INCH-POUND
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PERFORMANCE SPECIFICATION

METERS, ELECTRICAL INDICATING, PANEL TYPE, RUGGEDIZED, 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 the general requirements for watertight, ruggedized, 1-inch and 1.5-inch square flange, and 1-inch, 2.5-inch, 3.5-inch and 4.5-inch round flange (flush mounting), and panel type, indicating meters (see 6.1).

1.2 Classification.

1.2.1 Type. Meters [self-contained, unless otherwise specified (see 3.1)] covered by this specification should all be of the following types:

a. 1-inch, direct current, millivoltmeters, microammeters, milliammeters, ammeters, and voltmeters.
b. 1.5-inch, direct current, ammeters, voltmeters, and decibel meters.
c. 2.5-inch and 3.5-inch, direct current, alternating current meters.
d. 2.5-inch and 3.5-inch, alternating current, rectifier type voltmeters.
e. 3.5-inch, decibel meters.
f. 4.5-inch, direct current meters.

The specified sizes, shapes of flange, color schemes, ranges, kind of currents, and electrical units are indicated in the type designation (see 1.2.2). Unless otherwise specified, each meter should be scaled and calibrated for use on both ferrous panels and nonferrous panels.

1.2.2 Type designation. The type designation should be in the following form, and as specified (see 3.1 and 6.2):

MR13	P	001	DC	MA	R
Style (1.2.2.1)	Color scheme (1.2.2.2)	Full-scale value (1.2.2.3)	Kind of current (1.2.2.4)	Electrical units (1.2.2.5)	Ruggedized construction (1.2.2.6)

No spaces should appear between the groups of letters and numbers comprising the type designation.

1.2.2.1 Style. The style is identified by the two-letter symbol "MR" (Meter, Ruggedized, see 6.5.21) followed by a two-digit number. The number signifies the size of the meter and shape of the flange.

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, Attn: VAI, P.O. Box 3990, Columbus, Ohio, 43218-3990 or emailed to sound@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

1.2.2.1.1 First digit. The first digit identifies the nominal size of the meter, as follows:

0: 1-inch.
1: 1.5-inch.
2: 2.5-inch.
3: 3.5-inch.
4: 4.5-inch.

1.2.2.1.2 Second digit. The second digit identifies the shape of the flange and degree of enclosure, as follows:

3: Square flange, watertight.
4: Round flange, watertight, long scale.
5: Round flange, watertight (for nonferrous panels).
6: Round flange, watertight (for both ferrous panels and nonferrous panels).
7: Round flange, watertight (for ferrous panels).

1.2.2.2 Color scheme. The color scheme of the dial background, markings, and pointer is identified by a single letter, as follows:

A: Additional or other dial markings such as colored line at a particular reading, or a colored segment or segments on the dial embracing two or more readings, etc.
B: Black dial background; white markings and pointer.
F: Fluorescent (yellow) markings and pointer; black dial background.
M: Multicolored markings. Color of the dial background, markings, and pointer should be as specified (see 3.1).
P: Phosphorescent markings and pointer; black dial background.
W: White dial background; black markings and pointer.
Y: Buff dial background; black markings and pointer.

1.2.2.3 Full-scale value.

1.2.2.3.1 Zero left. Three digits designating the units indicated identify the full-scale value for meters, with zero at left. When the full-scale is less than three digits, zeros are inserted at the left to fill out to three digits. Where the letter "R" is used in this group between two digits, it represents a decimal point.

Example: 1R5 represents 1.5

1.2.2.3.2 Offset- zero. Two digits identify the full-scale value of offset-zero meters, including zero-center meters, with a letter between, which gives the decimal value of the digits, as follows:

D: Tenths.
H: Hundreds.
T: Tens.
U: Units.

Example: 5H5 represents 500-0-500

1.2.2.4 Kind of current. Two letters identify the kind of current for which the meter is designed, as follows:

AC: Alternating current, 60 Hz nominal frequency, 25 Hz to 125 Hz operating frequency, iron-vane type only.
AE: Alternating current, 800 Hz nominal frequency, iron-vane type only.
AF: Alternating current, 400 Hz nominal frequency, iron-vane type only.
AR: Alternating current sine wave (60 Hz to 1,000 Hz), rectified type.
DC: Direct current.
RF: Radio frequency (50 kHz or above) conventional scale.
RL: Radio frequency (50 kHz or above) linear expanded scale.

1.2.2.5 Electrical unit. Two letters identify the electrical unit indicated by the meter, as follows:

AA: Amperes.	MA: Milliamperes.
DB: Decibels.	MV: Millivolts.
KA: Kiloamperes.	UA: Microamperes.
KV: Kilovolts.	VV: Volts.

1.2.2.6 Ruggedized construction. The letter "R" designates that the meter is of ruggedized construction.

1.2.2.7 Special meters. Four letters "SP--" are used in place of the letters specified in 1.2.2.4 and 1.2.2.5 for meters having special features such as adjusted resistance, special scale markings, etc. The Defense Supply Center, Columbus will supply the identifying letters and prepare the drawings for these meters without further coordination.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-H28	-	Screw-Thread Standards for Federal Services.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	-	Electronic and Electrical Component Parts, Test Methods for
MIL-STD-1285	-	Marking of Electrical and Electronic Parts

(See Supplement 1A for list of specification sheets.)

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Document Automation and Production Service (DAPS) Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents from a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO-10012-1	-	Quality Assurance Requirements for Measuring Equipment. Metrological Confirmation System for Measuring Equipment

(Copies of these documents are available online at http://www.iso.ch or from the International Organization for Standardization American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.)

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

J-STD-002	-	Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires

(Copies of this document are available from http://www.ipc.org or IPC - Association Connecting Electronics Industries, 3000 Lakeside Drive, Suite 309 S, Bannockburn, IL 60015-1249.)

NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCLS)

NCSL-Z540.1	-	Calibration Laboratories and Measuring and Test Equipment - General Requirements-Replaces Mil-Std-45662

(Copies of these documents are available from http://www.ncsli.org or to National Conference of Standards Laboratories (NCSL), 2995 Wilderness Place, Suite 107, Boulder, CO 80301-5404.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets, or MS sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

3.2 Qualification. Except as noted below, meters furnished under this specification and covered by specification sheets listed in Supplement 1A to this specification shall be products that are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL) before contract award (see 4.5 and 6.3). When meters are required in ranges or sensitivity not listed in the specification sheets, the meters shall be procured without additional qualification from those suppliers who have qualified meters in ranges or sensitivity that extend above and below the nonstandard range. This also applies to meters that have additional or other dial markings (i.e., a colored line at a particular scale marking, a colored segment, or segments on the dial embracing two or more scales, etc.).

3.3 Material. The material for each part shall be as specified herein. However, when a definite material is not specified, a material shall be used, which will enable the meters 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. Recovered materials shall be used to the maximum extent possible (see 3.33).

3.3.1 Molding thermosetting plastic. Molding thermosetting plastic material shall enable the meters to meet the operational and environmental requirements of this specification (see 6.6).

3.3.2 Fluorescent material. Fluorescent material shall be selected to enable the meters to meet the performance and environmental requirements of this specification (see 6.7).

3.3.3 Metal parts. External metal parts shall be of corrosion-resisting material or material treated to resist corrosion. Internal metal parts shall be adequately resistant to corrosion so that no impairment of operation, beyond the limits specified herein, will result due to corrosion when the meters are subjected to the tests specified herein.

3.3.4 Gaskets. Material used in gaskets shall not cause corrosion of metal parts, with which they come in contact.

3.3.5 External finishes. External finishes shall be applied to enable the meter to meet the operational and environmental requirements of this specification. The exterior finishes on metal parts not exposed to view from the front of the panel, on which the meter is mounted, shall have an unspecified color (see 6.8).

3.3.5.1 Front of meter. The finish on the portion of the case exposed to view from the front panel, on which the meter is mounted, shall be semi gloss black. This requirement does not apply to the external zero adjuster or the dial mounting screws (see 6.8).

3.3.6 Internal finishes. Internal finishes shall not melt, crack, chip, blister, or scale as the result of the tests specified herein.

3.3.7 Phosphorescent material. Phosphorescent material used on dials and pointers shall be selected to enable the meter to meet the performance and environmental requirements of this specification (see 6.7).

3.3.8 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of handset components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.12.1).

3.4 Interface and physical dimensions. Meters shall be of the interface, weight, and physical dimensions specified (see 3.1).

3.4.1 Balancing of moving element. The moving element shall be balanced by a means, which will provide an easily accessible method of rebalancing. Solder or an adhesive, to fix the balance weights or to function as a part of the balance weights, shall not be used, except when the instrument has a separate non-soldered adjustable balance weight.

3.4.2 Magnets. If laminated or multiple-piece magnets are used, the laminations or the components shall be securely fastened together so that they will not separate or loosen as a result of the tests specified herein.

3.4.3 Threaded parts. All threaded parts, except for bearing holding screws, shall be in accordance with FED-STD-H28. Where practical, all threads shall be in conformity with the coarse-thread series. The fine-thread series shall be used only for applications that might show a definite advantage through their use. Where a special diameter-pitch combination is required, the thread shall be of American National Form and of any pitch between 16 and 36, which is used in the fine-thread series.

3.4.3.1 Engagement of threaded parts. All threaded parts shall engage by at least three full threads.

3.4.3.2 Machine screws and nuts. All machine screws and nuts shall enable the meter to meet the operational and environmental requirements of this specification (see 6.9).

3.4.3.3 Locking of screw-thread assemblies. Screw-thread assemblies shall not loosen as a result of the tests specified herein. When practicable, use of split-type lock washers or equivalent under all nuts is recommended.

3.4.4 Cases. Unless otherwise specified (see 3.1), meter cases shall be made of metal which is capable of meeting all of the operational and environmental requirements specified herein. The dimensions shall be as specified (see 3.1). The back of the flange shall be flat and smooth. The contour of the case shall readily permit watertight gasket sealing between the meter case and the panel on which it is mounted.

