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SUPERSEDING

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MILITARY SPECIFICATION**VOLT-AMMETER: DUAL POINTER DIRECT CURRENT**

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. This specification covers design requirements and all performance requirements for procurement of a dual pointer direct current volt-ammeter.

1.2 Classification. Meters shall be furnished in ranges as specified on MS 18098.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications of the issue in effect on date of invitation for bids form a part of this specification, to the extent specified herein.

SPECIFICATIONS**FEDERAL**

- QQ-C-320 — Chromium Plating
(Electrodeposited)
- QQ-N-290 — Nickel Plating (Electrodeposited)
- QQ-P-416 — Plating, Cadmium
(Electrodeposited)

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- MIL-S-61 — Shunts, Instrument,
External 50 Milli-

volt (Lightweight
Type)

- MIL-P-116 — Preservation,
Methods of
- MIL-N-3336 — Nut, Self Locking, In-
strument Mounting
- MIL-D-70327 — Drawings, Engineer-
ing and Associated
Lists
- MIL-I-5272 — Environmental Test-
ing, Aeronautical
and Associated
Equipment, General
Specification for
- MIL-C-5541 — Chemical Films for
Aluminum and Alu-
minum Alloys
- MIL-S-6872 — Soldering Process,
General Specifica-
tion for
- MIL-S-7742 — Screw Threads,
Standard, Optimum
Selected Series,
General Specifica-
tion for
- MIL-P-7936 — Parts and Equipment,
Aeronautical, Pre-
paration for Del-
ivery

FSC 6625

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MIL-A-8625 — Anodic Coatings, for Aluminum and Aluminum Alloys

MIL-L-25142 — Luminescent Material, Fluorescent

STANDARDS**FEDERAL**

FED. STD.
No. 595 — Colors

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MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-130 — Identification Marking of U. S. Military Property

MS33558 — Numerals and Letters, Aircraft Instrument Dial, Standard Form of

MS33586 — Metals, Definition of Dissimilar

MS18098 — Volt-Ammeter, Dual Pointer, Direct Current

(Copies of the applicable documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Preproduction. The meters furnished under this specification shall be a product, samples of which have been tested and passed the preproduction tests specified herein.

3.2 Standard parts. With the exception of 3.2.1, MS and AN standard parts shall be used where they suit the purpose. They shall be identified on the drawings by their part numbers.

3.2.1 Commercial parts. Commercial parts having suitable properties may be used where, on the date of invitation for bids, there are no suitable standard parts. In any case, commercial utility parts such as screws, bolts, nuts, cotter pins, having suitable properties may be used provided:

(a) They can be replaced by the standard parts (MS or AN) without alteration.

(b) The corresponding standard part numbers are referenced in the parts list, and, if practicable, on the contractor's drawings.

3.3 Materials. Materials shall conform to applicable specifications and shall be as specified herein. Materials for which there are no applicable specifications, or which are not specifically described herein, shall be of the best quality, of the lightest practicable weight, and suitable for the purpose intended.

3.3.1 Critical materials. Noncritical materials shall be used where practicable. Where the use of a critical material is essential to meet specification requirements, the material used shall be the least critical of those which are adequate for the purpose.

3.3.2 Metals. Metals shall be of the corrosion-resistant type, or shall be suitably protected as specified herein to resist corrosion due to salt spray or atmospheric condition to which the meters may be subjected when in storage or during normal service life.

3.3.2.1 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals as defined in Standard MS33586 shall not be used in intimate contact with each other. The use of dissimilar metals separated by suitable nonmetallic insulating material will be permitted.

3.3.3 Nonmagnetic materials. Nonmagnetic materials shall be used for all parts of the

meters except where magnetic materials are essential.

3.3.4 Fungus-proof materials. Materials which are nutrients for fungi shall not be used where it is practicable to avoid them. Where used and not hermetically sealed, they shall be treated with a fungicidal agent acceptable to the procuring activity. However, if they will be used in a hermetically sealed enclosure, fungicidal treatment will not be necessary.

