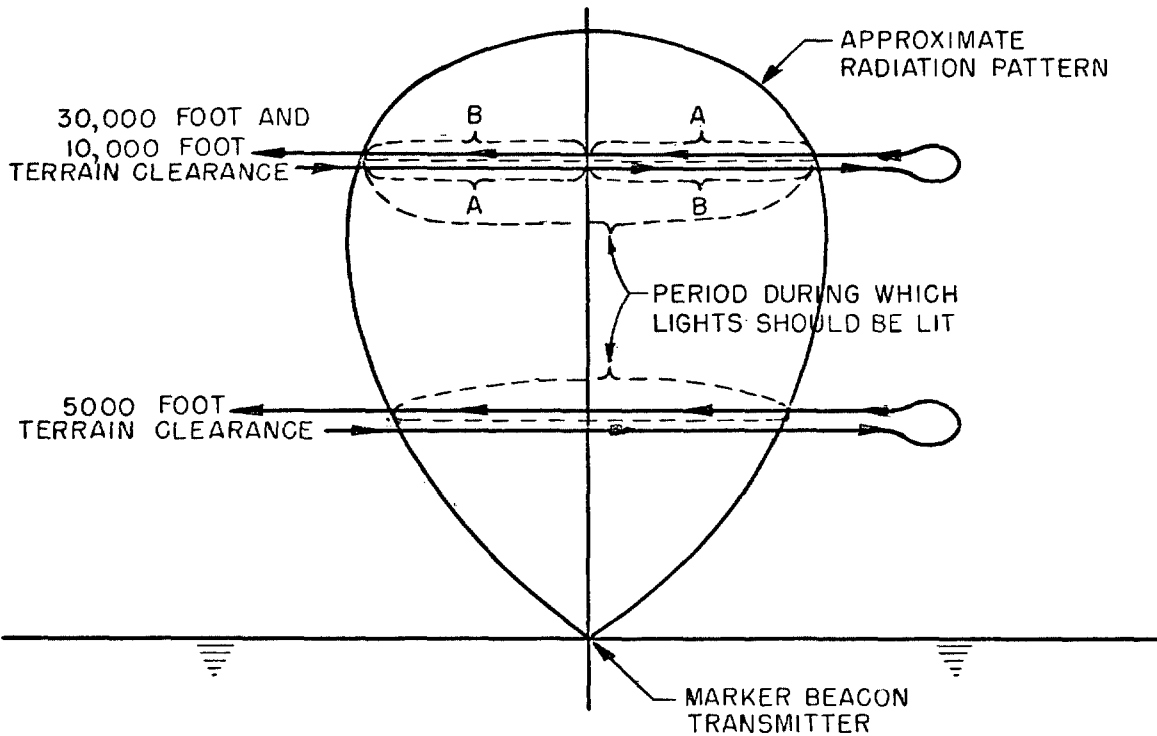


Figure 1. Flight profile (Side view of transmitter radiation pattern)

PROCEDURES:

- a. Two flight "passes" through the transmitter pattern shall be required, one in each direction. "Passes" shall be made with normal stores and landing gear extended.
- b. The flight passes shall be made at 2000 feet altitude (terrain clearance) and at 2000 feet horizontal range from the transmitter.
- c. The lights shall be lit for the two passes for approximately the same distance in each direction. (Thus indicating symmetrical reception of signal for both sides of the aircraft.)

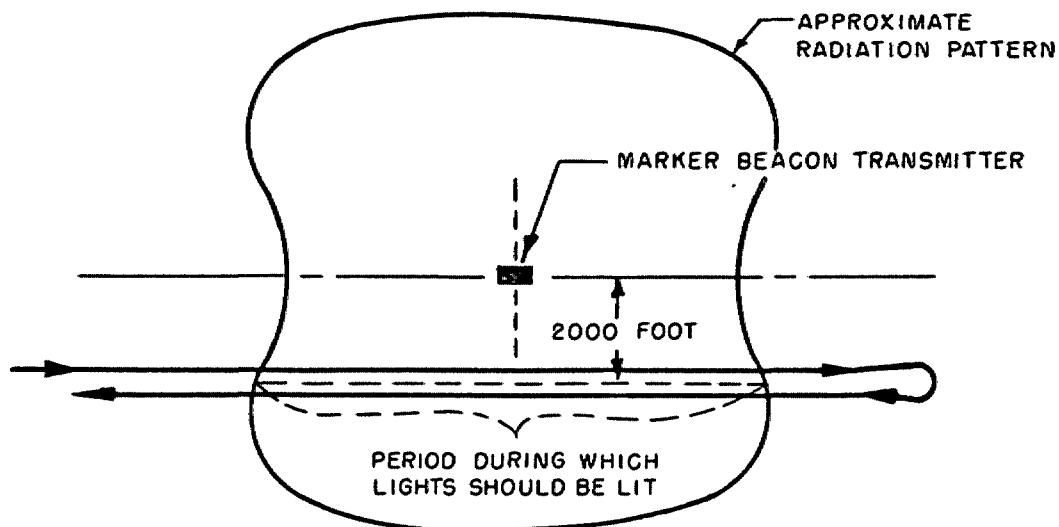


Figure 2. Flight profile (Top view of transmitter radiation pattern)

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

4.7.1 Antenna subsystem components specifications. The supplier 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 supplier 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 supplier 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. The correlation between full scale antenna patterns and the scale model antenna patterns on a suitable ground plane shall be included in the report. 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 VHF antenna subsystem.

4.7.4.2 Electrical, mechanical, and environmental test data. The supplier shall submit a detailed test report covering the electrical, mechanical, and environmental tests in accordance with the specifications 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 supplier 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 supplier shall submit a detailed flight test program plan in accordance with the test requirements specified herein. This report shall include complete information on the test facilities to be used both on the ground and in the air. At least one photograph of the ground antenna subsystem showing its location and local environment shall be included. 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 supplier on the antenna subsystem. This report shall include the following:

- a. Recorded data in tabular or graphic form obtained during flight tests.
- b. Power outputs of transmitters on test frequencies.
- c. Complete data on subsystem losses between the receiver and the receiving elements of the antenna subsystem.
- d. Unsatisfactory results with the reasons why satisfactory results were not obtained.
- e. Total number of flight hours required to perform the test.
- f. Results of radio interference tests required by MIL-E-6051.

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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 report. The supplier shall submit a final engineering report consisting of pictorial, graphic, and written material necessary to completely describe the location and installation of CFE or Government furnished equipment (GFE) antenna subsystems in the aircraft. Performance data shall include voltage standing wave ratio curves as measured in a full-scale mockup or in the aircraft itself. The supplier's identification numbers of each component of the over-all subsystem shall be included.

5. PREPARATION FOR DELIVERY

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

6. NOTES

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

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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 supplier may obtain design and installation data for a typical VHF marker beacon antenna upon request to the procuring activity.

Custodians:
Air Force - 11

Preparing activity:
Air Force - 11

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