

MILITARY SPECIFICATION

TRANSFORMERS, VARIABLE, POWER

GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers general requirements for tapped and continuously variable transformers which are either manually operated or motor driven. Included are variable transformers for aircraft light dimming controls (see 6.1).

1.2 Classification. Transformers covered by this specification shall be of the following classifications (see 3.1 and 6.2.1).

- Class I - Transformers exceeding 2 pounds in weight.
- Class II - Transformers weighing 2 pounds or less.

2. APPLICABLE DOCUMENTS

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

SPECIFICATION

FEDERAL

- L-P-513 - Plastic Sheet, Laminated, Thermosetting, Paper-Base, Phenolic-Resin.
- NN-P-71 - Pallets, Materials Handling, Wood, Double Faced, Stringer Construction.
- QQ-S-571 - Solder, Tin Alloy: Tin-Lead Alloy; and Lead Alloy.
- QQ-S-781 - Strapping, Steel, Flat and Seals.
- PPP-B-566 - Boxes, Folding, Paperboard.
- PPP-B-585 - Boxes, Wood, Wirebound.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Boxes, Shipping, Fiberboard.
- PPP-B-676 - Boxes, Setup.
- PPP-T-60 - Tape, Packaging, Waterproof.
- PPP-T-76 - Tape, Pressure-Sensitive Adhesive, Paper, (For Carton Sealing).

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- MIL-I-10 - Insulating Compound, Electrical, Ceramic, Class L.
- MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
- MIL-W-76 - Wire and Cable, Hookup, Electrical, Insulated.
- MIL-P-116 - Preservation-Packaging, Method of.
- MIL-W-583 - Wire, Magnet, Electrical.
- MIL-P-997 - Plastic Material, Laminated, Thermosetting, Electrical Insulation, Sheets, Glass Cloth, Silicone Resin.
- MIL-S-3950 - Switches Toggle, Environmentally Sealed, General Specification For.
- MIL-S-8805 - Switches and Switch Assemblies, Sensitive, and Push (Snap Action), General Specification for.
- MIL-F-14256 - Flux, Soldering, Liquid (Resin Base).
- MIL-P-15037 - Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.

- MIL-P-15047 - Plastic-Material, Laminated Thermosetting, Sheets, Nylon Fabric Base, Phenolic-Resin.
- MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 111).
- MIL-W-16878 - Wire, Electrical, Insulated, High Temperature.
- MIL-B-43014 - Boxes: Water Resistant Paperboard, Folding, Set-up, and Metal-Stayed.
- MIL-C-45662 - Calibration System Requirements.
- MIL-T-83721/1 - Transformer, Variable, Power, 400 Hz.

STANDARDS

FEDERAL

- FED-STD-592 - Color.

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-147 - Palletized Unit Loads on 40" x 48" Pallets.
- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-462 - Electromagnetic Interference Characteristics, Measurements of.
- MIL-STD-810 - Environmental Test Methods.
- MIL-STD-831 - Test Reports, Preparation of.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.
- MS-33742 - Shaft, Control Knob.

(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.)

2.2 Other publications. The following document forms 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.

NATIONAL BUREAU OF STANDARDS

- Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.)

3. REQUIREMENTS

3.1 Specification sheets. The individual part requirements shall be as specified herein and in accordance with the applicable specification sheets or drawings. In the event of any conflict between this specification and the specification sheet or drawing, the latter shall govern.

3.2 First article inspection. Transformers furnished under this specification shall be products which have been tested and have passed the first article inspection specified in 4.5.

3.3 Materials. The materials shall be as specified herein; however, when a definite material is not specified, a material shall be used which will enable the transformers to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Substitution of materials. If the supplier desires to substitute another material for a specified material or fabricated part, he shall submit a statement to the Government describing the proposed substitution, together with evidence to substantiate his claim that such substitute is suitable. At the discretion of the Government, test samples may be required to prove the suitability of the proposed substitute. Before substitutions are made, approval for each substitution shall be obtained in writing from the Government.

3.3.2 Flammable materials. Materials used in constructing these transformers shall be:

- (a) For class I - Nonflammable and nonexplosive, insofar as practicable. When this is not practicable, all materials shall be self-extinguishing (see 6.4.4).
- (b) For class II - Nonflammable and nonexplosive.

3.3.3 Corrosive materials. Corrosive materials used in any of the manufacturing processes shall be removed or neutralized so that no corrosion will result from such use. Insofar as practicable, materials used in the construction of transformers shall be noncorrosive.

3.3.4 Insulating materials. The insulating materials used shall not support combustion, emit explosive gases or give off toxic or noxious gases when subjected to arcs (such as those caused by a short circuit). Plastic materials with cellulose fillers will not be permitted in parts that may be subjected to arcing or surface creepage.

3.3.4.1 Laminated phenolic. When electrical characteristics are involved, only natural uncolored materials shall be used. Laminated phenolic materials shall conform to:

- (a) For class I - MIL-P-997, L-P-513, MIL-P-15037, and MIL-P-15047.
- (b) For class II - MIL-P-997 and MIL-P-15037.

3.3.4.2 Molded phenolic or melamine. Molded phenolic or melamine materials shall conform to MIL-M-14 or equivalent.

3.3.4.3 Ceramic (external use). Ceramic materials shall conform to MIL-I-10.

3.3.5 Wire.

3.3.5.1 Magnet wire. Magnet wire shall conform to the types and sizes specified in MIL-W-583. Government approval shall be required when other types and sizes of magnet wire are used.

3.3.5.2 Insulated wire. When insulated wire is used as wire terminals, the wire shall be of the types and sizes covered in MIL-W-76 or MIL-W-16878. Government approval shall be required when other types and sizes of insulated wire are used as terminals.

3.3.5.3 Leads, (class II only). The leads to external terminals shall be stranded wire, unless otherwise specified (see 3.1 and 6.2.1).

3.3.6 Solder and soldering flux. Solder, when used, shall be in accordance with QQ-S-571. Soldering flux shall be in accordance with MIL-F-14256.

3.3.7 Screws, nuts, and washers. All mounting and terminal screws, nuts, and washers shall be of corrosion-resistant material or shall be protected against corrosion.

3.4 Design and construction.

3.4.1 Mounting screws and mounting inserts. Screw threads shall be class 2A or 2B, as applicable (see 3.1 and 6.2.1), in accordance with Handbook H28. External screw threads, class 2 fit, after receiving a finish, shall be capable of accepting a nut of class 2B fit. Internal screw threads, class 2 fit, after receiving a finish, shall be capable of accepting a screw of class 2A fit. Maximum installation torque shall be in accordance with the following:

Screw size	Torque (pounds-inches)
.112-40 UNC - - - - -	3
.138-32 UNC - - - - -	5
.164-32 UNC - - - - -	6
.190-32 UNC - - - - -	8
.250-20 UNC - - - - -	8
.312-18 UNC - - - - -	8

Nuts shall run down to within two threads of mounting surface. Two threads shall be visible on the terminal stud after all hardware and attached circuitry is placed on the stud.

3.4.2 Terminals.

3.4.2.1 Solder terminals. Solder terminals may be of any shape, and shall be capable of being readily soldered. The height of the solder terminal shall be considered as the maximum distance from the terminal mounting surface to the highest point, including the additional height obtained if semiflexible terminals are straightened. The type of terminal and the maximum size of round wire which the terminal will accept externally shall be as specified (see 3.1 and 6.2.1).

3.4.2.2 Quick-connect (push-on) terminals. When applicable, quick-connect terminals shall be of the material and physical dimensions specified (see 3.1 and 6.2.1).

3.4.2.3 Stud-type terminals. When specified (see 3.1 and 6.2.1), external stud terminals shall be supplied with two nuts, two flat washers, and one lockwasher. The height of the terminal assembly shall be the distance from the free end of the stud to the terminal mounting surface. The type of terminal, size of screw thread, and the exposed length $\pm 1/16$ inch shall be as specified (e.g., stud, .164-32 UNC-2AX .375) (see 3.1 and 6.2.1). Terminal studs on class II transformers shall be separated by insulation barriers that are greater than the height of the terminal studs. Studs shall be firmly mounted to header and electrical contact surface shall be higher than the header surface.

3.4.3 Mounting studs (when specified) (see 3.1 and 6.2.1). External mounting studs shall be provided with a flat washer and locknut, or with a flat washer, lockwasher, and a nut.

