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MILITARY SPECIFICATION

ARRESTER, LIGHTNING, GENERAL SPECIFICATION FOR

This specification has been approved by the Department of the Air Force and by the Naval Air Systems Command.

1. SCOPE

1.1 This specification covers the general requirements for aircraft lightning arresters used with radio receiving and transmitting antenna systems.

2. APPLICABLE DOCUMENT

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

Military

MIL-E-17555	Electronic and Electrical Equipment and Associated Repair Parts Preparation for Delivery of
MIL-C-45662	Calibration of Standards

STANDARDS

Military

MIL-STD-15	Graphic Symbols for Electrical and Electronics Diagrams
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-143	Specification and Standards, Order of Precedence for the Selection of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-749	Preparation and Submission of Data for Approval of Nonstandard Electronic Parts
MS33586	Metals, Definition of Dissimilar

FSC 5920

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

United States of America Standards Institute

USA Y14.1 - 1957 Size and Format
USA Y32.16 - 1965 Electrical and Electronics Reference Designations

(Copies of the above publication may be obtained from the United States of America Standards Institute, Inc., 10 East 40th Street, New York, N.Y.10017.)

3. REQUIREMENTS

3.1 Detail specification sheets. - Detail requirements or exceptions applicable to individual arresters shall be as specified in the applicable detail specification sheet which forms a part of this specification. In the event of any conflict between requirements of this specification and the detail specification sheet, the latter shall govern.

3.1.1 Requirements for arresters not covered by detail specification sheets. - Contractors who are required to utilize arresters, applicable to this specification, which are not covered by detail specification sheets, shall comply with the requirements of MIL-STD-749. An additional copy of all pertinent data, test reports covering the approved arrester and notification of approval shall be submitted to the preparing activity so that the item may be appropriately covered by a detail specification sheet. The contractor shall require that arresters not covered by detail specification sheets meet all applicable requirements of this specification.

3.1.2 Electrical schematic drawing. - The arrester electrical schematic drawing shall be shown on the detail specification sheet. Electrical symbols shall be in accordance with MIL-STD-15 and electrical reference designations shall be in accordance with USA Y14.1.

3.2 First article inspection. - Arresters furnished under this specification shall be a product which has successfully passed the testing as set forth herein and approved.

3.3. Quality conformance. - Production lightning arresters furnished to the requirements of this specification shall be subjected to all quality conformance inspections specified herein. (See 4.5.)

3.4 Materials. - Materials shall conform to applicable specifications and shall be as specified herein. Materials and parts not specified shall be of the best quality, of the lightest weight consistent with the requirements of this specification and shall be selected in accordance with this specification and in accordance with MIL-STD-143. Explosive materials shall not be used. External arrester materials which are flammable or could produce toxic fumes shall not be used.

3.4.1 Metals. - Metals shall be corrosion resistant or suitably protected to resist corrosion. Nonconductive finishes shall not be used on electrical conductive surfaces. Use of dissimilar metals, as defined by MS33586, shall be avoided.

3.5 Design and construction. - The arresters shall be of the design, construction, dimensions, and weight as specified herein or as specified on the applicable detail specification sheet (see 3.1).

3.5.1 Lightning stroke indication. - Unless otherwise specified on the detail specification sheet, the arrester shall be constructed in such a manner so that visual observation will reveal if the arrester has been subjected to a lightning stroke as specified in 4.6.11 . Other indicating means shall be approved by the qualifying activity (see 6.3).

3.5.2 Mounting attitude. - The arrester shall be mounted in its operating position as specified on the detail specification sheet (see 3.1).

3.5.3 Water accumulation. - The arrester shall be so designed to preclude accumulation of water when mounted in its operation (attitude) position.

3.5.4 Seal leak rate. - The leak rate of the gas within the arrester when tested in accordance with 4.6.12.1 shall not exceed the equivalent of a 10 percent decrease in pressure in an 8-month period at or above the maximum rated altitude or near vacuum conditions. The gas used as a dielectric shall not deteriorate itself or cause deterioration of any internal parts of the arrester under operating (including lightning stroke passage) and dormant conditions.

3.5.5 Lightning stroke.- The arrester shall remain intact after being subjected to the test specified in 4.6.11, 4.6.11.1, and 4.6.11.1.1.