3.3.5 Corrosion fumes. The materials used in the meters shall not liberate deleterious fumes.

3.4 Design and construction. The meter shall be so designed and constructed that no parts will work loose in service. It shall be built to withstand the strains, jars, vibration and such other conditions as are incident to usage, shipping, storage, etc. The ammeter shall be of the expanded scale type; the voltmeter shall be of the suppressed zero construction with scale range of 15 to 33 volts. The indicator shall be as shown on MS18098. Table I gives additional applicable information.

3.5 Case. The outline dimensions of the meters shall conform to MS 18098.

3.5.1 Body. The body of the case shall be made of lightweight metal or suitable thermosetting plastic moulding material uniform in texture, and shall have a smooth surface. The case shall be finished in a durable lusterless black finish, Color 37038 of FED. STD. No. 595.

3.5.2 Cover glass. The cover glass shall be clear and free from flaws which interfere with normal reading of the meter.

3.6 Dial. The dial shall be made of stiff material firmly secured to its mounting and shall be marked as specified. Paper dials will be satisfactory only when adequately bonded

to and backed by a metal support. The dial shall be of such material and so secured as to meet all the tests specified herein without fading, discoloring, warping or other deterioration.

3.6.1 Distance — Dial to cover glass. The distance from the dial to the cover glass shall be as small as practicable and shall not exceed $\frac{5}{32}$ inch.

3.6.2 Visibility of dial. The pointer, numerals, and all other specified markings on the dial shall be visible from any point within the frustum of a cone whose sides make an angle of 30° with a perpendicular to the dial and whose small diameter is the aperture of the case.

3.7 Pointers. The meter pointers shall be of rigid construction suitable for the intended applications and shall not become damaged or distorted when subjected to any of the tests specified herein. The pointers shall be as shown in MS18098.

3.7.1 Ammeter index and voltmeter masking index. The ammeter shall be provided with an adjustable striped index and the voltmeter shall be provided with an adjustable masking index as shown on MS18098 with adjustment accessible from the front of the case. Background of each index shall be durable dull black.

3.8 Pointer clearance (parallax). The clearance between the pointer and the graduated scale shall not exceed 0.05 inch.

3.9 Shunts. External shunts, when furnished with meters, shall be in accordance with Specification MIL-S-61. External shunts shall not be furnished with meters unless specified by the procuring activity.

3.9.1 The ammeter shall be adjusted to give full scale reading at 50 millivolts with a shunt lead resistance of 0.5 ± 0.05 ohms in series with the meter.

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3.10 Bearings and pivots. Moving elements shall turn on hardened, accurately ground, and highly polished steel pivots bearing on highly polished first-quality sapphire, diamond jewels, or other materials that have been approved as alternates to precious gems.

3.11 Adjustment. Meters shall be adjusted to provide full scale readings as specified.

3.11.1 Accuracy adjustment. Meters shall be provided with some practicable shop means of adjustment to accuracy. Charging to the magnet and magnetically treating it to obtain accuracy shall be considered as meeting this requirement. Internal resistances shall be easily accessible.

3.12 Calibration adjustment. The voltmeter shall be provided with a calibration adjustment accessible from the front of the case. It shall provide for a minimum range of adjustment of 1.25 volts above and below 28 volts with 28 volts impressed on the meter. The calibration adjustment shall be suitably insulated to eliminate all danger to the operator. The adjustment mechanism (or screw) shall be designed and constructed to prevent damage when meter is placed face down and also shall have sufficient friction to prevent it from shaking loose and changing its adjustment due to the vibration test specified herein. (See par 4.7.2.)

3.13 Accuracy at room temperature. Unless otherwise specified, the ammeter shall indicate correctly within ± 2 percent of full scale deflection for each major graduation. The voltmeter, when adjusted by means of the calibration adjustment to read accurately at 28 volts, shall indicate correctly at the other major scale points within $\pm 0.7V$. These tests shall be conducted at room temperature of $25 \pm 5^{\circ}C$. ($77 \pm 9^{\circ}F$). (See par 4.7.3.)