3.4.4.1 Vibration and shock isolators. Where vibration and shock isolators are used, they shall be secured to the interior of the meter case by suitable means such as by molding or bonding, or by vulcanization, if of elastomeric material.

3.4.4.2 Window. Meters shall be provided with a window of a transparent material, free from detrimental defects that would prevent the meter from being easily read. Such defects include scratches, discoloration, chips, cracks, striate (parallel groves), electrostatic effect, or crazing (see 6.5.2). This requirement applies both before and after the tests specified herein. Windows shall not become loose when subjected to any of the tests specified herein.

3.4.4.2.1 Scale visibility. The scale and window shall be so designed that the entire graduated scale of the meter shall be readable at any angle up to 45 degrees below the horizontal centerline and 20 degrees to either side of the vertical centerline. Under these conditions, with general illumination coming from above, in front, and at an angle of 45 degrees from perpendicular to the middle of the dial, the graduated scale shall be readable, with no objectionable shadows on the graduated scale. 3.4.4.3 Sealing. Meter cases shall be sealed by means of gaskets; by fusing or soldering metal to metal, or metal to glass; or by means which will enable the meter to withstand the tests specified herein.

3.4.5. Dial, scale, pointer, color scheme, and bezel.

3.4.5.1 Dial. The dial shall be made of stiff material firmly supported and secured to its mounting. 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 ensure freedom from warping, fading, or other deterioration during the tests specified herein. The dial shall be so located within the meter case that the perpendicular distance at any point from the face of the dial to the front surface of the meter mounting panel is not more than 0.203 (13/64) inch, when the meter is mounted with normally supplied mounting accessories. In a design utilizing convex windows or where the installation of an overload protective device is required, the maximum clearance between the face of the dial and the inside surface of the window shall not exceed 0.234 (15/64) inch. The clearance between the periphery of the dial and the inside of the case shall not exceed 0.141 (9/64) inch at any point except the lower third portion of the dial.

3.4.5.2 Scale.

3.4.5.2.1 Length. The scale length shall be as specified (see 3.1).

3.4.5.2.2 Divisions. The value of each scale division, whenever practicable, shall be 1, 2, or 5 of the units measured or any decimal multiple or sub multiple of these numbers. In the case of multiple-scale meters or meters for other specialized uses, exceptions to this requirement may be necessary, but shall be avoided when reasonably possible. The angle subtended by a scale division shall be not less than 1 degree. Style 05, style 06, and style 07 shall have 10 scale divisions, the value of each being one-tenth of the full-scale value.

3.4.5.3 Pointer. The meter shall have a pointer formed to permit accurate readings at the usual distance, from which the meter is viewed and approximate readings up to the distance of legibility of the scale markings. The pointer shall be of rigid construction, suitable for the intended application, and shall not become damaged or distorted when subjected to any of the tests specified herein.

3.4.5.3.1 Pointer clearance (parallax). When the meter is not provided with means for avoiding errors in reading due to parallax, the clearance between the pointer index and the graduated scale shall not exceed 0.06 inch, on enclosure 5 and enclosure 7 (see 1.2.2.1.2). All other types shall not exceed 0.10 inch.

3.4.5.3.2 Pointer deflection. The pointer deflection shall be as specified (see 3.1).

3.4.5.4 Color scheme. The color scheme for the dial background, pointer, and markings, shall be as specified in 1.2.2.2. When fluorescent pointer and markings are called for, the type designation, the cardinal scale marks with their numerals, the abbreviation of electrical units measured, and kind of current (for example, MADC), and not less than 0.25 (¼)-inch of the pointer tip shall be covered with fluorescent material as applicable [except 1-inch meters shall be 0.1875 (3/16) inch]. Other dial markings and the visible portion of the pointer not covered by fluorescent material, if painted, shall be white.

3.4.5.5 Bezel. When a bezel is used, it shall be made of material of sufficient strength to resist deformation.

3.4.6 Means of adjustment.

3.4.6.1 Accuracy adjustment. Meters shall be provided with means of adjustment to accuracy. Charging of the magnet and magnetically treating it to obtain accuracy, or adjusting the internal resistor, shall be considered as meeting this requirement.

3.4.6.2 Zero adjuster. All 2.5-inch, 3.5-inch, and 4.5-inch meters shall be provided with an external zero adjuster. Unless otherwise specified (see 3.1), all 1-inch and 1.5-inch meters are not required to have an external zero adjuster; however, if no external zero adjuster is provided, the initial zero setting shall be within 2 percent of full-scale length from the center of the zero mark. Meters of 1 inch or less scale length shall have the initial zero setting within 2 percent of full-scale length.

3.4.7 Terminals and connections. 3.4.7.1 Terminals. The 1-inch and 1.5-inch meters shall be provided with solder lugs or solder type terminals. The 2.5-inch, 3.5-inch, and 4.5-inch meters shall be provided with threaded-stud terminals (size .250-28 UNF-2A) and supplied with a solder lug, two nuts, and two washers for each terminal. Solder type terminals and solder lugs shall be suitably treated to facilitate soldering, such as being hot-tin dipped; shall be capable of accommodating AWG size 14 wire, unless otherwise specified (see 3.1); and shall be capable of carrying the applicable overload current and voltage.

3.4.7.1.1 Polarity. On all direct current meters, the left-hand terminal (with the meter in the normal mounting position and viewed from the rear) shall be the positive terminal.

3.4.7.2 Bonding, electrical. All permanent-magnet moving-coil meters shall have the magnetic system, dial, and internal metallic bezel ring (if used and insulated from case) electrically connected to the negative terminal.

3.4.8 Mounting. Meters shall be designed for mounting as specified (see 3.1).

3.4.8.1 Mounting hardware. Machine screws, nuts, split-ring lock-washers, and mounting rings shall be supplied with each meter. The machine screws shall have a semi gloss black finish.

3.4.9 External accessories. External accessories shall be furnished only when specified (see 3.1 and 6.2).

3.4.9.1 Resistors. External resistors for direct current measurement and alternating current measurement shall enable the meter to meet the operational requirements of this specification (see 6.10).

3.4.9.2 Shunts. External shunts for ammeters shall enable the meters to meet the operational requirements of this specification. For applicable ranges, see 6.11. Shunts for ranges not covered therein shall be as specified (see 6.2).

3.5 Solderability. When solder lugs are tested as specified in 4.7.2, determination shall be made that 95 percent of the total length of the fillet which is between the standard-wrap wire and the solder lug is tangent to the surface of the lug and is free from pinholes, voids, etc. A ragged or interrupted line out of the point of tangency between the fillet and the solder lug shall also be considered a defect and included in the above requirement (see 6.12).

3.6 Position influence. When meters are tested as specified in 4.7.3, the pointer tip shall not deviate from the zero mark more than the specified percentage of the full-scale length (see 3.1).

3.7 Zero adjustment (meters with an external zero adjuster only). When determined as specified in 4.7.4, the range of adjustment above and below zero from a reference mark shall be not less than 3 degrees. There shall be no damage to the meter, when the zero adjuster is rotated 360 degrees.

3.8 Sticking below zero (when applicable). When meters are tested as specified in 4.7.5, the pointer of meters shall show no evidence of sticking below zero. (This requirement does not apply to offset-zero meters.)

3.9 Accuracy. When measured as specified in 4.7.6, the accuracy shall be as specified (see 3.1).

3.10 Overshoot. When measured as specified in 4.7.7, the overshoot shall be as specified (see 3.1).

3.11 Response time. When measured as specified in 4.7.8, the response time shall be as specified (see 3.1).

3.12 Repeatability. When meters are tested as specified in 4.7.9, the repeatability error shall not be greater than 4 percent.

3.13 Power consumption (loss). When measured as specified in 4.7.10, the power consumption (loss) shall be as specified (see 3.1).

3.13.1 Effective resistance (decibel meters only). When measured as specified in 4.7.10.1, the effective resistance of decibel meters shall be as specified (see 3.1).

3.14 Frequency range (when applicable). 3.14.1 Alternating current meters. When tested as specified in 4.7.11.1, alternating current meters having a nominal frequency shall operate over the ranges specified. At the extreme frequencies, the change in indication from the reading at the nominal frequency shall not exceed the value specified (see 3.1).

3.14.1.1 Iron-vane meters. Iron-vane meters shall have a nominal frequency of 60 Hz, 400 Hz, or 800 Hz.

3.14.1.2 Rectifier type meters. Rectifier type meters shall be within the specified tolerances at 50 Hz to 1,000 Hz (see 4.7.11.2).

3.14.2 Decibel meters. When tested as specified in 4.7.11.3, decibel meters shall operate over the range specified and at the extreme frequencies. The change in indication at the scale positions specified shall not depart from the scale position at 1,000 Hz by more than the value specified (see 3.1).

3.15 Electrostatic effect. When the meter window is tested as specified in 4.7.12, the pointer shall return to zero ± 1 percent of full-scale deflection within 30 seconds.

3.16 High-temperature operation and high-temperature cycling.

3.16.1 High-temperature operation. When tested as specified in 4.7.13, meters shall indicate freely (see 6.5.7) at + 65 degrees C.

3.16.2 High-temperature cycling. When meters are tested as specified in 4.7.13, the change in indication at + 65 degrees C and the permanent change in indication after exposure to + 65 degrees C shall not exceed the specified percentages or decibel (dB) values (see 3.1).

3.17 Temperature influence (when applicable) (see 6.5.18). When meters are tested as specified in 4.7.14, the maximum temperature influence shall not exceed the specified percentage (see 3.1).

3.18 Low-temperature operation and effects of storage at extreme temperatures.

3.18.1 Low-temperature operation. When tested as specified in 4.7.15, the meters shall indicate freely (see definition 6.5.7) at - 55 degrees C, + 0 degrees C, and - 3 degrees C.

3.18.2 Effects of storage at extreme temperatures. When meters are tested as specified in 4.7.15, the permanent change in indication shall not exceed the specified percentages or decibel (dB) values (see 3.1).