3.4.4 Paint color. When a paint finish is specified (see 3.1 and 6.2.1), the color of the paint for class I transformers shall be light gray, semigloss, formula No. 111, as specified in MIL-E-15090. Class II transformers shall be painted lusterless black No. 37038 per FED-STD-595, unless otherwise specified (see 3.1 and 6.2.1). Unless otherwise specified (see 3.1 and 6.2.1), the manufacturer shall omit paint from the mounting area surface.

3.4.5 Operating shaft. All operating shafts shall be corrosion-resistant metal or have a corrosion-resistant coating or sleeve covering a metal inner shaft.

3.4.5.1 Shaft length. The lengths of standard operating shafts shall be as specified (see 3.1 and 6.2.1).

3.4.6 Enclosure (when specified)(see 3.1 and 6.2.1). Transformers shall have suitable enclosures for protection against electrical shock and mechanical damage.

3.4.7 Mounting conversion (when specified, see 3.1 and 6.2.1). Transformers shall be easily converted from surface mounting to back-of-panel mounting by removing the knob and sliding shaft through unit so it projects from center of mounting plate. The knob shall be capable of being mounted on either end of the shaft.

3.4.8 Index pin (class II only). Transformers shall be designed for mounting on a panel. A nonturn index pin shall be provided as specified (see 3.1 and 6.2.1).

3.4.9 Internal wire leads. Internal wire leads shall be attached to the coils and other internal components and terminals or case by soldering, welding, brazing, or other method (e.g., lead-sweating or nylon-coated wires) in such a manner as to provide adequate electrical connection and mechanical strength. Where soft solder is used to provide the electrical connection, wire leads shall be anchored mechanically.

3.4.10 Core and coil mounting. Cores and coils shall be rigidly secured to prevent any permanent change in the relative position of the parts. The coils shall be protected against injury from the core laminations or the form the coil is wound on. The means of securing the core and coil to the devices for mounting the transformers in the equipment (studs, lugs, inserts, brackets, etc.) shall not depend on soft solder alone for mechanical strength nor shall the transmission of the mechanical load of the core to the mounting devices depend on soft solder.

3.4.11 Potting, filling, or encapsulating material. The amount and coverage of potting, filling, or encapsulating material used shall be essentially the same for all units of a specific design. Potting, filling, or encapsulating material shall not flow from the case of the transformer or inductor during any of the applicable tests.

3.4.12 Stops. Stops shall be used to limit the mechanical travel of the brush assembly and may be a part of but shall not complete any electrical circuit. In no case shall the mechanical stop contact the brush carbon.

3.4.13 Commutator. The commutator surface shall be evenly wound, free from any foreign matter, and have a smooth surface.

3.4.14 Voltage control. The transformer shall incorporate a voltage control that will provide the range of output voltages from the minimum voltage position, to its maximum voltage as specified (see 3.1 and 6.2.1). Where tap switching is employed, a minimum of 10 taps shall be provided.

3.4.15 Dimensions. The dimensions of the transformer shall be as specified (see 3.1 and 6.2.1).

3.4.16 Weight. The weight of the transformer shall be as specified (see 3.1 and 6.2.1).

3.4.17 Control knob shaft. The control knob shaft shall conform to MS33742 for the specified nominal size (see 3.1 and 6.2.1).

3.4.18 Meters, fuses, power cords (when specified, see 3.1 and 6.2.1). Meters, fuses, and power cords shall be as specified (see 3.1 and 6.2.1). Military standard items shall be used when applicable.

3.4.18.1 Cased units. Cased units supplied with power cords shall be supplied with three prong plugs; one prong shall be connected to a wire grounded to the case.

3.4.19 Switch (when specified, see 3.1 and 6.2.1). Switches shall conform to MIL-S-8805. Toggle switches shall conform to MIL-S-3950.

3.4.20 Brush assembly. The brush assembly shall insure a uniform positive pressure on the commutator over the entire range of mechanical travel. Smooth electrical control of the output voltage and continuous contact between the brush and its terminal shall be maintained over the entire range of shaft rotation. The entire rotating assembly shall be insulated from the operating shaft. The brush assembly shall be designed so that a slight misalignment will not affect the reliability of the brush contact with the commutator. There shall be no contact between the brush holder and the commutator when the carbon is completely worn. The minimum clearance between commutator and brush holder shall be 0.012 inch.

3.5 Resistance to solvents. When transformers are tested as specified in 4.7.2, there shall be no evidence of mechanical damage and the markings shall remain legible. The paint or exterior finish shall not soften, peel, or show other signs of deterioration.

3.6 Radial play (see 6.4.3). When transformers are tested as specified in 4.7.3, the radial play shall not exceed .010 inch.

3.7 Mechanical travel. When transformers are tested as specified in 4.7.4, the mechanical travel shall be as specified (see 3.1 and 6.2.1). When switch taps are used, the angle between adjacent taps and the total mechanical travel shall be as specified (see 3.1 and 6.2.1).

3.8 Phasing (electrical alinement) (when applicable). The alinement of the functional angles of the individual units of a ganged assembly shall be performed by the supplier at time of assembly so that when tested as specified in 4.7.5, the voltage ratio of all units of the assembly fall within the following limits of their specified values at any angle of operating shaft rotation.

- (a) ± 1 volt for 120 volt unit.
- (b) ± 2 volts for 240 volt unit.
- (c) ± 4 volts for 480 volt unit.

3.9 Mechanical backlash. When tested as specified in 4.7.6, the operating shaft shall not move in excess of 2.0 degrees without moving the contact arm.

3.10 Stop strength. When tested as specified in 4.7.7 the stops of the transformers shall withstand the torque applied to shaft without damage.

3.11 Shaft torque. When tested as specified in 4.7.8, the torque shall not exceed 5 pound-inches, unless otherwise specified (see 3.1 and 6.2.1), to prevent self-rotation of the shaft.

3.12 Terminal strength. When transformers are tested as specified in 4.7.9, there shall be no evidence of loosening or rupturing of the terminals or other mechanical damage. Bends shall not be considered damaged unless surface cracking is evident. There shall be no rotation of the terminals. Rotation of the external portion of the metallic portion of a "hook" type terminal exceeding 10 degrees shall not constitute a failure. Following torque terminal shall be without deflection or failure.

3.13 Dielectric withstanding voltage. When transformers are tested as specified in 4.7.10, there shall be no arc-over (air discharge), flashover (surface discharge), breakdown of insulation (puncture discharge) or physical damage.

3.14 Winding continuity. When transformers are tested as specified in 4.7.11, all windings shall be electrically continuous.

3.15 Insulation resistance. When transformers are tested as specified in 4.7.12, the minimum insulation resistance shall be one of the following values:

- (a) 10,000 megohms.
- (b) 1,000 megohms.

3.16 Electrical characteristics. When transformers are tested as specified in 4.7.13, the applicable electrical characteristics and tolerances shall be as specified (see 3.1 and 6.2.1).

3.16.1 Voltage regulation. When transformers are tested as specified in 4.17.13.1, the change in the output voltage from the maximum resistive load setting to a no-load condition shall not exceed:

- (a) For class I - 5 percent or less, unless otherwise specified (see 3.1 and 6.2.1).
- (b) For class II - 6 percent for KVA ratings (see 6.4.1) less than .5KVA and 5 percent for KVA ratings of .5KVA or greater.

3.16.2 Volt-ampere output. When transformers are tested as specified in 4.7.13.2, the transformer shall be capable of delivering the percentage of the maximum current into a fixed resistive load within the range of output voltages corresponding to the curve shown on figure 1. At any point above 30 percent of the maximum output voltage, the volt-ampere output curve shall not vary more than ± 5 percent from the curve of figure 1.

3.16.3 Tap voltage (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.13.3, the percentage of maximum output voltage for each tap shall be within ± 5 percent of the following values:

<u>Tap no.</u>	<u>Percentage maximum voltage</u>
1	31.0
2	36.7
3	41.4
4	46.0
5	52.0
6	58.2
7	66.5
8	75.0
9	87.5
10	100.0

3.17 Temperature rise. When transformers are tested as specified in 4.7.14, with the transformer delivering its maximum rated output, the maximum temperature rise shall be equal to or less than:

- (a) For class I - 55°C.
- (b) For class II - 100°C, unless otherwise specified (see 3.1 and 6.2.1).