3.5.6 Spark gap voltage. - The spark gap voltage shall be factory-set such that the spark breakdown voltage when tested in accordance with 4.6.7 is within ±10 percent of the spark gap voltage specified by the detail specification sheet (see 3.1).

3.5.7 Series capacitor. - The style and value of the series capacitor shall be as specified on the detail specification sheet, and tested in accordance with 4.6.2.

3.5.8 Bleeder resistor. - The style and value of the bleeder resistor shall be as specified on the detail specification sheet. When tested in accordance with 4.6.4, the value shall conform to the specified limits.

3.5.9 Terminals. - The style and type of terminal connection shall be as specified on the detail specification sheet. When tested in accordance with 4.6.12.8, the terminals shall be electrically functional and show no visual signs of damage.

3.5. 10 Environment. - The arrester shall function in accordance with all requirements of this specification throughout the altitude and temperature limits specified on the detail specification sheets.

3.5.10.1 Moisture resistance. - The arrester shall be functional and within limits after being subjected to the moisture resistance test specified in 4.6.12.2.

3.5. 10.2 Salt spray. - The arrester shall be functional and within limits after being subjected to the salt spray test specified in 4.6.12.3.

3.5.10.3 Sand and dust. - The arrester shall be functional and within limits after being subjected to the sand and dust test specified in 4.6.12.4.

3.5.10.4 Thermal shock. - The arrester shall not exceed the limits specified on the detail specification sheet when tested in accordance with 4.6.12.5.

3.5.10.5 Vibration. - The arrester shall be functional and within limits after being subjected to the vibration requirement of 4.6.12.6.

3.5.10.6 Shock. - The arrester shall be functional and within limits after being subjected to the shock test requirement of 4.6.12.7.

3.5.11 R.F. current. - A radio frequency current in accordance with 4.6.5 shall be applied to the arrester for 10 minutes without excessive heating, deterioration, or failure of any arrester component, internal or external.

3.5.12 Shunt capacitance. - The shunt capacitance shall be within the limits specified on the detail specification sheet when tested in accordance with 4.6.6.

3.5.13 Radio frequency corona and voltage breakdown. - The arrester shall be subjected to a radio frequency voltage in accordance with 4.6.8 for a period of 5 minutes without evidence of radio frequency corona or voltage breakdown, internal or external, to the arrester.

3.5.14 DC corona and voltage breakdown. - The arrester shall be subjected to a dc voltage in accordance with 4.6.9 for a period of 30 seconds without evidence of corona or voltage breakdown, internal or external, to the arrester.

3.5.15 Performance. - The installed arrester shall not impair normal function of the receiving and transmitting equipment (see 4.4).

3.5.16 Markings. - Each arrester shall be permanently and legibly marked in accordance with MIL-STD-130 and the marking shall withstand the environmental tests specified herein. The arrester shall be marked with the manufacturer's name, part number, the military part number (see detail specification sheet), date code, and other markings as specified by the detail specification sheet. The date code shall consist of "MFD" followed by a four-digit number of which the first two digits indicate the month and the last two digits indicate the year, i.e., MFD-0564 would indicate a unit manufactured in May 1964.

3.5.17 Workmanship. - The arresters, including all parts and accessories, shall be constructed in a careful and workmanlike manner in accordance with good design and sound practice. Particular attention shall be given to neatness and thoroughness of soldering, wiring, impregnation of coils; marking of parts and assemblies; welding and brazing, painting, riveting, machine screw assemblies; and freedom of parts from burrs and sharp edges.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Resposibility 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 Test equipment and inspection facilities. - Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspections and tests. The supplier shall establish adequate calibration and inspection equipment to the satisfaction of the Government. Calibration of the standards which control the accuracy of the inspection equipment shall conform to MIL-C-45662.

4.3 Classification of inspections. - The inspection and testing of arresters shall be classified as follows:

(a) First article inspection (4.4)
(b) Quality conformance inspection (4.5 and 4.7)

4.4 First article inspection. -

4.4.1 Inspection routine. - The sample arresters shall be tested in the order given in the first article inspections specified in table I. The samples shall be identified to indicate the appropriate group of tests to which each was subjected.