3.19 Overload capacity.

3.19.1 Momentary overload. When direct current and alternating current meters, intended for current measurement, are tested as specified in 4.7.16.1, there shall be no mechanical or thermal injury, and the permanent change in indication shall be as specified (see 3.1).

3.19.2 Sustained overload. When meters are tested as specified in 4.7.16.2, the temporary zero shift, the permanent zero shift, and the permanent change in indication shall be as specified (see 3.1), except that for decibel meters, only the permanent change in indication shall apply.

3.19.3 Short-time overload. When meters are tested as specified in 4.7.16.3, the permanent change in indication shall be as specified (see 3.1). The maximum allowable deviation following this test shall be 2 percent greater than the stated accuracy of the instrument (see 3.1).

3.20 Dielectric withstanding voltage. When meters are tested as specified in 4.7.17, there shall be no damage or flashover.

3.21 Insulation resistance. When measured as specified in 4.7.18, the insulation resistance shall not be less than 20 megohms.

3.22 Water tightness. When tested as specified in 4.7.19, meters shall indicate freely (see definition 6.5.7) at a temperature of 23 degrees C $\pm$ 1 degree C. The meter, when observed through the meter window, shall show no visible evidence of moisture. A series of bubbles emanating from the interior of the meter shall be considered failure to pass the test. Bubbles, which are the result of entrapped air on the various exterior parts of the case, shall not be considered a leak.

3.23 Thermal shock. When meters are tested as specified in 4.7.20, there shall be no warping, cracking, or discoloring to a degree detrimental to the performance or utility of the meter.

3.24 Moisture resistance. When meters are tested as specified in 4.7.21, there shall be no visible evidence of moisture within the case. The maximum allowable deviation following this test shall be 2 percent greater than the stated accuracy of the instrument and the repeatability error shall not exceed 5 percent.

3.25 Impact test for windows (not applicable to style 05, style 06, and style 07). When tested as specified in 4.7.22, meter windows shall withstand the impact without breaking, cracking, crazing, or chipping.

3.26 Thermal shock by immersion. After the test specified in 4.7.23, there shall be no visible evidence of loosening of the terminals.

3.27 Resistance to soldering heat (solder terminals). When tested as specified in 4.7.24, solder type terminals shall exhibit no change in electrical continuity, and there shall be no evidence of loosening of terminals.

3.28 Terminal strength (stud terminals). When tested as specified in 4.7.25, threaded stud terminals shall exhibit no change in electrical continuity, and there shall be no evidence of loosening of terminals, deformation of the stud, or damage to the threads.

3.29 Vibration. When tested as specified in 4.7.26, the meters shall retain serviceability and shall show no evidence of breakage, permanent deformation, or loosening of parts. After this test, the repeatability error shall not exceed 5 percent of full-scale length. The cumulative deviation from absolute accuracy, including zero-shift, shall be not greater than 5 percent. This permitted deviation is an overall deviation and is not in addition to the initial-accuracy tolerance.

3.30 Random drop. When tested as specified in 4.7.27, the meters shall show no evidence of breakage, permanent deformation, or loosening of parts, and shall retain their serviceability. After this test, the repeatability error shall not exceed 5 percent of full-scale length. The cumulative deviation from absolute accuracy, including zero shift, shall not be greater than 5 percent. The permitted deviation is an overall deviation and is not in addition to the initial-accuracy tolerance.

3.31 Shock (specified pulse). When tested as specified in 4.7.28, the meters shall show no evidence of breakage, permanent deformation, or loosening of parts, and shall retain their serviceability. After this test, the repeatability error shall not exceed 5 percent of full-scale length. The cumulative deviation from absolute accuracy, including zero-shift, shall not be greater than 5 percent. This permitted deviation is an overall deviation and is not in addition to the initial-accuracy tolerance.

3.32 Marking. Meters shall be marked in accordance with MIL-STD-1285, with the information specified in the contract, such as special dial markings and nonstandard ranges.

3.32.1 Cases. The words "Sealed - Do not open" shall be marked on the side or back or the meter case.

3.32.1.1 Terminal identification. On direct current meters, the symbol "+" shall be marked on the positive terminal or on the case as close to the positive terminal as practicable (see 3.4.7.1.1).

3.32.2 Dials. Dial markings shall be sharply defined and visible from the front of the case. However, these markings shall not be so conspicuous as to distract attention from the scale markings.

3.32.2.1 Dial markings. Unless otherwise specified (see 3.1), the following information, when applicable, shall appear on the meter dial:

a. Type designation (see 1.2.2). (Under no circumstances will any MR number be applied by the manufacturer to any meter, which is not in accordance with the specification and the specification sheets.)
b. Full-scale value.
c. Self-contained.
d. "DC" for direct current or "AC" for alternating current, etc.
e. Manufacturer's name or code symbol or both (in accordance with MIL-STD-1285, except date coding is not required).
f. Manufacturer's part number or catalog number, or both (optional front or back).
g. Designation of the electrical units measured (volts, amperes, etc.).
h. The electrical quantity necessary to produce end-scale deflection of the basic movement, when the end-scale value can only be attained with the use of external accessories.
i. External accessories as required. Example: Use with external shunt.
j. Ratio of the appropriate current transformer expressed as 1000:5 or 1000/5, or 200:1 or 200/1.
k. Ratio of the appropriate potential (voltage) transformer expressed as 3300:110 or 3300/110, or 30:1 or 30/1.

3.32.2.2 Form of letters and numerals. It is preferred that letters and numerals used in marking meter dials be in accordance with figure 1. However, any form which is clear, distinct, and readable within the intent of this specification is acceptable.

3.33 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.34 Workmanship. Meters shall be processed in such a manner as to be uniform in quality and the interiors of the meters shall be free from metal filings, grease or oil, foreign material, dust, or other loose particles that will affect life, serviceability, or appearance.

THE RATIO OF THE HEIGHT TO WIDTH OF LINE
SHALL BE NOT LESS THAN 6 TO 1

FIGURE 1. Preferred style of letters and numerals marking dial.

4. VERIFICATION

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

a. Materials inspection (see 4.3).
b. Qualification inspection (see 4.5).
c. Conformance inspection (see 4.6).

4.2 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 ISO-10012-1 and NCSL Z540-1 or equivalents as approved by the qualifying activity.

4.3 Materials inspection. Prior to any fabrication, materials inspection shall consist of certification supported by data, which verifies that the materials listed in table I and used in fabricating the meters enable the meters to meet the requirements of this specification.

TABLE I. Materials inspection.

Material	Requirement paragraph
Plastic	3.3.1
Fluorescent	3.3.2
Metals	3.3.3
Gaskets	3.3.4
Finishes	3.3.5
Phosphorescent	3.3.7
Machine screws and nuts	3.4.3.2
Window	3.4.4.2

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 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample size. The number of sample units comprising a sample of meters to be subjected to qualification inspection shall be as specified in the appendix to this specification.

4.5.2 Inspection routine.

4.5.2.1 Single-type submission. The sample units shall be subjected to the qualification inspection specified in table II, in the order shown within each group. Group I and group IV may be performed simultaneously and prior to group II and group III. Group II and group III may be performed in any order desired. However, tests within a group shall be performed in the order shown. Six sample units shall be subjected to the inspection of group I. These sample units shall then be divided so that three sample units shall be subjected to the inspections of group II and three sample units shall be subjected to the inspections of group III. Four sample units not previously inspected shall be subjected to the inspections of group IV.

4.5.2.2 Combined submission (see appendix 20.1.2). The additional sample units shall be subjected to the following qualification inspection only, in the order shown:

a. Visual and mechanical examination (external).
b. Position influence.
c. Zero adjustment (meters with an external zero adjusted only).
d. Sticking below zero (when applicable).
e. Accuracy.
f. Overshoot.
g. Response time.
h. Repeatability.
i. Power consumption (loss).
j. Frequency range (when applicable).
k. Dielectric withstanding voltage.
l. Insulation resistance.

4.5.3 Failures.

4.5.3.1 Single-type submission. The number of failures permitted for a single-type submission shall be as specified in table II. Failures in excess of the number permitted shall be cause for refusal to grant qualification.

4.5.3.2 Combined submission. No failures are permitted for the additional sample units in a combined submission.

4.5.4 Retention of qualification. To retain qualification, the supplier shall forward a summary of conformance inspections every 12 months (group A and group B) and qualification verification inspections every 36 months (group C and group D) to the qualifying activity. The qualifying activity shall establish the initial reporting dates. Continuation shall be based on the following requirements:

a. The manufacturer has not modified the design of the item.
b. The specification requirements for the item have not been amended, as to affect the character of the item.
c. Lot rejection for group A and group C does not exceed their sampling plans.
d. The requirements of group B and group D inspections are met.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Groups A and B inspections of product, for delivery, shall be performed.

4.6.1.1 Inspection lot. An inspection lot shall consist of meters of the same style, type of construction, kind of current, electrical unit, and range. Meters in the same inspection lot shall be produced under essentially the same conditions and offered for inspection at one time.

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

4.6.1.2.1 Sampling plan. A sample of parts shall be randomly selected in table IV. If one or more defects are found, the manufacturer shall notify the procuring activity and the responsible government inspector of such failure and take corrective action on the materials or processes, or both, as warranted and the entire lot shall be rescreened and defects removed.

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 re-inspection, using the same sampling plan as for the original inspection. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.3 Group B inspection. Group B inspection shall consist of the test specified in table III, in the order shown. Group B inspection shall be made on sample units, which have passed group A inspection.