The ambient temperature range for class I shall be -20°C to 55°C, unless otherwise specified (see 3.1 and 6.2.1) and for class II it shall be as specified (see 3.1 and 6.2.1).

3.18 Solderability (when applicable). When transformers are tested as specified in 4.7.15, they shall meet the applicable criteria for terminal evaluation.

3.19 Life. When tested as specified in 4.7.16, there shall be no evidence of physical or electrical damage as indicated by an open circuit (a break in the continuity of any electrical circuit within the transformer being tested) or short circuit occurring within the transformer (such as shorted turns or faulty insulation between layers, between turns, between windings and case or core, or between windings and shield.)

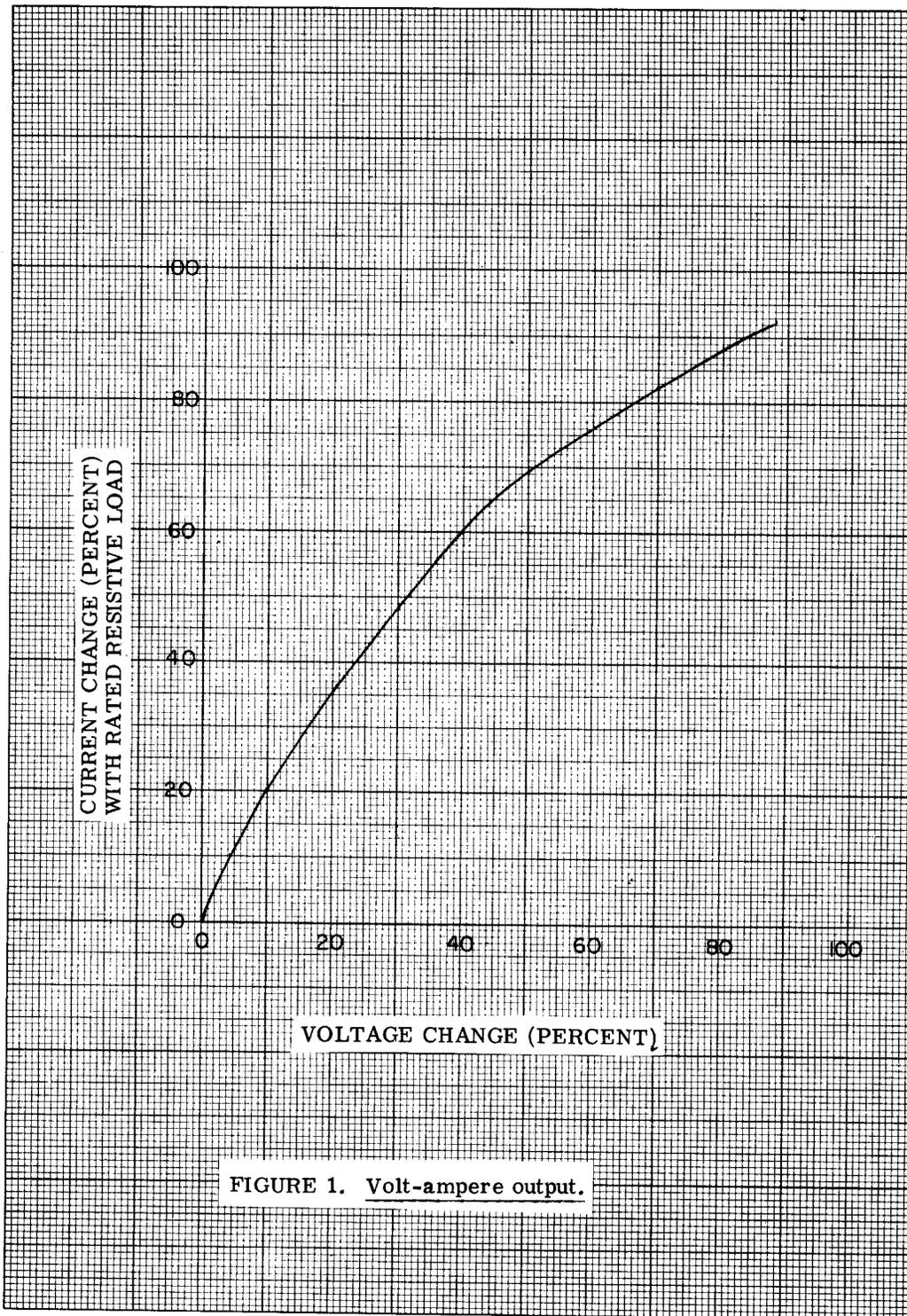


FIGURE 1. Volt-ampere output.

3.20 Explosion (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.17, there shall be no evidence of mechanical or electrical damage. They shall be operative at the conclusion of the test.

3.21 Acceleration (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.18, there shall be no evidence of mechanical or electrical damage during or after testing. Units shall be operative at the conclusion of the test.

3.22 Sand and dust (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.19, there shall be no evidence of mechanical or electrical damage during or after testing. Units shall be operative at the conclusion of the test.

3.23 Salt spray (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.20, there shall be no evidence of mechanical or electrical damage.

3.24 Electromagnetic interference (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.21, they shall meet the interference tests of MIL-STD-462 as specified (see 3.1 and 6.2.1).

3.25 Vibration, high frequency (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.22, not more than 10 percent of the total surface shall have peeling, flaking, chipping, cracking, crazing, or other impairment of the protective coating; no leakage of filling material; and no evidence of other physical damage such as cracks or bursting or bulging of the case. There shall be no evidence of electrical discontinuity during or after testing.

3.26 Shock (specified pulse). When transformers are tested as specified in 4.7.23, not more than 10 percent of the total surface shall have peeling, flaking, chipping, cracking, crazing, or other impairment of the protective coating; and no evidence of other physical damage such as cracks or bursting or bulging of the case.

3.27 Thermal shock. When transformers are tested as specified in 4.7.24, there shall be no evidence of mechanical or electrical damage and they shall be operative following the test.

3.28 Humidity. When tested as specified in 4.7.25, there shall be no degradation of electrical and dielectric characteristics. No swelling of materials that destroy functional utility, no cracking, peeling, flaking, chipping, crazing, or other impairment of the protective coating shall be in evidence.

3.29 Moisture resistance (when specified, see 3.1 and 6.2.1). When transformers are tested as specified in 4.7.26, not more than 10 percent of the total surface shall have peeling, flaking, chipping, cracking, crazing, or other impairment of the protective coating. No evidence of other physical damage such as impairment of brush mechanism, brush track, restriction of the rotating shaft, or corrosion affecting the mechanical or electrical operation.

3.30 Life (rotational). When transformers are tested as specified in 4.7.27, they shall show no evidence of damage to the shaft or the transformer. A cycle consists of travel through 95 percent of actual electrical travel and return to starting point.

3.31 Overload (class II only). When transformers are tested as specified in 4.7.28, they shall not show permanent distortion or damage.

3.32 Visual and mechanical examination external (post test). When transformers are examined as specified in 4.7.1.1.1 not more than 10 percent of the total surface shall have peeling, flaking, chipping, cracking, crazing, or other impairments of the protective coating. There shall be no leakage of the filling material, no evidence of other physical damage; such as cracks, bursting, or bulging of the case, or corrosion affecting the mechanical or electrical operation of the units.

3.33 Fungus. All external materials shall be nonnutrient to fungus growth or shall be suitably treated to retard fungus growth. The manufacturer shall certify that all external materials are fungus resistant (see 4.7.29) or perform the specified test (see 3.1 and 6.2.1). There shall be no evidence of fungus growth on the external surfaces.

3.34 Marking. Transformers shall be marked for identification in accordance with method I of MIL-STD-1285. The terminals of class II transformers shall be marked appropriately with the terms HV, LV, and ground. Other terminals such as switch connections shall also be identified. Circuit schematics shall be marked on the case of class II units.

3.35 Workmanship. Transformers shall be processed in such a manner as to be uniform in quality and shall meet the requirements of 3.3, 3.4, and 3.34, as applicable, and shall be free of defects that will affect life serviceability or appearance.

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.

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

- (a) Materials inspection (see 4.3).
- (b) First article inspection (see 4.5).
- (c) Quality conformance inspection (see 4.6).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table I, used in fabricating the transformers, are in accordance with the applicable referenced documents prior to such fabrication.

TABLE I. Materials inspection.