3.14 Damping factor. The meters shall have an efficient damping arrangement to prevent excessive oscillation of the pointers at fluctuating loads. The damping factor

shall not be less than 2.5 for the ammeter and 2.0 for the voltmeter, (see 6.2.2) when tested as specified in 4.7.4.

3.15 Response time. Response time when tested as specified in 4.7.5 shall not exceed 2.5 seconds when a voltage or current sufficient to give full-scale momentary deflection is suddenly applied. (See 6.2.6.)

3.16 Balancing. When meters are tested as specified in 4.7.6 the pointer tip shall not deviate from the zero mark by more than 2 percent of the full scale length for ammeters. The voltmeter pointer shall remain at the 28V mark within ± 0.7 volt.

3.17 Vibration Error. Neither pointer oscillation nor pointer displacement shall exceed 3 percent of full scale deflection for the ammeter, ± 1 volt for the voltmeter, when the meter is subjected to the test of par 4.7.7. At the conclusion of the test the meter shall pass an accuracy at room temperature test.

3.18 Insulation resistance. The insulation resistance between each terminal and the metal panel upon which the instrument is mounted shall be not less than 20 megohms at a potential of 500 volts dc, when tested in accordance with 4.7.8. The same tolerance shall apply when 300 volts dc is applied between one terminal of the voltmeter and one terminal of the ammeter.

3.19 Insulation test. A voltage of 1000 volts rms alternating current, commercial frequency, applied for a period of one minute shall cause no breakdown of insulation when tested in accordance with 4.7.9.

3.20 Magnetic effect. The meters shall be magnetically shielded so that they will not cause a deflection of the compass of more than 6 degrees when tested as specified in 4.7.10.

3.21 Temperature influence. The temperature influence of the meters when tested as specified in 4.7.11 shall not exceed 1.0 per-

cent for the ammeter and 0.2 volt for the voltmeter (see 6.2.8).

3.22 Heat effect. When tested as specified in 4.7.12 meters shall indicate freely at 70° C. (158° F.). The change in indication at the end of each heat cycle shall not exceed 1.75 volt for the voltmeter or 2.5 percent for the ammeter. The maximum permanent change in indication between the beginning of the first heat cycle (initial accuracy indication) and the end of the third cycle shall not exceed 2 percent for the ammeter or 0.5 volt for the voltmeter.

3.23 Low temperature. The change in indication when the meter is subjected to the low temperature exposure test of 4.7.13, shall not exceed 8 percent for the ammeter and 1.35 volt for the voltmeter.

3.24 Vibration failure. The meter shall satisfactorily pass an accuracy at room temperature test after being subjected to the vibration test specified in 4.7.14. The zero of the ammeter shall not have changed. The friction error shall not exceed 1½ times the allowable room temperature scale errors.

3.25 Shock. Permanent errors in the meter indication resulting from shock of the character and intensity specified in 4.7.15 shall not exceed 2 percent of full-scale deflection for the ammeter and 0.7 volt for the voltmeter. No screws, bearings, pivots, or other parts shall become loosened or unduly damaged so as to affect the operation of the meter.

3.26 Momentary overload. Meters shall be sufficiently rugged to withstand a series of momentary overloads as described in 4.7.16 without incurring damage other than a permanent error, at any part of the scale, of not more than one percent of the full scale length for the ammeter and 0.33 volt for the voltmeter.

3.27 Sustained overload. Meters shall withstand for 8 hours sustained loads as specified in 4.7.17 without a permanent change in indication of more than 1 percent of the full-scale length for the ammeter or 0.33 volt for the voltmeter. The ammeter permanent zero shift shall not be greater than 1.0 percent of the full-scale length. No other permanent damage shall have occurred. The temporary zero shift shall not exceed 2 percent of the full-scale length for the ammeter.

3.28 Humidity. The meters shall operate satisfactorily after subjection to the humidity test specified in 4.7.18. The permanent change in indication after the final humidity cycle shall not exceed 3 percent of full scale.