TABLE II. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of failures permitted (see 4.5.3)	
			Discrete	Total 1/
Group I (six sample units) 2/				2
Visual and mechanical examination (external)	(See table IX)	4.7.1.1	0	
Solderability 3/	3.5	4.7.2	0	
Position influence	3.6	4.7.3	0	
Zero adjustment (meters with an external zero adjuster only)	3.7	4.7.4	0	
Sticking below zero (when applicable)	3.8	4.7.5	1	
Accuracy	3.9	4.7.6	0	
Overshoot	3.10	4.7.7	0	
Response time	3.11	4.7.8	0	
Repeatability	3.12	4.7.9	1	
Power consumption (loss)	3.13	4.7.10	0	
Frequency range (when applicable)	3.14	4.7.11	1	
Electrostatic effect	3.15	4.7.12	1	
High-temperature operation and high temperature cycling	3.16	4.7.13	1	
Temperature influence (when applicable)	3.17	4.7.14	1	
Low-temperature operation and effects of storage at extreme temperatures	3.18	4.7.15	1	
Overload capacity	3.19	4.7.16	0	
Dielectric withstanding voltage	3.20	4.7.17	0	
Insulation resistance	3.21	4.7.18	0	
Water tightness	3.22	4.7.19.1	0	
Group II (three sample units)			Discrete	
Thermal shock	3.23	4.7.20	0	
Moisture resistance	3.24	4.7.21	0	
Dielectric withstanding voltage	3.20	4.7.17	0	
Insulation resistance	3.21	4.7.18	0	
Water tightness	3.22	4.7.19	0	
Impact test for windows (not applicable to style 05, style 06, and style 07)	3.25	4.7.22	0	
Visual and mechanical examination (external and internal)	(See table IX)	4.7.1	0	
Group III (three sample units)			0	
Thermal shock by immersion	3.26	4.7.23	0	
Resistance to soldering heat (solder terminals)	3.27	4.7.24	0	
Terminal strength (stud terminals)	3.28	4.7.25	0	
Water tightness	3.22	4.7.19.1	0	
Visual and mechanical examination (external and internal)	(See table IX)	4.7.1	0	
Group IV (four sample units)				
Vibration	3.29	4.7.26	0	
Random drop	3.30	4.7.27	0	
Shock (specified pulse)	3.31	4.7.28	0	
Visual and mechanical examination (internal)	(See table IX)	4.7.1.2	0	

1/ Maximum total number of permitted failures during group I testing. The disposition of a failed sample and continuation of testing shall be determined by the qualifying activity.
2/ Nondestructive tests.
3/ Six separate solder lugs only.

TABLE III. Group A and group B conformance inspections.

Examination or test	Requirement paragraph	Method paragraph
Group A inspections		
Visual and mechanical examination (external)	(See table IX)	4.7.1.1
Position influence	3.6	4.7.3
Sticking below zero (when applicable)	3.8	4.7.5
Accuracy	3.9	4.7.6
Group B inspections		
Zero adjustment (meters with an external zero adjuster only)	3.7	4.7.4
Overshoot	3.10	4.7.7
Response time	3.11	4.7.8
Repeatability	3.12	4.7.9
Power consumption (loss)	3.13	4.7.10
Dielectric withstanding voltage	3.20	4.7.17
Insulation resistance	3.21	4.7.18
Water tightness	3.22	4.7.19.2
Solderability 1/	3.5	4.7.2

1/ Six separate solder lugs only.

TABLE IV. Group A and group B sampling plans.

Lot Size	Sample size	
	Group A	Group B
2 to 8	Entire lot	2
9 to 15	9	3
16 to 25	13	3
26 to 50	13	5
51 to 90	13	6
91 to 150	13	7
151 to 280	20	10
281 to 500	29	11
501 to 1,200	34	15
1,201 to 3,200	42	18
3,201 to 10,000	50	22
10,001 to 35,000	60	29
35,001 to 150,000	74	29
150,001 to 500,000	90	29
500,001 and over	102	29

4.6.1.3.1 Sampling plan. A sample of parts shall be randomly selected in table IV. If one or more defects are found, the manufacturer shall notify the procuring activity and the responsible government inspector of such failure and take corrective action on the materials or processes, or both, as warranted and the entire lot shall be rescreened and defects removed.

4.6.1.3.2 Disposition of sample units. Sample units, which have passed group B inspection, may be delivered on the contract or purchase order.

4.6.1.3.3 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 re-inspection, using the same sampling plan as for the original inspection. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.4 Qualification verification inspection. Qualification verification inspection shall consist of group C and group D. Except where the results of these inspections show non-compliance with the applicable requirements (see 4.6.1.4.5), delivery of products, which have passed group A and group B, shall not be delayed pending the results of these qualification verification inspections.

4.6.1.4.1 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table V, in the order shown and shall be performed every 36 months. Group C inspection shall be made on sample units selected from inspection lots, which have passed the group A and group B inspection.

4.6.1.4.1.1 Sampling plan. The sampling plan shall be in accordance with table IV and table VI. At the time of this inspection, the total number of meters of each case size shall be selected from meters produced during the preceding 6-month period, under the general requirements of this specification, and shall be as indicated on table V.

TABLE V. Group C inspection.

Examination or test	Requirement paragraph	Method paragraph
Subgroup 1 (one-half of sample)		
Thermal shock by immersion	3.26	4.7.23
Water tightness	3.22	4.7.19.1
Visual and mechanical examination (internal)	(See table IX)	4.7.1.2
Subgroup 2 (one-half of sample)		
Vibration	3.29	4.7.26
Random drop	3.30	4.7.27
Shock (specified pulse)	3.31	4.7.28
Visual and mechanical examination (internal)	(See table IX)	4.7.1.2

TABLE VI. Sampling for group C inspection.

Total government production of each case size for a 6-month period	Sample (all size meters)
300 or less	6
301 to 3,000 inclusive	12
3,001 to 10,000 inclusive	18
10,001 and over	24

4.6.1.4.2 Group D inspection. Group D inspection shall consist of the examinations and tests specified in table VII, in the order shown for each subgroup and shall be performed every 3 years. Group D inspection shall be made on sample units selected from lots, which have passed group C inspection.

4.6.1.4.2.1 Sampling plan. Six meters of each case size shall be selected, except if the movements are the same for one or more sizes, then six meters from that combined group shall be selected.

Example:
1-inch ----------6 meters
1.5-inch----------6 meters
2.5-inch, 3.5-inch, 4.5-inch, ----------6 meters (combined)

The meters to be tested shall be selected by the Government from groups “A” through “I” of table VIII. The groups have been arranged so that any meter, which appears in a group, is representative of all meters appearing in the group below it. In the range column, the range appearing first is representative of all ranges following.

Example: A 100 microampere dc meter represents all higher microampere dc ranges. However, a 10 ampere dc meter represents all lower dc ampere ranges.

Judicious choice of meters for test should be made to affect the greatest possible coverage.

4.6.1.4.3 Failures. If one or more sample units fail group C or group D inspection, the sample for the particular group shall be considered to have failed.

4.6.1.4.4 Disposition of sample units. Sample units, which have been subjected to group C or group D inspection, shall not be delivered on the contract or purchase order.

TABLE VII. Group D inspection.

Examination or test	Requirement paragraph	Method paragraph
Subgroup 1 (3 sample units)		
Frequency range (when applicable)	3.14	4.7.11
Electrostatic effect	3.15	4.7.12
High-temperature operation and high-temperature cycling	3.16	4.7.13
Temperature influence (when applicable)	3.17	4.7.14
Low-temperature operation and effects of storage at extreme temperatures	3.18	4.7.15
Overload capacity	3.19	4.7.16
Dielectric withstanding voltage	3.20	4.7.17
Subgroup 2 (3 sample units)		
Thermal shock	3.23	4.7.20
Resistance to soldering hear (solder terminals)	3.27	4.7.24
Terminal strength (stud terminals)	3.28	4.7.25
Moisture resistance	3.24	4.7.21
Dielectric withstanding voltage	3.20	4.7.17
Insulation resistance	3.21	4.7.18
Water tightness	3.22	4.7.19.1
Impact test for windows (not applicable to style 05, style 06, and style 07)	3.25	4.7.22
Visual and mechanical examination (external and internal)	(See table IX)	4.7.1

TABLE VIII. Representative meters for group D inspection.

Group	Kind of current and electrical units	Range
A	DCUA	20 to 80 μA
B	DCUA	100 to 800 μA
	DCMA	1 to 8 mA
	DCVV	500 to 800 volts (1 mA)
	DCKV	1 to 30 kV (1 mA)
C	DCVV	1.5 to 300 V
D	DCAA	1 to 10 amperes
	DCMA	10 to 800 mA
E	DCAA	15 to 800 amperes (50 mV)
F	ACVV	1.5 to 800 V
G	ACMA	10 to 800 mA (60 to 800 Hz)
	ACAA	1 to 30 amperes
H	DB	-10 to +6 dB
I	ARVV	1.5 to 800 V
	ARKV	1 to 30 kV

4.6.1.4.5 Noncompliance. If a sample fails group C or group D inspection, the supplier shall take corrective action on the materials or processes, or both, as warranted, This applies to all units of product, which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C or group D inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the Government) , using the same sampling plan as for the original inspection. Group A and group B inspection may be reinstituted; however, final acceptance shall be withheld until the group C or group D reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the responsible inspection activity and the qualifying activity.

4.7 Method of examination and test. Unless otherwise specified herein, inspection (including all inspection requiring scale readings) shall be performed with the meter mounted on a vertical panel and in the position in which it is normally used. A minimum of six meter readings shall be taken at approximately equidistant-marked points on the scale, including the zero and full-scale readings. In addition, the following shall apply:

a. Tapping. When taking meter readings, the meter or its support shall be tapped lightly, as with the erasure end of the pencil.
b. Parallax. Care should be exercised to avoid the effect of parallax when taking meter readings.
c. Thermal stability. Unless otherwise specified herein, meters shall be maintained at the specified inspection temperature for a period of not less than 2 hours to attain thermal stability prior to reading the meters.
d. Zero adjustment. When an external zero adjuster is provided, the meter shall be set on zero before each set of readings, except when determining the zero-shift (see 3.19.2, 4.7.26, 4.7.27, and 4.7.28). Readings shall not be corrected for zero errors on meters without zero adjusters.
e. Reference standards. Reference standards shall be used to check the indications of meters submitted for inspection. Accuracies and tolerances specified are absolute. Readings of the reference standards shall be corrected before determining compliance.
f. Method of calibration. In cases of dispute, but not limited thereto, the pointer of the meter under inspection shall be set to the center of the scale marking at which the calibration is being made and the value measured by the reference standard.