Materials	Requirement paragraph	Applicable specification
Insulating material: Laminated phenolic	3.3.4.1	MIL-P-997, L-P-513, MIL-P-15037, or MIL-P-15047
Molded phenolic or melamine	3.3.4.2	MIL-M-14
Ceramic (external use)	3.3.4.3	MIL-I-10
Wire:		
Magnet wire	3.3.5.1	MIL-W-583
Insulated wire	3.3.5.2	MIL-W-76 or MIL-W-16878
Solder and soldering flux	3.3.6	MIL-F-14256 or QQ-S-571

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.5 First article inspection. First article inspection shall be performed by the supplier, after award of contract and prior to production, at a location acceptable to the Government. First article inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. First article approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders. First article inspection test reports shall be prepared in accordance with MIL-STD-831.

4.5.1 Sample size. Three transformers shall be subjected to first article inspection.

4.5.2 Inspection routine. The sample shall be subjected to the inspections specified in table II, in the order shown. All sample units shall be subjected to the inspection of group I. The sample shall then be divided as specified in table II for groups II and III.

4.5.3 Failures. One or more failures shall be cause for refusal to grant first article approval.

TABLE II. First article inspection.

Examination or test	Requirement paragraph	Method paragraph
<u>Group I (all sample units)</u>		
Resistance to solvents - - - - -	3.5	4.7.2
Visual and mechanical examination (external) - - - - -	3.1, 3.3 to 3.3.7 incl., 3.4 to 3.4.8 incl. 3.34 and 3.35	4.7.1.1
Radial play - - - - -	3.6	4.7.3
Mechanical travel- - - - -	3.7	4.7.4
Phasing (when applicable)- - - - -	3.8	4.7.5
Mechanical backlash- - - - -	3.9	4.7.6
Stop strength - - - - -	3.10	4.7.7
Shaft torque - - - - -	3.11	4.7.8
Terminal strength- - - - -	3.12	4.7.9
Dielectric withstanding voltage:		
At atmospheric pressure - - - - -	3.13	4.7.10.1
At barometric pressure (when applicable) - - - - -	3.13	4.7.10.2
Winding continuity - - - - -	3.14	4.7.11
Insulation resistance- - - - -	3.15(a)	4.7.12
Electrical characteristics - - - - -	3.16	4.7.13
Visual and mechanical examination (external) - - - - -	3.1, 3.3 to 3.3.7 incl, 3.4 to 3.4.8 incl, 3.34 and 3.35	4.7.1.1
<u>Group II (1 sample unit)</u>		
Temperature rise - - - - -	3.17	4.7.14
Solderability (when applicable)- - - - -	3.18	4.7.15
Life - - - - -	3.19	4.7.16
Winding continuity - - - - -	3.14	4.7.11
Insulation resistance - - - - -	3.15(b)	4.7.12
Dielectric withstanding voltage:		
At atmospheric pressure - - - - -	3.13	4.7.10.1
Electrical characteristics - - - - -	3.16	4.7.13
Visual and mechanical examination (external) - - - - -	3.1, 3.3 to 3.3.7 incl, 3.4 to 3.4.8 incl, 3.34 and 3.35	4.7.1.1

TABLE II. First article inspection. -Continued

Examination or test	Requirement paragraph	Method paragraph
<u>Group III (1 sample unit)</u>		
Explosion (when specified) - - - - -	3.20	4.7.17
Acceleration (when specified) - - - - -	3.21	4.7.18
Sand and dust (when specified) - - - - -	3.22	4.7.19
Salt spray (when specified) - - - - -	3.23	4.7.20
Electromagnetic interference (when specified)- - - - -	3.24	4.7.21
Vibration, high frequency (when specified) - - - - -	3.25	4.7.22
Shock (specified pulse)- - - - -	3.26	4.7.23
Winding continuity- - - - -	3.14	4.7.11
Dielectric withstanding voltage: At atmospheric pressure- - - - -	3.13	4.7.10.1
Thermal shock- - - - -	3.27	4.7.24
Winding continuity- - - - -	3.14	4.7.11
Humidity - - - - -	3.28	4.7.25
Dielectric withstanding voltage: At reduced voltage- - - - -	3.13	4.7.10.3
Insulation resistance - - - - -	3.15	4.7.12
Moisture resistance (when specified) - - -	3.29	4.7.26
Dielectric withstanding voltage: At reduced voltage - - - - -	3.13	4.7.10.3
Insulation resistance - - - - -	3.15	4.7.12
Life (rotational) (1 sample unit)- - - - -	3.30	4.7.27
Mechanical backlash- - - - -	3.9	4.7.6
Overload (class II only) - - - - -	3.31	4.7.28
Winding continuity - - - - -	3.14	4.7.11
Insulation resistance - - - - -	3.15(b)	4.7.12
Dielectric withstanding voltage: At reduced voltage - - - - -	3.13	4.7.10.3
Visual and mechanical examination (external)(post test)- - - - -	3.32	4.7.1.1.1
Electrical characteristics- - - - -	3.16	4.7.13
Visual and mechanical examination (internal) (3 sample units)- - - - -	3.1,3.4.9 to 3.4.14 incl, and 3.35	4.7.1.2
<u>Group IV (1 sample unit)(when required)</u>		
Fungus <u>1/</u> - - - - -	3.33	4.7.29

1/ Test shall not be performed if the manufacturer provides certification that all external materials are fungus resistant.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.6.1.1 Inspection lot. Transformers having similar design, construction, and electrical characteristics, manufactured under essentially the same conditions and having similar materials, may be combined to form a lot. (Similar construction and materials shall be construed to include differences that will not affect test results). Sample units shall be so selected as to be, as far as practicable, representative of volt-ampere range of electrical values and physical dimensions included in the lot.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table III, in the order shown.

TABLE III. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph	AQL (Percent defective)	
			Major	Minor
Visual and mechanical examination (external) - - - -	3.1, 3.3 to 3.3.7 incl, 3.4 to 3.4.8 incl, 3.34 and 3.35	4.7.1.1	1.0	4.0
Radial play - - - - -	3.6	4.7.3	1.0	---
Mechanical travel - - - - -	3.7	4.7.4		
Phasing (when applicable) - - - -	3.8	4.7.5		
Mechanical backlash- - - - -	3.9	4.7.6		
Shaft torque- - - - -	3.11	4.7.8		
Dielectric withstanding voltage:				
At atmospheric pressure	3.13	4.7.10.1		
At barometric pressure (when applicable)	3.13	4.7.10.2		
Insulation resistance - - - - -	3.15(a)	4.7.12		
Winding continuity - - - - -	3.14	4.7.11		

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality levels (AQL) shall be as specified in table III. Major and minor defects shall be as defined in MIL-STD-105.

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table IV. The inspection shall be made on inspection lots which have been subjected to and have passed group A inspection.

TABLE IV. Group B inspection.

Tests	Requirement paragraph	Method paragraph
Electrical characteristics	3.16	4.7.13

4.6.1.3.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for special inspection level S-4. The AQL shall be 6.5 percent defective.

4.6.1.3.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.1.3.3 Disposition of sample units. Sample units which have been subjected to group B inspection may be delivered on the contract or purchase order.

4.6.2 Inspection of preparation for delivery. Except for commercial packaging, the sampling and inspection of the preservation-packaging and interior package marking shall be in accordance with the group A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract or purchase order (see 6.2).

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination.

4.7.1.1 External. Transformers shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.3.7 incl, 3.4 to 3.4.8 inclusive, 3.34, and 3.35).

4.7.1.1.1 Post-test. Transformers shall be examined to verify that the protective coating, filling material, and case construction are in accordance with the applicable requirements (see 3.32).

4.7.1.2 Internal. The case of the transformers shall be opened. The transformers shall then be examined to verify that the material, construction, contacts, solder connections, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4.9 to 3.4.14 inclusive, and 3.35).

4.7.2 Resistance to solvents (see 3.5). Transformers shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- (a) The marked portion of the transformer shall be brushed.
- (b) The number of sample units shall be as specified in table II.
- (c) Transformers shall be examined for mechanical damage.

4.7.3 Radial play (see 3.6). This test shall be performed in accordance with figure 2. The transformers shall be mounted horizontally by their normal mounting means with a dial indicator positioned so that the probe will contact the operating shaft within 1/8 inch of the front surface of the transformer. The force due to pressure and operation of dial gauges shall not exceed 1/3 ounce unless corrections are made in the gross force. A 3-pound load shall be applied radially to the operating shaft 1/8 inch from the mounting surface in two opposite directions, one at a time, first in the vertical plane and then in the horizontal plane. The radial play shall be the maximum positive and negative deviations added together without regard to algebraic signs.