TABLE I. First article inspections

Examination or test	Requirement paragraph	Test method paragraph
GROUP I (1 complete arrester sample)		
Examination of product		4.5.1.1
Terminal strength	3.5.9	4.6.12.8
Capacitor value	3.5.7	4.6.2
Resistor value	3.5.8	4.6.4
Radio frequency current	3.5.11	4.6.5
Shunt capacitance	3.5.12	4.6.6
Moisture resistance	3.5.10.1	4.6.12.2
Sand and dust	3.5.10.3	4.6.12.4
Salt spray	3.5.10.2	4.6.12.3
Vibration	3.5.10.5	4.6.12.6
Thermal shock	3.5.10.4	4.6.12.5
Shock	3.5.10.6	4.6.12.7
Spark gap voltage	3.5.6	4.6.7
Seal test	3.5.4	4.6.12.1

TABLE I. First article inspections (continued)

Examination or test	Requirement paragraph	Test method paragraph
GROUP II (1 complete arrester sample) *		
Examination of product		4.5.1.1
Capacitor value	3.5.7	4.6.2
Bleeder resistor value	3.5.8	4.6.4
Shunt capacitance	3.5.12	4.6.6
Spark gap voltage	3.5.6	4.6.7
Lightning stroke	3.5.5	4.6.11 4.6.11.1
Capacitor explosion *		4.6.10 *
*If capacitor is failed prior to assembly, one additional sample will be required.		
GROUP III (1 complete arrester with electrode(s) removed)		
Examination of product		4.5.1.1
Capacitor value	3.5.7	4.6.2
Bleeder resistor value	3.5.8	4.6.4
Radio frequency corona and voltage breakdown	3.5.13	4.6.8
DC corona and voltage breakdown	3.5.14	4.6.9
GROUP IV (Capacitor assembly, 3 samples)		
Examination of product		4.5.1.1
Capacitor value	3.5.7	4.6.2
Capacitor withstand voltage	3.5.7	4.6.3
RF current	3.5.11	4.6.5

4.5 Quality conformance inspection. - Quality conformance inspection shall consist of individual and sampling inspections.

4.5.1 Individual inspections. - Each arrester shall be subjected to the following inspections and tests prior to delivery. There shall be no failures.

4.5.1.1 Examination of product. - Arresters shall be examined to verify compliance with this specification and the applicable detail specification sheet as to design and construction, materials, physical dimensions, marking, workmanship, and other inspections deemed necessary by the procuring activity to assure conformance with requirements not covered by tests.

4.5.1.2 Series capacitor and bleeder resistor values. - Series capacitor and bleeder resistor values shall be determined by the applicable test method (see 4.6).

4.5.1.3 Seal test. - The arresters shall be subjected to the seal test in accordance with the test method as specified (see 4.6).

4.5.1.4 Spark gap voltage. - The gap breakdown voltage shall be measured to determine compliance with the requirements of 3.5.6 when tested in accordance with the test procedure specified in 4.6.7.

4.5.1.5 Shunt capacitance. - The shunt capacitance shall be measured in accordance with the test procedure specified in 4.6.6 to determine compliance with the capacitance value specified in 3.5.12.

4.5.2 Sampling inspections. - The sampling inspections shall consist of sampling plan A.

4.5.2.1 Rejection and reinspection. - The supplier may rework a rejected lot to correct the defects or screen out the defective units and submit for complete reinspection. Reworked lots shall be reinspected using tightened inspection as specified in MIL-STD-105.

4.5.2.2 Sampling plan A tests. - Sampling plan A tests shall consist of those tests specified in table II which shall be performed in the order shown. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for normal inspection. The acceptable quality level (AQL) value shall be 2.5 for all tests combined.

TABLE II. Sampling plan A tests

Examination or test	Requirement paragraph	Test method paragraph
Capacitor value	3.5.7	4.6.2
Shunt capacitance	3.5.12	4.6.6
Bleeder resistor value	3.5.8	4.6.4
Spark gap voltage	3.5.6	4.6.7

4.6 Test methods. -

4.6.1 Test conditions. - All tests shall be performed at the rated altitude and ambient temeprature range where applicable.

4.6.2 Capacitor value. - The value of the series capacitor shall be as specified in 3.5.7 and shall be measured in accordance with test method No. 305 of MIL-STD-202. The test frequency shall be optional and the accuracy of the measurement shall be ±5 percent.

4.6.3. Capacitor withstanding voltage. - The individual capacitor shall be subjected to and withstand without damage a direct current voltage which is twice the spark gap voltage value specified by the detail specification sheet (see 3.1). The voltage shall be applied for a period of 1/2 minute and shall be within ±5 percent of the specified value. This test is applicable for arresters with gap voltage ratings up to and including 13 kilovolt. Refer to detail specification sheet for test procedure applicable to arresters with ratings above 13 kilovolt.