4.7.1 Visual and mechanical examination.

4.7.1.1 External. Meters shall be examined without opening the case to verify that the applicable requirements are met (see table IX and 3.1).

4.7.1.2 Internal. Meters shall be disassembled to the extent necessary to verify that the applicable requirements are met (see table IX and 3.1).

4.7.2 Solderability (see 3.5). Solder lugs shall be tested in accordance with ANSI J-STD-002. Coating durability category 3 and test method C apply.

4.7.3 Position influence (see 3.6). The meter shall be mounted in the normal vertical position and the position of the pointer noted. On meters provided with an external zero adjuster, the pointer shall be set at the center of the zero mark. The meter shall then be rotated 60 degrees from this position in both clockwise and counterclockwise directions. The maximum deviation of the pointer shall be noted and expressed as a percentage of the full-scale length.

4.7.4 Zero adjustment (meters with an external zero adjuster only) (see 3.7). The adjustment test shall be performed as follows:

Step 1 - Rotate the zero adjuster to move the pointer up scale. Note the maximum deflection of the pointer.
Step 2 - Repeat step 1 for deflection down scale. If the pointer stop inhibits the motion of the pointer while the zero adjuster is being operated, it is permissible to energize the instrument sufficiently to prevent the pointer from touching the pointer stop during the test.

Record shall be made as to whether or not the zero adjuster can be rotated 360 degrees without damage to the meter.

4.7.5 Sticking below zero (when applicable) (see 3.8). The meter shall be energized to approximately one-third full-scale deflection and then suddenly de-energized. The meter shall be energized to two-thirds of full-scale deflection, and then suddenly de-energized. When the pointer moves below the zero mark, any evidence of the pointer sticking below zero shall be noted.

4.7.6 Accuracy (see 3.9). Meters mounted on a nonferrous panel (or ferrous panel for style 07) shall be checked for accuracy at a temperature of 23 degrees C ± 1 degree C. At least six tapped readings, including zero and end-scale value, shall be taken over the range of the meter and compared with readings of the reference standard. For group I tests of qualification and group A inspection tests, one of the meters (except style 05) shall then be mounted on a ferrous panel 0.09-inch thick and the accuracy readings repeated.

4.7.7 Overshoot (see 3.10). Electric power sufficient to produce momentary end-scale deflection shall be applied to the meter. (Decibel meters shall be deflected to the 0-dB scale position.) The maximum momentary deflection shall be observed and recorded in angular degrees. After the pointer has come to rest, the steady deflection shall be observed and recorded in angular degrees. When making this test on meters in which the overshoot can be significantly changed by the shunting effect of the power circuit, the circuit resistance shall be not less than 100,000 ohms and such that no additional damping is added to the system. The overshoot shall be taken as the ratio of:

1) the difference between the maximum momentary and steady deflections; and
2) the steady deflection

Both measured in angular degrees. The overshoot shall be expressed as a percentage.

Example: If the maximum momentary deflection is 90 degrees and the steady deflection is 75 degrees, the difference between the two is 15 degrees. The overshoot is
(15÷75) x 100 = 20 percent.

4.7.8 Response time (see 3.11). Steady electric power sufficient to produce momentary end-scale deflection shall be applied to the meter. (Decibel meters shall be deflected to 0-dB scale position.) The length of time, in seconds, required for the pointer to come to apparent rest shall be recorded. The pointer shall be considered as having come to apparent rest when it has attained the actual point of rest within 1 percent of full-scale value. The test shall be repeated five times, and the average length of time recorded for all measurements shall be considered the response time of the meter. When making this test on meters in which the response can be significantly changed by the shunting effect of the power circuit, the circuit resistance shall be not less than 100,000 ohms and such that no additional damping is added to the system.

TABLE IX. Visual and mechanical examination.

Requirement	External Requirement paragraph	Internal Requirement paragraph
Material	3.3, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5	3.3 to 3.3.5 inclusive
Interface and physical dimensions	3.4	3.4
Balancing of moving element	---	3.4.1
Magnets	---	3.4.2
Threaded parts	3.4.3	---
Machine screws and nuts	---	3.4.3.2
Locking of screw-thread assemblies	---	3.4.3.3
Cases	3.4.4, 3.4.4.1, 3.4.4.2, and 3.4.4.3	---
Vibration and shock isolators	---	3.4.4.1
Window	3.4.4.2	---
Scale visibility	3.4.4.2.1	---
Sealing	3.4.4.3	---
Dial	---	3.4.5.1
Scale length	3.4.5.2.1	3.4.5.2.1
Scale divisions	3.4.5.2.2	---
Pointer	3.4.5.3	3.4.5.3
Pointer clearance (parallax)	---	3.4.5.3.1
Color scheme	3.4.5.4	---
Bezel	---	3.4.5.5
Accuracy adjustment	---	3.4.6.1
Zero adjuster	3.4.6.2	---
Terminals	3.4.7.1	---
Polarity	3.4.7.1.1	---
Bonding, electrical	---	3.4.7.2
Mounting	3.4.8	---
Mounting hardware	3.4.8.1	---
Marking:		
Cases	3.32.1	---
Terminal identification	3.32.1.1	---
Dials	3.32.2	3.32.2
Form of letters and numerals	3.32.2.2	---
Workmanship	3.34	3.34

4.7.9 Repeatability (see 3.12 and 6.5.20). The repeatability test shall be performed as follows:

a. With tapping and with the instruments unenergized, set the pointer to zero with the instrument mounted in its normal mounting position. (Tapping shall be equivalent to that, which can be produced by the erasure end of a pencil.)
b. Increase the excitation from zero until the pointer indicates 50 percent of rated end-scale value, without tapping, and at a sufficiently slow rate so that there is no pointer overshoot.
c. Record value of excitation.
d. Increase value of excitation until the pointer indicates 100 percent of rated end-scale value, without tapping, and at a sufficiently slow rate so that there is no pointer overshoot.
e. Record value of excitation.
f. Increase value of excitation until the pointer indicates 105 percent of rated end-scale value, without tapping, and at a sufficiently slow rate so that there is no pointer overshoot.
g. Decrease value of excitation until the pointer indicates 100 percent of rated end-scale value, without tapping, and at a sufficiently slow rate so that there is no pointer overshoot.
h. Record the value of the excitation.
i. Decrease value of excitation until the pointer indicates 50 percent of rated end-scale value, without tapping, and at a sufficiently slow rate so that there is no pointer overshoot.
j. Record the value of the excitation.
k. Steps (b) through (j) are to be performed within a 3-minute period.

$$\text{Repeatability, percent} = \frac{E_1 - E_2}{Efs} \text{ X } 100$$

where:

E_1 = excitation required to accomplish upscale deflection to a division line
E_2 = excitation required to accomplish downscale deflection to the same division line
Efs = rated full-scale value

4.7.10 Power consumption (loss) (see 3.13). The power consumption (loss) shall be measured at end-scale deflection of the meter and recorded in terms of current, voltage, volt amperes, or ohms, as applicable.

4.7.10.1 Effective resistance (decibel meters only) (see 3.13.1). The effective resistance of decibel meters shall be measured as follows: The meters shall be deflected, by application of a sine wave alternating current voltage, to 0-dB scale position. This voltage shall be noted. A non-inductive variable resistance, such as a decade resistor, shall then be connected in series with the meter. A voltage, double that previously noted, shall then be applied. The decade resistance shall then be adjusted until the pointer again deflects to the reference scale mark. The resistance indicated by the decade resistor shall be considered the resistance of the meter between its terminals.

4.7.11 Frequency range (when applicable) (see 3.14).

4.7.11.1 Iron-vane (see 3.14.1.1). Alternating current meters having a nominal frequency of 60 Hz, 400 Hz, or 800 Hz shall be tested for satisfactory operation at the extreme operating frequencies specified (see 3.1). Meter readings shall be taken at the nominal frequency and at the extreme operating frequencies.

4.7.11.2 Rectifier type meters (see 3.14.1.2). Alternating current meters, rectifier type, shall be tested at 50/60 Hz, 500 Hz, and 1,000 Hz.

4.7.11.3 Decibel meters (see 3.14.2). Meter readings shall be taken at the scale positions and frequencies specified (see 3.1).

4.7.12 Electrostatic effect (see 3.15). Using a suitable pad of clean white-folded gauze or cheesecloth saturated with distilled water, clean the outside surface of the meter window. Remove all the excess moisture with a clean dry pad. Condition the meter by placing it in an atmosphere of 35 degrees C with less than 40 percent humidity for 1 hour. Within 1 minute after removing the meter from the chamber, briskly rub the meter window for 10 seconds (approximately 30 strokes), using a clean dry pad folded from an 18-inch square piece of nylon cloth.

4.7.13 High-temperature operation and high-temperature cycling (see 3.16). Meters shall be maintained at 23° C ± 1° C for sufficient time to attain thermal stability, and shall then be subjected to the procedure specified in table X. The change in indication at + 65° C (the maximum difference between corresponding readings of step 7 and step 9 in table X) shall be determined and expressed as a percentage of full-scale value. The permanent change in indication after the completed high-temperature cycling procedure (the maximum difference between corresponding readings of step 1 and step 9 in table X) shall be determined and expressed as a percentage of full-scale value (see 3.16.2).

4.7.14 Temperature influence (when applicable) (see 3.17). Accuracy readings shall be taken with the meter at a reference temperature at 23° C ± 1° C (see 4.7.6). The meter shall then be subjected to a temperature 20° C above the reference temperature (+ 43° C ± 1° C) for not less than 2 hours, until thermal stability is attained, and the accuracy readings repeated. The meter shall then be returned to the reference temperature of + 23° C ± 1° C for not less than 2 hours, until thermal stability is attained, and the accuracy readings repeated. The meter shall then be subjected to a temperature 20° C below the reference temperature (+ 23° C ± 1° C) for not less than 2 hours, until thermal stability is attained, and the accuracy readings repeated. One-half (see 6.5.18 for definition of temperature influence) of the maximum difference between each of the high temperature readings and the corresponding reference temperature readings shall be expressed as a percentage of full-scale value. A similar computation shall be made for the accuracy readings at the low temperature. If the maximum influences above and below the reference temperature are not equal, the greater percentage shall be considered the temperature influence.