4.7.4 Mechanical travel (see 3.7). Transformers shall be placed in a suitable angle-indicating device and the operating shaft shall be rotated from one stop to the other and held against the stops with a torque of approximately 3 pound-inches. The mechanical travel shall be determined from the number of degrees traversed between stops. When tapped units are tested the angle between taps shall also be measured.

4.7.5 Phasing (electrical alinement) (see 3.8). When applicable, the transformers shall be energized with the specified rated voltage (see 3.1 and 6.2.1). The outputs shall be open-circuited with a suitable voltmeter connected between the minimum and maximum voltage terminals. The control shaft shall then be rotated through the entire range of mechanical travel. The readings on the voltmeter shall be within the specified tolerances throughout the entire range of output voltages.

4.7.6 Mechanical backlash (see 3.9). The transformers shall be mounted in a suitable angle-indicating device with the shaft in approximately the middle of its range of mechanical travel. Rotate the shaft in a clock-wise direction until the contact assembly begins to rotate, then rotate in a counter-clockwise direction until the contact assembly begins to rotate. The angular difference between the extreme clockwise and counterclockwise rotation shall be the mechanical backlash.

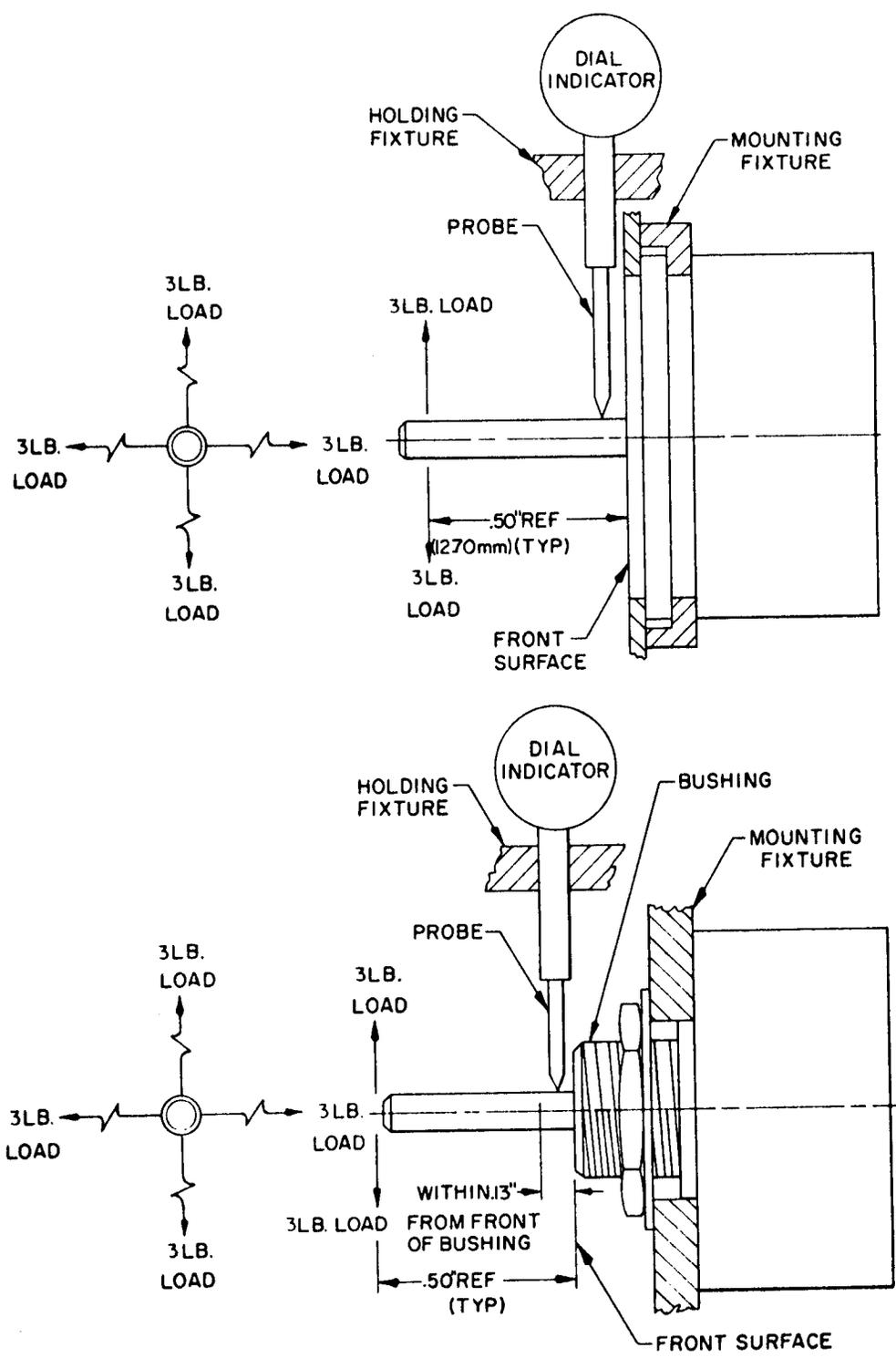


FIGURE 2. Measurement of radial play.

4.7.7 Stop strength (see 3.10). The following torque shall be applied to the stops for 1 minute minimum via the voltage control shaft:

- (a) Class I - 5 pound-inches minimum, unless otherwise specified (see 3.1 and 6.2.1).
- (b) Class II - 25 pound-inches minimum.

4.7.8 Shaft torque (see 3.11). The torque required to rotate the control shaft shall be determined by the torque-wrench method.

4.7.9 Terminal strength (see 3.12). Transformers shall be tested as specified in 4.7.9.1 to 4.7.9.3.2 inclusive, as applicable. After each test, the terminals shall be examined for loosening and rupturing, and other mechanical damage. Unless otherwise specified, all terminals on each test sample shall be subjected to the following tests, up to a maximum of four identical terminals per sample.

4.7.9.1 Pull.

4.7.9.1.2 Solder terminals. Transformers shall be tested in accordance with method 211 of MIL-STD-202. The following details shall apply:

- (a) Test-condition letter - A.
- (b) Points of measurement - A force as specified in table V shall be applied to each terminal at the point where the lead from the external circuit connects to it. The force shall be applied in any direction, including the weakest part of the terminal, and shall be increased gradually to the specified magnitude and held at that value for at least 5 to 10 seconds.

TABLE V. Pull.

Cross-sectional area of electrode at its smallest point at which lead from external circuit connects	Force
<u>Circular mils</u>	<u>Pounds</u>
<2,000 - - - - -	2.0
>2,000 - - - - -	4.5

4.7.9.2 Twist or bend.

4.7.9.2.1 Flat solder terminals. Any terminal that shows permanent deformation greater than 15 degrees of the metal portion of the terminal in the terminal-pull test specified in 4.6.9.1 shall be tested in accordance with method 211 of MIL-STD-202. This test does not apply to terminals that show permanent deformation or are not designed to be bent 45 degrees. The following details shall apply:

- (a) Test-condition letter - B.
- (b) Number of bending operations - Five times through an angle of 90 degrees (45 degrees each side of center).

4.7.9.3 Torque.

4.7.9.3.1 Stud type terminals. Transformers shall be tested in accordance with method 211 of MIL-STD-202, test-condition letter E, except applied torque shall be as shown in table VI.

TABLE VI. Torque (stud type terminals).

Thread size	Torque
	<u>pound - inches</u>
4-40	4.4
6-32	10.0
8-32	20.0
10-32	32.0
1/4-28	45.0

4.7.9.3.2 All other terminals. All other terminals shall be subjected to the torque specified in table VII. The torque shall be applied to the terminal at the point where the external lead wires normally connect to it. The motion shall be applied clockwise and counterclockwise in a plane perpendicular to the axis of the terminal. The equivalent diameter is equal to two times the distance from terminal center to point of wire connection after maximum permanent deflection due to the pull test.

TABLE VII. Torque (all other terminals).