3.29 Mounting lugs. Instrument mounting lugs when tested in accordance with 4.7.19 shall withstand an axial load of 175 lbs. without fracture.

3.30 Bearing adjustment screw. To prevent tampering, the bearing adjustment screw shall not be exposed outside of the instrument case.

3.31 Terminal posts. Threaded terminal posts shall be provided with the proper nuts and lock washers for attaching cable terminals as specified in MS 18098.

3.32 Screw threads. Screw threads 0.060 inch or larger in diameter shall be in accordance with Specification MIL-S-7742.

3.33 Interchangeability. All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part number shall be governed by the drawing number requirements of Specification MIL-D-5028.

3.34 Physical requirements.

3.34.1 Weight. The weight of the meter shall be as specified in MS 18098.

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3.34.2 Finish. Protective coatings and finishes which will crack, chip, or scale during normal service life or due to extremes of atmospheric conditions shall not be used.

3.34.2.1 Aluminum alloy parts. Where practicable, aluminum alloy parts shall be covered with an anodic film conforming to Specification MIL-A-8625. Aluminum alloys which do not anodize satisfactorily shall be coated with a chemical film in accordance with Specification MIL-C-5541.

3.34.2.2 Iron and steel parts. Where practicable, iron and steel parts shall be cadmium, chromium or nickel plated in accordance with Specifications QQ-P-416, QQ-C-320, and QQ-N-290, respectively.

3.34.3 Soldering. Soldering shall be performed in accordance with Specification MIL-S-6872.

3.35 Marking. All markings shall be durable to withstand usage encountered in service. The form of the letters and numerals shall conform to Standard MS33558. Numerals shall distinctly indicate the graduation to which each applies.

3.35.1 Dial and Pointers. The meter dial and pointers shall be marked as shown in MS18098.

3.35.2 Terminals. Studs shall not be electrically connected to the meter case. The polarity of the meter studs shall be legibly and permanently marked as specified in MS18098.

3.35.3 Case. The back of the meter shall be legibly and permanently marked as shown on MS18098.

3.36 Installation instructions. The contractor shall furnish with each meter one printed copy of instructions with illustrations and diagrams covering the installation of the meter. Prior to printing, the copies shall be

furnished to the procuring activity for approval. The instructions shall be printed on 8½ by 11 or 11 by 15 inch paper.

3.36.1 Envelope. An envelope furnished by the contractor, containing installation instructions and sufficient 6-32 NC-2 round-head durable black finish mounting screws and nuts (MIL-N-3336) for installing the meter in panels up to ¾ inch thick, shall be packaged with each meter, and shall be marked with the following information:

**“IMPORTANT
THIS ENVELOPE CONTAINS INSTRUCTIONS,
MOUNTING SCREWS AND
NUTS”**

3.37 Workmanship. The meter, including all parts and accessories, shall be constructed and finished to produce an instrument free from all defects which would affect proper functioning in service. Particular attention shall be given to neatness and thoroughness of soldering, wiring, and impregnation of coils, welding and brazing, painting, riveting, machine-screw assemblies, and freedom of parts from burrs and sharp edges.

4. QUALITY ASSURANCE PROVISIONS

4.1 The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specifications where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests. The inspection and testing of the volt-ammeter shall be classified as follows:

(a) *Preproduction tests:* Preproduction tests are those tests accomplished on samples which are representative of the production of the item after the award of contract, to determine that the production meets the requirements of this specification.

(b) *Acceptance tests:* Acceptance tests are those tests performed on the meters manufactured and submitted for acceptance under contract.

4.3 Preproduction tests. The preproduction tests of the volt-ammeter shall consist of all tests of this specification specified under paragraph 4.7 headed Test methods conducted in the following order.