TABLE X. Procedure for high-temperature cycling.

Cycle number	Step number	Procedure	Period (hours)
1	1/ 1	Take accuracy readings at 23°C ± 1°C.	
	2	Place meters in a chamber at 65° ± 2°C, and maintain temperature.	16
	3	Allow meter to cool at 23°C ± 1°C.	8
2	4	Repeat step 2.	16
	5	Repeat step 3.	8
3	6	Repeat step 2.	16
	1/ 7	Take accuracy readings at 65°C ± 2°C.	
	8	Repeat step 3.	8
	1/ 9	Take accuracy readings at 65°C ± 2°C.	

1/ See 4.7.6.

4.7.15 Low-temperature operation and effects of storage at extreme temperatures (see 3.18). Meters shall be maintained at 23° C ± 1° C, for a sufficient time to attain thermal stability, and shall then be subjected to the procedure specified in table XI. Following step 2, it shall be determined whether or not the meters indicate freely (see 3.18.1). The permanent change in indication after the completed extreme-temperature-cycling-procedure (the maximum difference between corresponding readings of step 1 and step 6 in table XI) shall be determined and expressed as a percentage of full-scale value.

TABLE XI. Procedure for effects of storage at extreme temperatures.

Step number	Procedure	Period (hours)
1/ 1	Take accuracy readings at 23°C ± 1°C.	
2	Place meters in a chamber at -55° +0° -3°C and maintain temperature.	6
3	Allow meters to stabilize at 23°C ± 1°C.	1 (minimum)
4	Place meters in a chamber at 85° +3° -0°C and maintain temperature.	6
5	Allow meters to stabilize at 23°C ± 1°C to maintain thermal stability.	
1/ 6	Take accuracy readings at 23°C ± 1°C.	---

1/ See 4.7.6.

4.7.16 Overload capacity (see 3.19).

4.7.16.1 Momentary overload (see 3.19.1). Direct current meters and alternating current meters intended for current measurement shall be subjected to 10 applications of a current equal to 10 times the end-scale value of the meter. The current shall be applied 9 times for 0.5 (½) second each time, with 1-minute intervals between successive applications, followed by an interval of 1 minute, after which the current shall be applied for 5 seconds. This procedure comprises a total of 10 applications, over an elapsed time of 9 minutes and 9.5 seconds. After 1 hour at 23° C ± 1° C following the above procedure, the permanent change in indication shall be determined. No repairs or adjustments, other than resetting the pointer to zero using the external zero adjuster if provided, are allowed. Internal shunts shall not be disconnected for this test.

4.7.16.2 Sustained overload (see 3.19.2). Meters shall be subjected for 8 hours to an application of energy 20 percent greater than end-scale value at a temperature of 23° C ± 1° C. Immediately after the load is withdrawn at the end of the 8-hour period, the temporary zero shift shall be determined. 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.

4.7.16.3 Short-time overload (see 3.19.3). Radio frequency meters shall be subjected to a current 50 percent greater than full-scale value for 2 minutes. The change in indication shall be determined 20 minutes after removal of the load.

4.7.17 Dielectric withstanding voltage (see 3.20). Meters shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

a. Magnitude of test voltage - As specified (see 3.1).
b. Nature of potential - AC.
c. Points of application of test voltage - The test voltage shall be applied between the “terminals-of-the-meter” (connected together) and the following:
   1. The exposed parts of the front of the meter.
   2. The face of the meter, including the external zero adjuster, if provided.
   3. Case.
d. Method of connection of test voltage to specimen - When applying voltage to a nonmetallic zero adjuster, a high-potential test electrode of suitable shape and size to provide a normal fit shall be inserted into the slot of the zero adjuster. When applying voltage to the face of the meter, a 0.25 (¼)-inch diameter test probe having a 0.33 (⅓)-inch radius tip shall be used.
e. Examinations after test - The meter shall be examined for evidence of damage or flashover.

4.7.18 Insulation resistance (see 3.21). Meters shall be tested in accordance with method 302 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition - B.
b. Mounting means - Meters shall be mounted on a metallic panel.
c. Points of measurements - The test voltage shall be applied between the “terminals-of-the-meter” (connected together) and the following:
   1. The exposed parts of the front of the meter.
   2. The face of the meter, including the external zero adjuster, if provided.
   3. Case.

4.7.19 Water tightness (see 3.22).

4.7.19.1 Qualification and group C and group D inspections. Meters shall be submerged to a depth not exceeding 1 foot in tap water in an enclosure. The pressure within the enclosure shall be reduced to an absolute pressure equal to 2.5 inches of mercury, maintained for 4 hours, and then returned to normal. Bubbles which are the result of entrapped air on the various exterior parts of the case shall not be considered a leak. After 4 hours at normal pressure, the meters shall be removed, dried, and examined.

4.7.19.2 Group B inspection. Meters shall be submerged to a depth not exceeding 1 foot in tap water in an enclosure. The pressure within the enclosure shall be reduced to an absolute pressure equal to 2.5 inches of mercury and maintained for 1 minute or until air bubbles cease to be given off by the water, whichever is longer. The immersed meters shall be observed for evidence of leakage as indicated by bubbles emanating from the interior of the meter. Bubbles which are the result of entrapped air on the various exterior parts of the case shall not be considered a leak.

4.7.20 Thermal shock (see 3.23). Meters shall be tested in accordance with method 107, MIL-STD-202, test condition A [except exposure time at extreme temperature shall be 0.5 (½) hour]. No measurements shall be made before or after cycling. Upon completion of this test, the meters shall be examined for evidence of warping, cracking, or discoloring to a degree detrimental to the performance or utility of the meter.

4.7.21 Moisture resistance (see 3.24). Meters shall be tested in accordance with method 106 of MIL-STD-202. The following details and exception shall apply:

a. Mounting - Meters shall be mounted on a vertical panel, using the mounting hardware supplied with the meters.
b. Initial measurement - Meter readings (see 4.7).
c. Loading voltage - Sufficient voltage, but not more than 120 volts, shall be applied to meters to maintain approximately one-half end-scale deflection.
d. Final measurements:
   1. Conditioning at 90 percent to 98 percent relative humidity - Not applicable.
   2. Meter readings shall be taken and the change in indication determined, and the repeatability shall be measured in accordance with 4.7.9.
   3. Meters shall be observed through the meter window to determine if moisture has penetrated. (The meter may be tilted for this purpose.)
   4. Meters shall be examined for evidence of corrosion between 24 hours and 26 hours after completion of test.

4.7.22 Impact test for windows (not applicable to style 05, style 06, and style 07) (see 3.25). Meters shall be solidly mounted, face up, on a heavy base. Meters shall then be subjected to the impact test of dropping a 4-ounce steel cylinder, with a spherical nose of 1-inch radius, from a height of 8 inches onto the center of the visible window opening. Meters shall then be examined for evidence of cracking, chipping, or crazing.

4.7.23 Thermal shock by immersion (see 3.26). Meters shall be subjected alternately to 10 cycles of immersion in tap water at:
a. + 85° C to + 88° C
b. 0° C to + 2° C.

The length of time for each immersion shall be 20 minutes. Not more than 5 seconds shall elapse between immersions.

4.7.24 Resistance to soldering heat (solder terminals) (see 3.27). Meters shall be tested in accordance with method 210, MIL-STD-202, test condition B. Depth of immersion shall be such that the hole intended to receive the wire shall be completely immersed.

4.7.25 Terminal strength (stud terminals) (see 3.28). Meters shall be tested in accordance with method 211, MIL-STD-202, test condition E.

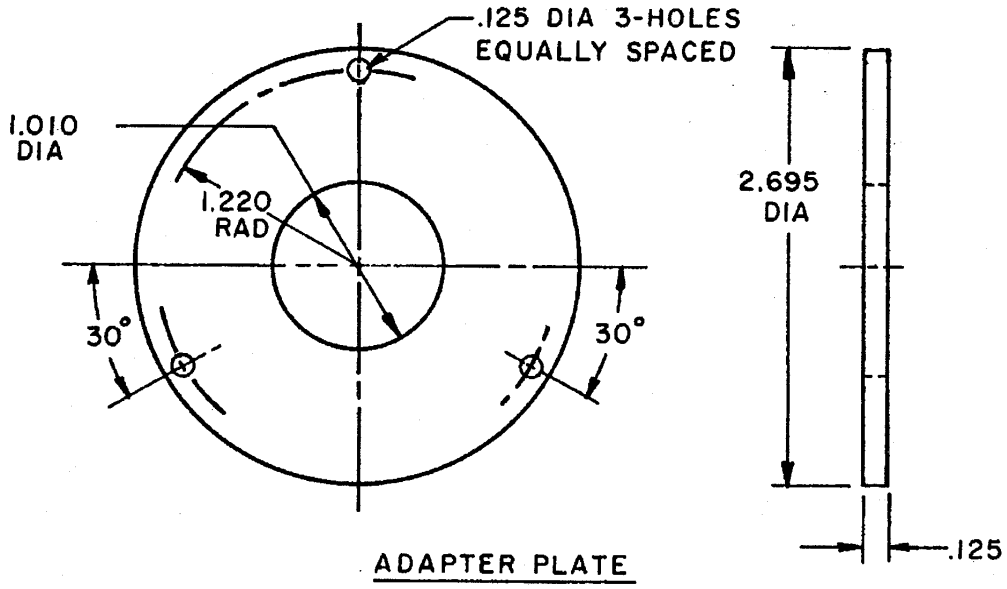
4.7.26 Vibration (see 3.29). Meters shall be tested in accordance with method 201, MIL-STD-202. The following details shall apply:

a. Test and measurements prior to vibration - External visual and mechanical examination (see 4.7.1.1), accuracy (see 4.7 and 4.7.6), repeatability tests (see 4.7.9), shall be performed before the vibration test. For meters equipped with external zero adjusters, the meter shall be set on zero before meter readings are taken.
b. Method of mounting - Meters shall be mounted vertically and in a position in which they are normally used, and shall be securely fastened to a suitable mounting plate, using the mounting hardware supplied with the meters.
c. Direction of motion - The test shall be conducted in the following sequence:
   1. Horizontal table motion, and vibrate side to side.
   2. Horizontal table motion, and vibrate front to back.
   3. Vertical table motion, and vibrate up and down.
d. Electrical-load conditions - Voltage sufficient to produce approximately three-fourths (0.75) end-scale deflection shall be applied intermittently (5 minutes "on", and 5 minutes "off").
e. Tests and measurements during and after vibration - After the vibration test; the meters shall be examined for evidence of breakage, permanent deformation, loosening of parts, and serviceability. The accuracy (see 4.7 and 4.7.6) and repeatability tests (see 4.7.9) shall be performed. For meters furnished with external zero adjusters, no corrections for zero shift are permitted after this test, or prior to next test. Record shall be made of the cumulative deviation from absolute accuracy.