Nominal diameter	Torque
<u>Inch</u>	<u>Ounce-inches</u>
1/16 - - - - -	0
>1/16 to 1/8 incl - - - - -	8
>1/8 to 3/16 incl - - - - -	18
>3/16 to 5/16 incl - - - - -	40
>5/16 to 1/2 incl - - - - -	80
> 1/2 - - - - -	160

4.7.10 Dielectric withstanding voltage (see 3.13). Transformers shall be tested in accordance with 4.7.10.1 and 4.7.10.2, when applicable.

4.7.10.1 At atmospheric pressure. Transformers shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Magnitude of test voltage - As specified in table VIII for transformer windings not grounded internally. However, where there is a high-voltage center-tap winding and another adjacent winding operated at a dc potential, the peak voltage that may be present between the windings should be considered in computing the test voltages. Test voltages greater than 1,000 volts rms shall be applied gradually at a rate not to exceed 500 volts rms per second.

TABLE VIII. Dielectric withstanding voltage at atmospheric pressure.

Working voltage ^{1/}	Rms test voltage (at 28 to 32 inches of mercury)
<25 - - - - -	50
>25 to 50 incl - - - - -	100
>50 to 100 incl - - - - -	300
>100 to 175 incl - - - - -	1,000
>175 to 700 incl - - - - -	2.8 x working voltage
>700 - - - - -	1.4 x working voltage, +1,000

^{1/} The working voltage is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered. This insulation may be between windings or between a winding and the case or core.

- (b) Nature of potential - AC.
- (c) Duration of application of test voltage - Minimum of 60 seconds for quality conformance inspection.
- (d) Points of application of test voltage:
 - (1) Winding to case or core - Between each winding and the case or core with all windings not under test grounded to the case, if cased or to the normal mounting means, if uncased, and to the core, if accessible.
 - (2) Between windings - The voltage shall be applied between each winding and each of the other windings with all windings not under test grounded to the case, if cased, or to the normal mounting means, if uncased, and to the core, if accessible. These tests need not be made if the winding-to-case or to-core test voltage of either winding under consideration is equal to, or greater than the winding-to-winding test voltage. The method used to perform the between-windings dielectric withstanding voltage test shall consist of two sources of test voltage so proportionated and phased that the winding-to-winding test voltages shall be according to table VIII. One terminal of each source shall be grounded to the case, if cased, or to the normal mounting means, if uncased, and to the core, if accessible. The test voltages applied shall not exceed the test voltages required for each of the windings to ground, and shall be applied so that the required test voltage appears between the windings. Multiple-section windings designed for operation only in series or parallel shall be considered as a single winding. In no case shall the test voltage applied between the windings exceed the sum of the test voltages for each of these windings to the case, if cased, or to the normal mounting means, if uncased, and to the core, if accessible.
- (e) High voltage source shall have a minimum of 1 kilovolt-ampere for voltages over a kilovolt.
- (f) Examination during and after test - Transformers shall be examined for evidence of arcing, flashover, breakdown of insulation, and damage. Failure may be evidenced by fluctuations in the leakage current, a steady increase in leakage current, or more than twice the normal leakage current at the specified test voltage (see 3.1 and 6.2.1). The normal leakage current shall be specified (see 3.1 and 6.2.1).

4.7.10.1.1 For special designs. Transformer windings internally grounded or having any part of the winding designed for operation at or near ground potential shall be subjected to the induced-voltage test or a combination of the dc dielectric withstanding voltage on the low-voltage terminal together with induced voltage, as applicable. Windings with special dielectric features (e.g., graded insulation) shall be subjected to the test voltage specified (see 3.1 and 6.2.1).

4.7.10.2 At barometric pressure. (see 3.13). Transformers designed for operation above 10,000 feet shall be tested as specified in 4.6.10.1 and in accordance with method 105 of MIL-STD-202. The following details shall apply:

- (a) Test-condition letter or altitude in feet if below 30,000 feet - As specified (see 3.1 and 6.2.1).
- (b) Magnitude of test voltage - As specified in table IX. A greater potential may be used at the option of the supplier.
- (c) Examination during and after test - Transformers shall be examined for evidence of arcing, flashover, breakdown of insulation, and damage.

TABLE IX. Dielectric withstanding voltage at barometric pressure.

Working voltage ^{1/}	Test voltage
<u>Volts</u>	<u>Volts, rms</u>
25	50
25 to 50 incl	100
50	300 or 1.25 x working voltage, whichever is greater

^{1/} The working voltage is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered. This insulation may be between windings or between a winding and the case or core.

4.7.10.3 At reduced voltage. Transformers shall be subjected to the dielectric withstanding voltage tests specified in 4.7.10.1, except that the test voltages shall be 75 percent of the values shown in table VIII and shall be applied for 5 seconds.

4.7.11 Winding continuity (see 3.14). All windings of transformers shall be tested for electrical continuity by any suitable means.

4.7.12 Insulation resistance (see 3.15). Transformers shall be tested in accordance with method 302 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Test-condition letter - B for first article inspection; and dc test potentials from 500 volts to 1,000 volts for quality conformance inspection. However, for quality conformance inspection, rejection shall be based on measurements made at 500 volts. For both first article and quality conformance inspection, the test voltage shall be 100 volts if the working voltage is less than 175 volts, and 50 volts if the working voltage is less than 25 volts.
- (b) Points of measurement - Winding-to-case or to-core - The potential shall be applied between each winding and the case to core with all windings not under test grounded to the case, if cased, or to the normal mounting means, if uncased, and to the core, if accessible.
- (c) Examination during and after test - Transformers shall be examined for evidence of arcing, flashover, breakdown of insulation, and damage. Any arc-over (air discharge), flash-over (surface discharge), or breakdown (puncture discharge) at the specified test voltage shall constitute failure. Failure may be evidenced by fluctuations in the leakage current, a steady increase in leakage current, or more than twice the normal leakage current at the specified test voltage. The normal leakage current shall be as specified (see 3.1 and 6.2.1).

4.7.13 Electrical characteristics (see 3.16). The electrical characteristics shall be determined by the tests specified herein, as applicable (see 3.1 and 6.2.1). Electrical tests included herein do not embrace all of the electrical tests that may be requested.

4.7.13.1 Voltage regulation (see 3.16.1). With the rated specified input voltage (see 3.1 and 6.2.1) applied and the shaft rotated to 50 percent of its maximum, a properly calibrated voltmeter shall be used to measure the output voltage with no load and specified rated resistive load applied (see 3.1 and 6.2.1). Voltage regulation shall be determined as follows:

$$\text{Regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}}$$

where V_{NL} = Output volts no load

V_{FL} = Output volts full load

4.7.13.2 Volt-ampere output (see 3.16.2). The transformer shall be tested to determine whether it meets the requirements of figure 1. Output current shall not be interrupted during any change of the voltage control.

4.7.13.3 Tap voltage (see 3.16.3) (when specified, see 3.1 and 6.2.1). A properly calibrated voltmeter shall be used to test the transformers energized at rated voltage (see 3.1 and 6.2.1) and frequency with the output terminals open circuited.

4.7.13.4 No load. Rated voltage at the lowest frequency or frequencies specified (see 3.1 and 6.2.1) shall be applied to the input with the output circuit open. The following shall be determined:

- (a) No load rms current.
- (b) No load power.

4.7.13.5 Full load. Voltage at the lowest frequency or frequencies specified (see 3.1 and 6.2.1) shall be applied to the input until output is loaded. The following shall be determined:

- (a) Maximum constant current rating.
- (b) Maximum constant impedance rating.
- (c) Input voltage at constant current and impedance rating.

4.7.13.6 DC resistance. The dc resistance of the winding shall be measured at or corrected to 20°C.

4.7.13.7 Frequency. The specified frequency or frequencies applied to the input shall be measured.

4.7.13.8 Efficiency (when specified, see 3.1 and 6.2.1). The efficiency of the variable transformer shall be measured.

4.7.13.9 KVA (VA) rating. The volt ampere rating of the transformer shall be determined.

4.7.13.10 Duty cycle. The duty cycle shall be continuous, unless otherwise specified (see 3.1 and 6.2.1).

4.7.13.11 Power factor. With rated voltage applied to the input and rated current flowing in a resistive load, the power factor shall be determined.