Test group 1 (all 6 samples)

- Examination of product
- Calibration adjustment
- Balancing
- Accuracy at room temperature
- Damping factor
- Response time
- Magnetic effect
- Temperature influence
- Heat effect at 70°C.
- Low temperature
- Vibration error
- Insulation resistance
- Insulation test

Test group 2 (two samples)

- Momentary overload
- Sustained overload

Test group 3 (two samples)

- Humidity

Test group 4 (two samples)

- Shock
- Vibration failure
- Mounting lugs

4.4 Acceptance tests. The acceptance tests of the meters shall consist of the individual

tests and the sampling tests of this specification.

4.4.1 Individual tests. The individual tests of the meters shall consist of the following tests conducted on each meter:

- Examination of product
- Calibration adjustment
- Accuracy at room temperature
- Damping factor

4.4.2 Sampling tests.

4.4.2.1 Lot. A lot shall consist of all meters manufactured under essentially the same conditions and submitted for acceptance at essentially the same time. The lot size shall be expressed in terms of meters.

4.4.2.2 Sampling for acceptance tests. Sampling for acceptance tests shall be in accordance with MIL-STD-105, inspection level L7, except that each sample size represented by the sample size code letter shall be used, with an acceptance number of zero and a rejection number of one. The samples selected shall be subjected to the following tests:

- Balancing
- Response time
- Vibration error
- Insulation resistance
- Heat effect at 70°C.
- Low temperature
- Magnetic effect
- Mounting lugs

4.5 Resubmitted inspection lots. The applicable paragraph of MIL-STD-105 shall apply except that a resubmitted inspection lot shall be inspected by the contractor under supervision of the Government inspector using tightened inspection. If the original acceptance number was zero, a sample size represented by the next higher sample size code letter shall be chosen. Before an inspection lot is resubmitted, full particulars concerning the cause of previous rejection

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and the action taken to correct the defect found in the inspection lot shall be furnished by the contractor to the inspector.

4.5.1 Individual tests may continue. For production reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of the entire lot shall not be made until it is determined that the lot meets all the requirements of the specification.

4.5.2 Defects in items already accepted. The investigation of a test failure could indicate that defects may exist in items already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and methods of correcting them.

4.6 Test conditions.

4.6.1 Atmospheric conditions. Unless otherwise specified, all tests required by this specification shall be tested at a room temperature of $25^{\circ} \pm 5^{\circ}\text{C}$.

4.6.2 Level position. Unless otherwise specified, the meter shall be tested in its level position in which the face is vertical.

4.6.3 Tapping. Either the meter or its support shall be tapped lightly in taking meter readings, except when ascertaining the affect of friction after vibration.

4.6.4 Parallax. Care should be exercised to avoid the effect of parallax when taking meter readings.

4.7 Test methods.

4.7.1 Examination of product. Each meter shall be examined externally to determine conformance with the applicable drawings and with all the requirements of this specification not covered by tests.

4.7.2 Calibration adjustment. The range of

volt meter calibration shall be determined. The voltmeter should then be adjusted to 28V when 28V DC is applied. The limits of the adjustment shall be as specified in 3.12.

4.7.3 Accuracy at room temperature. Each meter shall be calibrated to determine the accuracy of the instrument at room temperature. The accuracy may be checked at any reading on the scale and shall be within the tolerance specified in 3.13. For initial readings, the voltmeter shall be adjusted to read 28V when 28VDC is supplied. The meter shall not be readjusted for the rest of the tests.

4.7.4 Damping factor. When testing ammeters the external shunt shall be connected Voltage or current sufficient to produce momentary full-scale deflection shall be applied to the meter. After the pointer has come to rest, the steady deflection shall be taken and recorded. The damping factor shall not be less than that specified in 3.14. (See 6.2.2.)

4.7.5 Response time. Voltage or current sufficient to produce momentary full-scale deflection shall be applied to the meter. The length of time, in seconds, required for the pointer to come to rest shall be noted. This test shall be repeated several times and the average value taken as the response time of the meter. The pointer is to be considered as having come to apparent rest when it has reached the actual rest point within ± 1 percent of the scale length. The response time shall not exceed that specified in 3.15.