4.7.27 Random drop (see 3.30). Meters shall be tested in accordance with method 203, MIL-STD-202 or equivalent. After the random drop test, the meters shall be examined for evidence of breakage, permanent deformation, loosening of parts, and serviceability. The accuracy (see 4.7 and 4.7.6) and repeatability test (see 4.7.9) shall be performed. For meters furnished with external zero adjusters, no corrections for zero shift are permitted after the preceding vibration test, prior to or after this test, or prior to the next test. Record shall be made of the cumulative deviation from absolute accuracy.

4.7.28 Shock (specified pulse) (see 3.31). All meters shall be tested in accordance with method 213, MIL-STD-202. The following details and exceptions shall apply:

a. Mounting fixtures - The meters shall be suitably mounted using the mounting hardware supplied with the meters. One-inch meters shall be mounted on the adapter plate shown on figure 2, using the mounting ring supplied with each meter. The adapter plate with the meter attached shall be mounted on the carriage of the shock-testing mechanism, in the two positions shown on figure 2.
b. Test condition - I.
c. Electrical-load conditions - Two meters shall be energized at 0.75 (¾) full-scale deflection and the remainder shall be unenergized during this test.
d. Measurements during and after test - After each shock, the panel and meter-mounting hardware shall be examined and tightened where necessary. After the shock test, the accuracy (see 4.7 and 4.7.6) and repeatability test (see 4.7.9) shall be performed. For meters furnished with external zero adjusters, no correction for zero shift are permitted after the preceding random drop test, prior to or after shock test. Record shall be made of the cumulative deviation from absolute accuracy.



ADAPTER PLATE

Inches	mm
.005	.13
.125	3.18
1.010	25.65
1.220	30.99
2.695	68.45

NOTES:
1. All dimensions in inches.
2. Unless otherwise specified, tolerances are ±.005 on decimals and ±0.5 (½) degree on angles.
3. Metric equivalents are given for information only and are based upon 1 inch = 25.4 mm.

FIGURE 2. Meter-mounting accessories for shock test (1-inch meters only).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The meters specified herein are for military unique applications requiring ruggedized design and allow proper performance under extreme military operating conditions, which include vibration, thermal shock (- 65° C to + 85° C), mechanical shock (100 G's), and high humidity and temperature. In addition, these military requirements are verified under a qualification system. Commercial components are not designed to withstand these military environments.

6.1.1 Voltmeters. Two designs of alternating current voltmeters are covered under this specification (see 3.1). Voltmeters, both of the moving iron-vane types and the rectifier types, are included. They are not electrically interchangeable, as noted below:

a. Moving iron-vane types:
   1. Are sufficiently accurate for various wave forms (for crest factor to 2.3, see 6.5.3).
   2. Are limited to applications and frequencies, for which they are designed.
   3. Power consumption is significantly greater than rectifier types.

b. Rectifier types:
   1. Are inherently inaccurate for non-sinusoidal waves.
   2. Frequencies effective between 50 Hz and 1,000 Hz.
   3. Power consumption is considerably less than moving iron-vane types.

6.2 Acquisition requirements.

6.2.1 For meter types covered by performance specification sheets. Procurement documents should specify the following:

a. Title, number, and date of the specification.
b. Title, number, and date of the applicable specification sheet and the complete type designation (see 3.1).
c. External accessories (such as mounting gaskets, resistors, etc.), if required (see 3.1 plus 3.4.9, 3.4.9.1 and 3.4.9.2, inclusive).
d. Type of shunts for ranges not covered in A-A-55524, if required (see 3.4.9.2).
e. Special scale markings for color scheme "A" meters (see 1.2.2.2).
f. Multicolored markings for color scheme "M" meters (see 1.2.2.2).
g. Packaging requirements (see 5.1)

6.2.2 For meter types not covered by performance specification sheets. Procurement documents should specify the following:

a. Title, number, and date of the specification.
b. Size of meter, shape of flange, degree of enclosure, and type of panel for which calibrated.
c. Scale and pointer details.
d. Full-scale value.
e. Kind of current.
f. Electrical (or other) units indicated by the meter.
g. Scale length.
h. Sensitivity.
i. Power consumption.
j. Accuracy.
k. Overshoot.
l. Response time.
m. Effective resistance (rectifier meters only).
n. Frequency range (when applicable).
o. High-temperature operation and high-temperature cycling.
p. Temperature influence (when applicable).
q. Low-temperature operation and effects of storage at extreme temperatures.
r. Overload capacity.
s. Dielectric withstanding voltage.
t. Repeatability.
u. Type of seal.
v. External accessories, such as mounting gaskets, resistors, etc., if required (see 3.1) and 3.4.9, 3.4.9.1, and 3.4.9.2, inclusive.
w. Type of shunts for ranges not covered in A-A-55524, if required (see 3.4.9.2).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-10304, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements. And manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or purchase orders for products covered by this specification. Information pertaining to qualification of products may be obtained from the Defense Supply Center Columbus (DSCC-VQ), Post Office Box 3990, Columbus, OH 43218-3990.

6.4 Precautions.

6.4.1 Mounting of accessories. It is not considered good practice to mount accessory equipment on terminal studs or solder lug terminals.

6.4.2 Depth of meter. Attention of equipment designers and manufacturers is called to the fact that sufficient space should be provided in equipment for mounting standard meters of maximum depth and barrel diameter as shown (see 3.1), even though a meter of lesser diameter or depth may be employed in the initial design.

6.4.3 Magnetic shielding (not applicable to style 05 and style 07). Meters covered by this specification have sufficient magnetic shielding to permit their use on both ferrous panels and nonferrous panels without exceeding the specified accuracy tolerance. These meters may not have sufficient magnetic shielding to remain within the designated accuracy, when they are used in strong magnetic fields.

6.4.4 Special application. A new special meter should be used in switching circuits, where a variety of shunts or multipliers are used. New special meters must be coordinated with the Government, prior to inclusion in this specification.

6.4.5 0 to 150 scale meters. Meters reading 0 to 150 are especially recommended for multiple-purpose use in equipment, when suitable shunts and multipliers are used, so normal circuit reading is at 100. Abnormal circuit values are indicated directly, as a percentage of the normal reading.

6.5 Definitions. For the purpose of this specification, the following definitions shall apply:

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

6.5.2 Crazing. A network of fine cracks in the surface or glaze.

6.5.3 Crest factor. The crest factor is the ratio between:

(1) The peak voltage value that an average reading or root-mean-square voltmeter will accept without overloading and
(2) The full scale value of the range being used for measurement.

6.5.4 Decibel. A decibel (dB) is a logarithmic unit for expressing the ratio of two amounts of power. The number of dB denoting such a ratio is 10 times the logarithm to the base 10 of this ratio.

Example: With P_1 and P_2 designating two amounts of power and N the number of dB denoting their ratio:

$$N = 10\log_{10}\left(P_1/P_2\right)$$

6.5.5 End-scale value. The end-scale value is the value of the actuating electrical quantity that corresponds to end-scale indication. When zero is not at the end or at the electrical center of the scale, the higher value is taken.

6.5.6 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 the indication of the meter is greater than the true value.

6.5.7 Free indication. Meters should be considered as indicating freely, when the pointer of the meter under test moves simultaneously with the point of the reference standard with which it is being compared. The electrical energy supplied to both meters should be gradually increased from zero to an amount sufficient to produce end-scale deflection of the meter under test.

6.5.8 Full-scale value. The full-scale value is the largest value of the actuating electrical quantity, which can be indicated on the scale. However; in the case of instruments having their zero between the ends of the scale, the full-scale value is the arithmetic sum of the values of the actuating electrical quantity corresponding to the ends of the scale.

6.5.9 Meters.

6.5.9.1 Meter, dBm. A dBm meter is a decibel meter having a zero power level of 0.001 watt dissipated in a 600-ohm load.

6.5.9.2 Meter, decibel. A decibel meter is a meter calibrated in dB above or below a selected zero power level represented by the voltage resulting when such power is dissipated in a load of specified impedance.

6.5.9.3 Meter, electrical indicating. An electrical indicating meter is an electrically energized device for measuring the present value of the quantity under observation by visual means. The term "meter" includes the case, terminals, and all parts within the case or made a corporate part thereof.

6.5.9.4 Meter, rectifier. A rectifier meter is a combination of a meter sensitive to direct current and a rectifying means whereby alternating current may be measured.

6.5.9.5 Meter, watertight. A watertight meter is a meter so constructed as to prevent the entrance of moisture or vapor into the meter under the inspection conditions specified herein.

6.5.9.6 Meter, self-contained. A meter is self-contained, when all necessary accessories are included within the case as integral parts of the meter.

6.5.10 Moving element. The moving element of a meter comprises those parts that move as a direct result of a variation in the electrical quantity, which the meter is measuring.

6.5.11 Normal operating position. Unless otherwise specified (see 3.1), the normal operating position for meters is with the meter mounted on a vertical panel in the position in which it is normally viewed.