4.7.14 Temperature rise (see 3.17). The temperature rise of each winding shall be based on the change-in resistance method and computed by the following formula:

$$\Delta T = \frac{R-r}{r} (t + 234.5) - (T-t)$$

Where:

- ΔT = Temperature rise (in °C) above specified maximum ambient temperature (see 3.1 and 6.2.1).
- R = Resistance of winding (in ohms) at temperature (T + T).
- r = Resistance of winding (in ohms) at temperature (t).
- t = Specified initial ambient temperature (in °C).
- T = Maximum ambient temperature (in °C) at time of power shutoff. (T) shall not differ from (t) by more than 5 °C.

The transformers shall be conditioned for at least 8 hours at temperature (t) in a location free from drafts before resistance (r) is measured. Rated voltage shall be applied to the primary with the specified load across the secondary (see 3.1 and 6.2.1). Transformers shall be operated until two consecutive resistance readings on the highest resistance winding, taken 30 minutes apart, are the same. If the power is required to be shut off, the resistance measurements (R) shall be made as soon as possible. The transformers shall then be examined for evidence of physical damage. At the option of the supplier, the test may be performed at 60 Hz for transformers rated at 50/60 Hz provided the primary voltage is increased to 1.2 times the rated voltage and the secondary currents are maintained at rated current (6.4.2). Conditioning and all measurements shall be made at 50 percent rotation of the shaft.

4.7.15 Solderability (see 3.18). Transformers shall be tested in accordance with method 208 of MIL-STD-202. The following detail shall apply:

- (a) Number of terminations of each part to be tested - A minimum of two of each type of terminal.

4.7.16 Life (see 3.19). Transformers shall be tested in accordance with method 108 of MIL-STD-202. The following details apply:

- (a) Test temperature and tolerance - Maximum operating temperature +10 percent, -5 percent.
- (b) Operating conditions - Rated load, current, input voltage, and 50 percent shaft rotation.
- (c) Test-condition letter:
 - (1) Class I - D, unless otherwise specified (see 3.1 and 6.2.1).
 - (2) Class II - I.
- (d) Examinations after tests - Dielectric withstanding voltage and insulation resistance.

4.7.17 Explosion (see 3.20) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with method 109 of MIL-STD-202. The following detail shall apply:

- (a) Mechanical and electrical load - Rated load, maximum output voltage, rated current, and input voltage.

4.7.18 Acceleration (see 3.21) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with method 212 of MIL-STD-202. The following details shall apply:

- (a) Electrical loading - Brush contacts to be monitored, rated current, and voltage.
- (b) Test-condition letter A - At 50g, unless otherwise specified (see 3.1 and 6.2.1).
- (c) Examination after acceleration - Transformers shall be examined and observed for evidence of mechanical and electrical damage.

4.7.19 Sand and dust (see 3.22) (when specified, see 3.1 and 6.2.1). Transformers shall be subjected to the sand and dust test specified in method 110, MIL-STD-202. The following details shall apply:

- (a) Test condition - B.
- (b) Electrical loading - Brush contacts to be monitored with rated load, current, and voltage.
- (c) Examination after test - Units shall be examined for physical and electrical damage.

4.7.20 Salt spray (corrosion) (see 3.23) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- (a) Test-condition - B.
- (b) Salt solution concentration - 5 percent.
- (c) Examination after exposure - The transformers shall be thoroughly washed. The temperature shall not exceed 38°C. The transformer shall be placed in an oven maintained at 50° ± 3°C for 24 ± 4 hours. At the end of this period the transformers shall be removed from the oven and examined for corrosion.

4.7.21 Electromagnetic interference (see 3.24) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with MIL-STD-462. The test method shall be as specified (see 3.1 and 6.2.1).

4.7.22 Vibration, high frequency (see 3.25) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

- (a) Electrical loading - Rated voltage and current, brush contacts to be mounted.
- (b) Method of mounting - Transformers shall be rigidly mounted by their normal mounting means.
- (c) Test-condition letter - D, unless otherwise specified (see 3.1 and 6.2.1).
- (d) Examinations after vibration - Transformers shall be examined for evidence of physical damage.

4.7.23 Shock (specified pulse (see 3.26)). Transformers shall be tested in accordance with method 213 of MIL-STD-202. The following details and exception shall apply:

- (a) Test-condition letter - B or C, as specified (see 3.1 and 6.2.1).
- (b) Number and direction of applied shocks - 30 shocks, five in each of the six directions.
- (c) Examinations after shock - After the test, transformers shall be examined for evidence of physical damage.

4.7.24 Thermal shock (see 3.27). Transformers shall be tested in accordance with method 107 of MIL-STD-202. The following detail and exception shall apply:

- (a) Test-condition letter - A, except that step 3 shall be the specified maximum ambient temperature plus one-half the allowable temperature rise. The time for steps 2 and 4 shall be 5 minutes maximum.
- (b) After cycling - Transformers shall be examined for evidence of physical damage.

4.7.25 Humidity (see 3.28). Transformers shall be tested in accordance with method 103 of MIL-STD-202. The following details shall apply:

- (a) Measurements after conditioning - Not applicable.
- (b) Test condition letter - B, unless otherwise specified (see 3.1 and 6.2.1).
- (c) Loading voltage - Not applicable.
- (d) Final measurements - After drying period, transformers shall be subjected to the dielectric withstanding voltage at reduced voltage (see 4.7.10.3) and insulation resistance (see 4.7.12).

4.7.26 Moisture resistance (see 3.29) (when specified, see 3.1 and 6.2.1). Transformers shall be tested in accordance with method 106 of MIL-STD-202. The following details shall apply:

- (a) Mounting - On racks.
- (b) Initial measurements - Not applicable.
- (c) Conditioning - The 24 hour initial drying period prior to the first cycle may be omitted.
- (d) Polarization - Unless otherwise specified (see 3.1 and 6.2.1), polarization is applicable. The polarizing voltage shall be applied during steps 1 to 6 inclusive, between all windings not connected directly to the core or case, and to the core or case. When the dielectric withstanding test voltage is less than 100 volts rms, a 50 volt dc polarizing voltage may be used. The polarizing voltage shall be positive with respect to the core and the case.
- (e) Loading voltage - Not applicable.
- (f) Final examinations - Upon completion of step 6 of the final cycle, transformers shall be removed from the humidity chamber and the overload voltage shall be applied to the units as soon as possible after removal from the humidity chamber; in no case shall this interval exceed 6 hours.
- (g) Visual examination - Transformers shall be examined for any visible damage including corrosion and obliteration of marking.

4.7.27 Life (rotational) (see 3.30). Transformers shall be tested in accordance with method 206 of MIL-STD-202. The following details shall apply:

- (a) Cycle rate - 15 cycles per minute, maximum.
- (b) Test condition letter - D, unless otherwise specified (see 3.1 and 6.2.1).
- (c) Temperature and atmospheric conditions - Standard test conditions (20°C) under rated load conditions.
- (d) Test prior to rotations - The physical linear amount of brush wear in inches (cm).

4.7.28 Overload (see 3.31) (class II only). Transformers shall be tested in accordance with one of the following tests:

- (a) An overload of 250 percent above the rated maximum current shall be applied for a cyclic period of 1 minute "on" and 19 minutes "off" for 100 hours.
- (b) An overload of 150 percent above the rated maximum current shall be applied for a cyclic period of 5 minutes "on" and 15 minutes "off" for 100 hours.

4.7.29 Fungus (see 3.33) (when specified, see 3.1 and 6.2.1). Unless certification is provided, transformers shall be tested in accordance with method 508 of MIL-STD-810.

5. PREPARATION FOR DELIVERY

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, or as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Transformers shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Transformers shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

5.1.1.4 Unit packaging. Transformers shall be individually packaged in accordance with the submethods of MIL-P-116 specified herein ensuring compliance with the general requirements paragraph under methods of preservation (unit protection) and the physical protection requirements paragraph therein.

5.1.1.4.1 Transformers up to 5 pounds. Transformers weighing less than five pounds shall be packaged in accordance with submethod I1c. Each unit package shall be placed in a supplementary container conforming to PPP-B-566 or PPP-B-676.

5.1.1.4.2 Transformers 5 pounds and over. Transformers weighing five pounds and over shall be packaged in accordance with submethod I1b. The unit container shall conform to PPP-B-636, class weather resistant.

5.1.1.5 Intermediate packaging. Not required.

5.1.2 Level C. Transformers shall be clean, dry, and packaged in a manner that will afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

5.2 Packing. Packing shall be level A, B, or C, or as specified (see 6.2). Unit containers conforming to 5.1.1.4.2 may be used as shipping containers provided only one unit package is being shipped to a destination and the requirements for the applicable level of packing specified herein are met.