4.7.6 Balancing. The pointer of the voltmeter shall be made to read 28V with the meter in the vertical position. The instrument shall then be tilted 60 degrees from the vertical in any direction, and the position of the pointers shall not deflect more than the amount specified in 3.16.

4.7.7 Vibration error. The meters shall be subjected to a vibration error test in accord-

ance with the requirements of Procedure IV of Specification MIL-E-5272. The meter shall be successively deflected to approximately five equidistant points on the scale during this test. In no case, however, shall the pointer be held at any given scale mark for more than 30 minutes.

4.7.8 Insulation resistance. The voltage as specified in 3.18 shall be applied between each terminal post and the metal panel upon which the instrument is mounted. The test shall also be conducted between one terminal of the voltmeter and one terminal of the ammeter.

4.7.9 Insulation test. The voltage as specified in 3.19 shall be applied between each terminal post and the metal panel upon which the instrument is mounted. The test shall also be conducted between one terminal of the voltmeter and one terminal of the ammeter.

4.7.10 Magnetic effect. The indicator shall be properly connected and power applied. The indicator shall be revolved about a short bar-magnet compass with the nearest part of the indicator $5\frac{1}{2}$ inches from the bar-magnet. The compass shall have its compensating magnets removed and shall be set up in a uniform magnetic field whose horizontal intensity is between 0.17 and 0.19 oersted. The indicator shall be revolved in a horizontal plane which is perpendicular to the axis of the bar-magnet. The indicator shall be held in positions 0, 45, 90, 135, 180, 225, 270, and 315 degrees from the initial position. At each of these positions the indicator shall be rotated 360 degrees about its horizontal axis. The tolerance of 3.20 applies.

4.7.11 Temperature influence. Meter readings shall be taken with the meter at a reference temperature of $25^{\circ} \pm 2^{\circ}\text{C}$. Readings shall be taken at not less than five points (approximately equidistant) on the scale, such readings to include the maximum scale

value. The meter shall then be subjected to a temperature 20°C . above the reference temperature for not less than 2 hours, until thermal stability is attained, and the readings repeated. The same procedure shall be repeated at a temperature 20°C . below the reference temperature. One half of the difference between each reading at the high temperature and the corresponding reading at the reference temperature shall be expressed as a percentage of full-scale value. A similar computation shall be made for the readings at the low temperature. If the influences above and below the reference temperature are not equal, the greater value shall be considered the temperature influence. The tolerance of 3.21 applies.

4.7.12 Heat effect at 70°C . (158°F). Meters shall be placed in heated air and maintained at a temperature of 70°C . (158°F .) with an internal relative humidity of not more than 5 percent for 16 hours. At the conclusion of this period and while still heated to this temperature, meters shall be read throughout the calibrated scale. The tests shall be made 3 times successively. The tolerance of 3.22 shall apply.

4.7.13 Low temperature. The meter shall be subjected for a minimum period of 48 hours to a temperature of -65°C . (-85°F .) The temperature shall then be raised to -55°C . (-67°F .) and maintained for 24 hours. At the end of that period, and while still at that temperature, the meter shall be checked for accuracy. The tolerances of 3.23 apply.

4.7.14 Vibration failure. The meters shall be tested in accordance with Procedure V of Specification MIL-E-5272. (See 3.24.)

4.7.14.1 At the conclusion of the Vibration tests, the meter shall be connected to a source of potential or current, as applicable, and readings taken throughout the calibrated scale. These readings are to be taken on both ascending and descending scales, the latter

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to observe the effect of friction. The errors due to vibration shall not exceed the values specified in 3.24.

4.7.14.2 The condition of the pivots and bearings after the Vibration tests shall be observed through a microscope of at least 40 diameters.