4.6.4 Bleeder resistor value. - The resistance of the bleeder resistor shall be the value as specified in 3.5.8 and shall be measured in accordance with test method No. 303 of MIL-STD-202.

4.6.5 Radio frequency current. - A radio frequency current of the value and frequency specified by the detail specification sheet shall be passed through the arrester between the equipment and antenna terminals.

4.6.6 Shunt capacitance. - The shunt capacitance of the arrester shall be in accordance with 3.5.12 when tested in accordance with test method 305 of MIL-STD-202. The test frequency shall be optional and the accuracy of the measurement shall be ±5 percent. The measurement shall be made between the equipment terminal and the mounting flange with the flange at ground potential.

4.6.7 Spark gap voltage. - The gap breakdown voltage shall be determined by applying the voltage from a 2-megacycle power supply between the antenna terminal and the arrester grounding provision. A suitable meter shall be used to measure the peak rf voltage value (see 3.5.6).

4.6.8 Radio frequency corona and voltage breakdown. - The arrester (with gap electrode(s) removed) shall be subjected to a rf voltage which is 10 percent in excess of the maximum rf voltage at the maximum altitude and temperature specified by the applicable detail specification sheet (see 3.1) with a dc corona current of 200 microamperes flowing through the bleeder resistor. The test shall be repeated at existing ground level conditions at the testing location.

4.6.9 DC corona and voltage breakdown. - The arrester (with gap electrode(s) removed) shall be subjected to a dc voltage 10 percent in excess of the maximum dc voltage and at the maximum altitude and temperature specified by the applicable detail specification sheet, (see 3.1) with a dc corona current of 200 microamperes flowing through the bleeder resistor. The test shall be repeated at existing ground level conditions present at the testing location.

4.6.10 Capacitor explosion. - The series capacitor shall be prefailed by overvoltage either before or after assembly in the arrester. Following the overvoltage application, a lightning stroke, as specified in 4.6.11 shall be applied between the antenna and equipment terminals of the arrester with the grounding provisions floating. Resultant damage, including explosive effects, shall be confined to the interior of the arrester. The external arrester housing shall remain intact and sealed. Oscillograms shall be taken of each of the three components of stroke current.

4.6.11 Lightning stroke. - The arrester shall effectively bypass the full charge for each of 12 lightning strokes having the following successive current components.

(a) An initial component rising from zero to a crest value of 100,000 $\pm$5,000 amperes in 5 $\pm$2 microseconds and decaying to 50,000 $\pm$10,000 amperes in 10 $\pm$3 microseconds from the beginning of the current with a voltage rise rate of not less than 1 kilovolt per microsecond.

(b) Immediately following, a second component of the same polarity, rising to 2,000 $\pm$100 amperes within 5 milliseconds from the beginning of the first component and with a total charge transfer in excess of 20 coulombs.

(c) Immediately following, a third component of the same polarity consisting of a continuous discharge transfering at least 300 coulombs having a duration of not less than 1 second or more than 2 seconds. The arrester shall bypass 6 lightning strokes as specified in (a), (b), and (c) above and the spark gap breakdown voltage shall not vary more than $^{+8}_{-20}$ percent of the specified gap breakdown voltage (see 3.1) after each stroke. The gap breakdown voltage shall be monitored following each stroke and shall be equal to the highest of three individual breakdown voltages occurring after a steadily increasing voltage. The arrester shall successfully bypass 6 additional strokes without failure of arrester or its component parts except that the gap breakdown voltage need not remain within the $^{+8}_{-20}$ percent tolerance.

A #36 solid copper wire shall be loosely connected from the arrester equipment terminal to the flange when subjected to the stroke. The wire length shall be as short as practical with solid positive connections at both ends. Loops and sharp turns or bends should be avoided. Vaporization of the wire constitutes failure of the arrester. The main loop or swing of the initial current component under 4.6.11(a) shall pass through the arrester. Additional loops or oscillations due to stroke current generator characteristics shall be limited to within 5 percent of the initial component. The three current components of (a), (b), and (c) shall be of the same polarity for each given stroke at a time interval of 30 minutes minimum. Opposite polarity shall be alternately applied for each successive stroke

so that the first, third, fifth, seventh, ninth, and eleventh strokes shall have a negative polarity to the antenna terminal of the arrester and the second, fourth, sixth, eighth, tenth, and twelfth strokes shall have a positive polarity applied to the antenna terminal. Each of the three stroke current components of each stroke shall be permanently recorded by suitable recording equipment capable of single sweep.