5.2.1 Level A. The packaged transformers shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. In lieu of the closure and waterproofing requirement in the appendix of PPP-B-636, closure and waterproofing shall be accomplished by sealing all seams, corners, and manufacturer's joint with tape, two inches minimum width, conforming to PPP-T-60, class 1 or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636 using nonmetallic or tape banding only.

5.2.2 Level B. The packaged transformers shall be packaged in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closures shall be in accordance with the appendix thereto.

5.2.3 Level C. The packaged transformers shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity. These packs shall conform to the applicable carrier rules and regulations and may be the supplier's commercial practice when such meets the requirements of this level.

5.2.4 Unitized loads. Unitized loads, commensurate with the level of packing specified in the contract or order, shall be used whenever total quantities for shipment to one destination equal 40 cubic feet or more. Quantities less than 40 cubic feet need not be unitized. Unitized loads shall be uniform in size and quantities to the greatest extent practicable.

5.2.4.1 Level A. Transformers, packed as specified in 5.2.1, shall be unitized on pallets in conformance with MIL-STD-147, load type I, with a fiberboard cap (storage aid 4) positioned over the load.

5.2.4.2 Level B. Transformers, packed as specified in 5.2.2, shall be unitized as specified in 5.2.4.1 except that the fiberboard caps shall be class domestic.

5.2.4.3 Level C. Transformers, packed as specified in 5.2.3, shall be unitized with pallets and caps of the type, size and kind commonly used for this purpose. These unitized loads shall conform to the applicable carrier rules and regulations and may be the supplier's commercial practice when such meets the requirements of this level.

5.3 Marking. In addition to any special marking required by the contract or purchase order (see 6.2), each unit package, supplementary and exterior container and unitized load shall be marked in accordance with MIL-STD-129.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2, and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Packaging inspection. The inspection of these packaging requirements shall be in accordance with 4.6.2.

5.4.3 Army procurements.

5.4.3.1 Level A (maximum military protection) unit packaging. All supplementary containers shall either be weather (or water) resistant or overwrapped with waterproof barrier materials. Containers conforming to PPP-B-566 or PPP-B-676 shall be overwrapped with water-proof barrier materials or shall conform to MIL-B-43014 (see 5.1.1.4.1).

5.4.3.2 Level A (maximum military protection) and level B (minimum military protection) packing. For level A packing when quantities per destination are less than a unitized load, the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601, overseas type; PPP-B-621, class 2, style 4 or PPP-B-585, class 3, style 2 or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to QQ-S-781, type I, finish A. When the gross weight exceeds 200 pounds or the container length and width is 48 x 24 inches or more and the weight exceeds 100 pounds, 3 x 4 inch skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant as specified in level A and the containers shall be banded (see 5.2.1 and 5.2.2).

5.4.3.3 Level A and B unitization. For level A and B unitization, the fiberboard caps shall be weather resistant and softwood pallets conforming to NN-P-71, type IV, size 2 shall be used. The load shall be bonded to the pallet by strapping conforming to QQ-S-781, type I, finish A or shrink film (see 5.2.4.1 and 5.2.4.2).

5.4.3.4 Commercial unit packaging and packing. Commercial unit packaging and packing shall conform to the requirements of 5.1.2 and 5.2.3, as applicable.

5.4.3.5 Commercial marking. All unit, intermediate and exterior containers shall, as a minimum, be marked with the following: noun nomenclature, national stock number (or part number when the NSN is not given), Government contract or purchase order number, quantity, contractor's name and any additional marking which may be required by the contract or the contractor's policy or procedures. Exterior containers shall also be marked with the appropriate address. All markings shall be applied by any means providing legibility.

6. NOTES

6.1 Intended use. These transformers are suitable for conventional applications when varying the voltage is required.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Title, number, and date of the applicable specification sheet, and the complete part number (see 3.1 and 6.2.1).
- (c) Inspection of commercial packaging (see 4.6.2).
- (d) Levels of preservation-packaging and packing required (see 5.1 and 5.2).
- (e) Special marking, if required (see 5.3).

6.2.1 For transformers not covered by specification sheets: Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Classification (see 1.2).
- (c) When first article inspection is performed (see 3.2), the following is required:
 - (1) The laboratory at which first article inspection is to be performed.
 - (2) Sample, submission of data, and inspection routine, if other than that specified (see 3.2 and 6.3).
- (d) Leads (class II only), if other than stranded wire (see 3.3.5.3).
- (e) Type of terminal, material, and physical dimensions (see 3.4.2).
 - (1) Whether hardware is required for stud terminals and detail requirements of stud terminals (see 3.4.1 and 3.4.2.3).
- (f) Whether hardware is required for mounting studs (see 3.4.3).
- (g) Whether a paint finish is required and if it is to be applied to mounting surface (see 3.4.4).
- (h) Shaft length (see 3.4.5.1).
- (i) Enclosure, if required (see 3.4.6).
- (j) Mounting conversion, if required (see 3.4.7).
- (k) Index pin (class II), if required (see 3.4.8).
- (l) Voltage control range (see 3.4.14).
- (m) Dimensions (see 3.4.15).
- (n) Weight (see 3.4.16).
- (o) Control knob shaft size (see 3.4.17).
- (p) Whether meters, fuses, and power cords are required (see 3.4.18).
- (q) Whether switch is required and the type of switch applicable (see 3.4.19).

- (r) Mechanical travel (see 3.7).
 - (s) Shaft torque if other than 5 pound-inches (see 3.11).
 - (t) Electrical characteristics, rated voltage, loads, and tolerances (see 3.16 and 4.7.13).
 - (u) Maximum ambient temperature and maximum allowable temperature rise (see 3.17).
 - (v) Whether explosion is required (see 3.20).
 - (w) Whether acceleration is required and test condition letter (see 3.21).
 - (x) Whether sand and dust is required (see 3.22).
 - (y) Whether salt spray is required (see 3.23).
 - (z) Whether electromagnetic interference is required (see 3.24).
- (aa) Whether vibration high frequency is required and test condition letter, if other than "D" (see 4.7.22).
 - (ab) Marking (see 3.34).
 - (ac) Dielectric withstanding voltage at barometric pressure and test condition letter (see 4.7.10.2).
 - (ad) Dielectric withstanding test voltages for windings with special dielectric features (see 4.7.10.1.1).
 - (ae) Duration of life test, if other than specified values (see 4.7.16).
 - (af) Shock (specified pulse) test condition letter (4.7.23).
 - (ag) Humidity test condition letter, if other than "B" (see 4.7.25).
 - (ah) Polarization if not applicable during moisture resistance test (see 4.7.26).
 - (ai) Fungus if required (see 4.7.29).
 - (aj) Inspection of commercial packaging (see 4.6.2).
 - (ak) Levels of preservation-packaging and packing required (see 5.1 and 5.2).
 - (al) Special marking, if required.
 - (am) The particular complementary document (e.g., whether it is a manufacturer's drawing, brochure, catalog listing, etc.).

6.3 First article inspection. Information pertaining to first article inspection of products covered by this specification should be obtained from the procuring activity for the specific contracts involved (see 3.2).

6.4 Definitions.

6.4.1 KVA rating. KVA rating is the normal line voltage times the rated load current.

6.4.2 Rated current. Rated current is the maximum current that a transformer can carry indefinitely without physical or electrical damage.

6.4.3 Radial play. The radial play is the total radial excursion of the shaft, expressed in inches, and measured at a specified distance from the front surface of the unit, with a specified radial load applied alternately in opposite directions at a specified point.

6.4.4 Mechanical backlash. The mechanical backlash, measured in degrees, is the maximum allowed angular rotation of the shaft, without the contact assembly rotating when the direction of rotation is reversed.

6.4.5 Self-extinguishing. Self-extinguishing is the disappearance of visible flame within 1 minute after an impingement of external flame for 15 seconds per method 111 of MIL-STD-202.

MIL-T-83721

Custodians:

Army - EL
Navy - EC
Air Force - 85

Preparing activity:

Air Force - 85

Project No. 5950-0466

Review activities:

Army - EL, AT
Navy - EC
Air Force - 11, 17, 80
DSA - ES

User activities:

Army - EL, MI, ME, MU, SG
Navy - MC, EC
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