4.7.15 *Shock.* The meters shall be tested in accordance with Procedure I of Specification MIL-E-5272. Meters shall be mounted in their normal vertical mounting position and subjected to 10 shocks with an acceleration value of 50 gravity units each in a direction normal to the axis of the moving system at a rate of build-up and decay as defined by the shock-test device specified. The meters shall then be rotated 90 degrees counter-clockwise in the plane of mounting and subjected to 10 shocks of the same magnitude and direction as previously. The meters shall then be mounted in a horizontal plane, face upward, and subjected to 10 shocks of the same magnitude as at first but in a downward direction parallel to the axis of the moving system. Permanent error in indication shall be ascertained. Meter mechanisms shall be examined for loosening of or damage to parts. At the conclusion of this Shock test, the meters shall be subjected to the Vibration tests specified in 4.7.7. (See 3.25.)

4.7.16 *Momentary overload.* Ammeters shall be subjected to 10 applications of a current equal to 10 times end-scale value of the meter. The current shall be applied 9 times for $\frac{1}{2}$ second each time with one minute intervals between successive applications, followed by an interval of one minute, after which the current shall be applied for 5 seconds. After one hour at $20^{\circ} \pm 2^{\circ}$ C. following the above test, the permanent change in indication shall be determined. No repairs or adjustments will be allowed. Voltmeters shall be subjected to a similar test except that the overload shall be 3 times end-scale in lieu of that above. (See 3.26.)

4.7.17 *Sustained overload.* Voltmeters shall be subjected to an application of voltage equal to $1\frac{1}{2}$ times end-scale value, and current measuring meters shall be subjected to an application of energy 20 percent greater than end-scale value, for a period of 8 hours. Immediately after the load is removed at the end of the 8-hour period, the temporary zero shift shall be determined at $25^{\circ} \pm 2^{\circ}$ C. Sixteen hours after completion of the 8-hour overload period, the permanent zero shift shall be noted, and the permanent change in indication shall be determined at $25^{\circ} \pm 2^{\circ}$ C. (See 3.27.) For the voltmeter "zero" shall be taken with 28V dc applied to the meter.

4.7.18 *Humidity.* The volt-ammeter shall be tested in accordance with procedure III of Specification MIL-E-5272. No damage shall result from this test that will have an adverse effect on meter operation or the internal multiplier resistor. The meter shall pass a scale error test at the end of the first hour after removal from humidity. (See 3.28.)

4.7.19 *Mounting lugs.* The indicator case shall be mounted face downward on the movable head of a suitable testing machine with the face of the case in a horizontal plane so that the mounting lugs receive no added support. A suitable pin shall be inserted through the hole in the mounting lug and attached to a pull strap in the stationary head of the machine. A load of 175 pounds shall be applied for one minute to each lug in a direction toward the front of the case. The lugs shall withstand the applied load without fracture and there shall be no damage to any part of the indicator.

5. PREPARATION FOR DELIVERY

5.1 *Preservation and packaging.* Preservation and packaging shall be levels A or C, as specified (see 6.3).

5.1.1 The meters shall be packaged in accordance with Specification MIL-P-7936.

The method of preservation shall be in accordance with Specification MIL-P-116, Method II.

5.1.2 Preservation and packaging shall be such as to prevent deterioration or damage during handling and shipment from the supply source to the first receiving activity.

5.2 Packing. Packing shall be levels A, B, or C as specified (see 6.3).

5.2.1 *Levels A and B.* The meters shall be packed in accordance with Specification MIL-P-7936. The level or levels required shall be as specified in the invitation for bid or contract.

5.2.2 *Level C.* The meters shall be packed to insure that the shipment arrives in a satisfactory condition at destination. The shipment shall conform to the applicable carriers rules and regulation in effect at the time of shipment.

5.3 Marking. The interior and exterior containers shall be marked as specified in Specification MIL-P-7936.

6. NOTES

6.1 *Intended use.* The meters covered by this specification are intended for use in aircraft electrical systems.

6.2 *Definitions.* For the purpose of this specification the following definitions shall apply:

6.2.1 *Accuracy.* The accuracy is a number which defines the limit of error, expressed as a percentage of full-scale value.