4.6.11.1 High current stroke. - The arrester shall be subjected to one additional high current stroke following subjection to the 12 strokes described in 4.6.11. The high current stroke shall consist of the following successive current components.

(a) An initial component rising from zero to a crest value of 200,000 ±10,000 amperes in 10 ±2 microseconds and decaying to 100,000 ±20,000 amperes in 20 ±4 microseconds from the beginning of the current. The high current discharge shall be fired through the arrester with the flange grounded in the normal manner.
(b) A second component of the same polarity rising to 2,000 ±100 amperes within 5 milliseconds from beginning of the first component and with a total charge transfer in excess of 20 coulombs.
(c) Immediately followed by a third component of the same polarity consisting of a charge of at least 500 coulombs having a duration of 2 seconds maximum, but no less than 1 second.

The main loop or swing of the initial current component under 4.6.11.1(a) shall pass through the arrester. Additional loops or oscillations due to stroke current generator characteristics shall be limited to within 10 percent of the initial component. The three current components of (a), (b), and (c) shall be of the same polarity for the given stroke. Each of the three stroke current components of the stroke shall be permanently recorded by suitable recording equipment. The arrester shall bypass the stroke and remain intact but shall not be required to be functional.

4.6.12 Environmental and physical tests. - The following listed tests shall be performed in accordance with MIL-STD-202. Unless otherwise specified the arrester shall be capable of meeting all requirements of this specification after completion of the tests.

4.6.12.1 Seal test. - The leak rate shall be determined in accordance with method No. 112, test condition C, procedure I. Test condition B shall be used to check against leakage of the sealed off evacuation port.

4.6.12.2 Moisture resistance. - The arrester shall be subjected to Method No. 106B in accordance with figure 106-1 with exception that the vibration, step 7b shall be omitted.

4.6.12.3 Salt spray. - The arresters shall be subjected to method No. 101B, test condition B utilizing a 5 percent salt solution.

4.6.12.4 Sand and dust. - The arresters shall be subjected to method No. 110, test condition A.

4.6.12.5 Thermal shock. - The arrester shall be subjected to the test described by method No. 107B, test conditon A.

4.6.12.6 Vibration. - The arrester shall be subjected to method No. 204A, test condition C with exception that the frequency range shall be as specified by the detail specification. The arrester shall be attached by its normal mounting to a rigid fixture means so that the vibration input to the arrester is identical to the vibration input to the fixture. Resonating points on the arrester shall be determined and monitored to establish the amplitude and frequency. A resonant condition or loosening of internal parts may be indicated by visual observation and by emission of audible noise generated from within the arrester housing.

4.6.12.7 Shock. - The arrester shall be subjected to shock tests in accordance with method 205C, test conditon B.

4.6.12.8 Terminal strength. - Each electrical terminal shall be subjected to method 211, test conditions A and E. The arrester under test shall be rigidly supported by its normal mounting means (see 3.5.9).

4.7 Inspection for preparation for delivery. - The preservation, packaging, packing and marking of the arresters shall be inspected in accordance with MIL-E-17555 to verify conformance to section 5.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking. - Arresters shall be prepared for delivery in accordance with MIL-E-17555. Packaging level A or C, packing level A, B, 6r C and any special marking required shall be as specified in the contract or order (see 6.2).

6. NOTES

6.1 Intended use. - The lightning arresters covered by this specification are intended for installation in aircraft. The function of the arrester is to prevent lightning damage to electronic equipment connected to the antenna and to minimize damage to the aircraft structure when the antenna is struck by lightning.

6.2 Ordering data. - Procurement documents should specify:

(a) Detail specification number and title.
(b) Military part number specified in the detail specification (see 3.8).
(c) Levels of protection and any special marking required (see 5.1).

6.3 Acceptance of products. - Request for information pertaining to acceptance of products covered by this specification should be addressed to the AFLC Engineering and Technical Division, (SGMES), Wright-Patterson Air Force Base, Ohio 45433.

6.4 Marginal indicia. - Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

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