6.2.2 *Damping factor.* The damping factor is the ratio of the steady deflection in angular degrees to the difference in angular degrees between maximum momentary deflection and steady deflection produced by a sudden application of constant electric power.

6.2.3 *Error.* The error is the difference between the indication and the true value of the quantity measured. It is the quantity which, when algebraically subtracted from the indication, gives the true value. A positive error denotes that the indication of the meter is greater than the true value.

6.2.4 *Full-scale value.* The full-scale value is equal to the largest value of the actuating electrical quantity which can be indicated on the scale. For the voltmeter full scale is considered 0 to 33 volts.

6.2.5 *Balancing.* The position influence on balance is the maximum displacement of the pointer which is caused solely by a 60° rotation, in a vertical plane, from the normal operating position of the meter, in the direction which produces the most unfavorable conditions as to position.

6.2.6 *Response time.* Response time is the time in seconds required for the pointer to come to rest after a change in the value of the measured quantity.

6.2.7 *Scale division.* A scale division is the increment between the centers of two consecutive scale marks.

6.2.8 *Temperature influence.* Temperature influence is the change (percentage of full-scale value) in the indication caused by a difference in ambient temperature of 10°C. from a reference temperature.

6.3 *Ordering data.* Procurement documents should specify the following:

- (a) MS Part No., title, number, and date of this specification.
- (b) Levels of packaging and packing desired.

6.4 *Provisions of preproduction tests.* Manufacture of any further volt-ammeter on the particular contract shall be suspended until the samples submitted are pronounced satis-

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factory by the procuring activity. When a contractor is in continuous production of these volt-ammeters from contract to contract, submission of further preproduction samples on the subsequent contracts may be waived at the discretion of the procuring activity. Approval of preproduction samples or the waiving of preproduction tests does not preclude the requirements of acceptance testing.

6.4.1 It shall be understood that the product supplied under contractor order shall be identical to the corresponding preproduction sample in design, construction, quality, material, workmanship, and method of manufacture. Deviation from the standards of the

preproduction sample shall be made only by the Procuring Activity. Evidence of unauthorized change shall constitute cause for rejection.

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodians:

Army—MO
Air Force—ASD
Navy—Wep

Preparing activity:

Navy—Wep

Proj. No. 6625-0173

TABLE I. Dial and pointer details

MARKING	HEIGHT OR LENGTH, INCH ± 0.010	WIDTH OF LINE OR GRADUATION INCH ± 0.005	FINISH	FOR NAVY PROCUREMENT ONLY
ALL NUMERALS	0.109	↑ FLUORESCENT LUMINESCENT MATERIAL MIL-L-25142 (INCLUDING POINTERS) ↓	↑ LUSTERLESS WHITE NO. 37875 SPEC FED-STD-595 (INCLUDING POINTERS) ↓
LETTERING AMPS, VOLTS, D.C.	0.109		
SECTOR LINES	0.016		
MAJOR GRADS	0.078	0.016		
PROJECTION AND MAJOR GRADS BEYOND SECTOR LINE	0.031	0.016		
INTERMEDIATE GRAD (AMMETER MS 18098-300) 50 AND 150 AMPS.	0.078	0.016		
INTERMEDIATE GRADS (AMMETER MS 18098-450) 50, 100, 200, 250, 350, AND 400 AMPS.	0.078	0.016		
MINOR GRADS (VOLTMETER) 26, 27, 28, AND 29 VOLTS.	0.062	0.010		
MINOR GRADS (AMMETER MS 18098-150) 10, 20, 30, 40, 60, 70, 80, AND 90.	0.062	0.010		
MINOR GRADS (AMMETER MS 18098-300) 125 AND 175 AMPS.	0.062	0.010		
CALIBRATION MARK ON VOLTMETER MASKING INDEX	0.078	0.010		
ALL OTHER MINOR GRADS	0.062	0.010		
AMMETER INDEX STRIPES	0.031		
INDICES	FED-STD-595	FED-STD-595
MS PART NO.	0.062	BLACK NO. 37038	BLACK NO. 37038