6.5.12 Overshoot. The overshoot is the ratio between (1) the over travel of the pointer beyond a new steady deflection and (2) the change in steady deflection, when a new constant value of the measured quantity is suddenly applied. The over travel and deflection are determined in angular measure and the overshoot is usually expressed as a percentage.

6.5.13 Position influence. The position influence is the maximum displacement of the pointer, which is caused solely by a 60-degree rotation in a vertical panel in the position in which it is normally viewed.

6.5.14 Power consumption (loss). Power consumption (loss) is the electrical power required to produce end-scale deflection of the meter. Power consumption (loss) may be expressed in terms of units other than units of power, such as milliamperes (mA), millivolts (mV), volt-amperes, or ohms, which are more useful in determining the suitability of a particular meter for a desired application.

6.5.14.1 Alternating current meters.

6.5.14.1.1 Current and voltage measuring meters. In alternating current and voltage measuring meters, the power consumption (loss) is expressed in volt amperes.

6.5.14.2 Direct current meters.

6.5.14.2.1 Current measuring meters. In direct current measuring meters, the power consumption (loss) is expressed in millivolts (mV).

6.5.14.2.2 Voltage measuring meters. In direct voltage measuring meters, the power consumption (loss) is expressed in ohms or amperes.

6.5.14.3 Rectifier meters.

6.5.14.3.1 Voltage measuring meters. In voltage measuring meters, including power and volume level indicators, the power consumption (loss) is expressed in ohms or millivolts.

6.5.15 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.

6.5.16 Scale division. A scale division is the incremental value of the measured quantity between the centers of two consecutive scale marks.

6.5.17 Scale length. The scale length is the length of the path described by the tip of the pointer in moving from one end of the scale to the other. In the case of pointers extending beyond the scale division marks, the pointer shall be considered as ending at the outer end of the shortest scale division marks. For multiple-scale meters, the longest scale shall be used to determine the scale length.

6.5.18 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 (see line 7 of 4.7.14)

6.5.19 Mechanism. The mechanism is the arrangement of parts for producing and controlling the motion of the indicating means. It includes all the essential parts necessary to produce the results, but does not include the case, cover, dial, or any parts, such as series resistors or shunts, whose function is to adapt the meter to the quantity to be measured.

6.5.20 Repeatability. The repeatability of an instrument is the ability to repeat its readings taken when the pointer is deflected upscale, compared to the readings taken when the pointer is deflected downscale, expressed as a percentage of the full-scale value.

6.5.21 Meter, Ruggedized. Ruggedized means a durable construction that is able to maintain normal service in unusually harsh operational environments, which are characterized by violent motion and extremes of temperature, humidity and corrosive conditions.

6.6 Molding thermosetting plastic (see 3.3.1). It is recommended that molding thermosetting plastic material, in accordance with ASTM D 5948, be considered for use. Copies of this document are available online at http://www.astm.org or from the ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

6.7 Fluorescent/Phosphorescent material (see 3.3.2 and 3.3.7). It is recommended that the standard specification for Phosphorescent Safety Markings, in accordance with ASTM E 2072, Test Method E 2073, and Guide E 2030 (use of yellow is recommended for fluorescent), be considered for use. Copies of these documents are available from the ASTM International.

6.8 External finishes (see 3.3.5). It is recommended that external finishes, in accordance with MIL-DTL-14072, be considered for use where finishes not exposed to view from the front of the panel are either type I (exposed) or type II (sheltered) Finishes exposed to view from the front panel are type I (exposed), in compliance with semi gloss black conforming to FED-STD-595/27038. These documents are available from the DAPS.

6.9 Machine screws and nuts (see 3.4.3.2). It is recommended that machine screws and nuts, in accordance with Federal Specifications FF-S-92 and FF-N-836 respectively, be considered for use. These documents are available from the DAPS.

6.10 Resistors (see 3.4.9.1). It is recommended that external resistors, in accordance with MIL-PRF-29, MIL-PRF-39005 or MIL-PRF-55182 (direct current measurement) and MIL-PRF-55182 (alternating current measurement), be considered for use. These documents are available from the DAPS.

6.11 Shunts (see 3.4.9.2). It is recommended that external shunts, in accordance with the Commercial Item Description A-A-55524, be considered for use. This document is available from the DAPS.

6.12 Solderability (see 3.5). Refer to Guideline 5 of MIL-HDBK-454 for more information on soldering. This document is available from the DAPS.

6.12.1 Tin whisker growth (see 3.3.8). The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to ASTM B 545 (Standard Specification for Electrodeposited Coatings of Tin). Copies of this documents are available from http://www.astm.org or ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

6.13 Part or Identifying Number (PIN). This specification requires a PIN that is as described in the appropriate reference to associated documents (see 3.1).

6.14 Subject term (key word) listing.

Accuracy
Balancing of moving element
Bezel
Current measuring
Decibel
Dial
Dielectric withstanding voltage
Electrostatic effect
Frequency range
Full-scale value
Insulation
Magnets
Overshoot
Position influence
Pointer clearance
Rectifier
Repeatability
Response time
Scale visibility
Shunts
Temperature influence
Vibration and shock isolators
Voltage measuring
Zero adjustment

6.15 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmentally Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm. Further information is available at the following EPA site: http://www.epa.gov/epaoswer/hazwaste/minimize/. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

6.16 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples and related data for qualification inspection of meters covered by this specification. The procedure for extending qualification of the required sample to other meters covered by this specification is also outlined herein. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. SUBMISSION

20.1 Sample.

20.1.1 Single-type submission. A sample consisting of 10 sample units of each meter type listed in column 2 of table XIII, for which qualification is sought, shall be submitted.

20.1.2 Combined submission. When qualification of a meter type is contingent upon previous or concurrent qualification of a similar-meter type, two additional sample units of the meter type listed in column 1 of table XIII (for which qualification is sought) shall be submitted, in addition to the 10 sample units of the similar-meter type listed in column 2, previously or concurrently submitted.

20.2 Direct current microammeters and milliammeters. When submitting sample units of direct current microammeters and direct current milliammeters, the supplier shall state which ranges under this specification are the same basic constructions. When the sample units submitted for qualification inspection do not cover all the different basic constructions for the ranges listed (see 3.1), meters with all the basic constructions required to cover these ranges shall also be submitted for qualification inspection, together with a statement of the ranges covered by each basic construction.

30. EXTENT OF QUALIFICATION

30.1 Single-type submission. Qualification of a meter type submitted for inspection includes qualification of the ranges listed (see 3.1), within the limits designated in table XIII, as applicable. Approval of meters calibrated for use on ferrous panels will provide approval of meters of the same type calibrated for use on nonferrous panels. Approval of color scheme of any type meter will provide approval of that color scheme for all other types.

TABLE XIII. Single-type submission of meters.

Kind of meter	Type designation of meter for inspection	Ranges covered	Spec Sheet
1-inch meters			
DC microammeters	MR03*050DCUAR 1/	50 μA up to but not including 100 μA 2/	20
DC microammeters	MR03*100DCUAR 1/	100 μA up to but not including 500 μA 2/	20
DC microammeters	MR06*100DCUAR 1/	100 μA up to but not including 500 μA and all voltmeters 2/	31
DC microammeters and milliammeters	MR03*001DCMAR 1/	500 μA up to but not including 10 mA and all external multiplier voltmeters 2/	20
DC milliammeters	MR06*001DCMAR 1/ MR03*500DCMAR 1/ MR06*500DCMAR 1/	10 mA through 500 mA 2/	30 20 ---
DC voltmeters	MR03*150DCVVR 1/	All self-contained voltmeters through 150 volts. 2/	20
DC voltmeters	MR06*100DCVVR 1/	All self-contained voltmeters through 100 volts. Style 05 and style 07 have the same ranges as style 06. 2/	32
1.5-inch meters			
DC microammeters	MR13*050DCUAR 1/	50 μA up to but not including 100 μA 2/	24
DC microammeters	MR13*100DCUAR 1/	100 μA up to but not including 500 μA 2/	24
DC microammeters and milliammeters	MR13*001DCMAR 1/	50 μA up to but not including 10 mA and all external multiplier voltmeters 2/	24
DC milliammeters	MR13*500DCMAR 1/	10 mA through 1 ampere 2/	24
DC voltmeters	MR13*200DCVVR 1/	All self-contained voltmeters through 200 volts. 2/	21
RF ammeters	MR1**005RLAAR 1/	MR1**005RLAAR 2/	---

See footnotes at end of table.

TABLE XIII. Single-type submission of meters - Continued.

Kind of meter	Type designation of meter for inspection	Ranges covered	Spec Sheet
2.5-inch meters			
DC voltmeters	MR26*300DCVVR 1/	All self-contained voltmeters through 200 volts. 2/	4
DC microammeters and milliammeters	MR26*020DCUAR 1/ 3/ MR26*100DCUAR 1/ 4/ MR26*001DCMAR 1/	50 μA up to but not including 10 mA and all external multiplier voltmeters 2/	5 5 5
	MR26*297SPECR	MR26*297SPECR 1/ 2/	9
	MR26*500DCMAR	10 through 500 mA 2/	5
DC ammeters	MR26*010DCAAR 1/	All self-contained 2/	5
	MR26*100DCAAR 1/	All external shunt 2/	5
RF ammeters	MR2**005RFAAR 1/	All (conventional scale) 2/	---
	MR2**005RLAAR 1/	All (linear expanded scale) 2/	---
RF milliammeters	MR3**200RFMAR 1/	All (conventional scale) 2/	---
	MR3**200REMAR 1/	All (linear expanded scale) 2/	---
RF ammeters	MR3**005RFAAR 1/	All (conventional scale) 2/	---
	MR3**005RFAAR 1/	All (linear expanded scale) 2/	---
AC voltmeters	MR26*300ACVVR 1/	All 60-Hz voltmeters 2/	
AC voltmeters (rectifier)	MR26*200ACVVR 1/	All rectifier voltmeters 2/	25
AC milliammeters	MR26*500ACMAR	All 60-Hz milliammeters 2/	7
AC ammeters	MR26*005ACAAR	All 60-Hz ammeters 2/	7
3.5-inch meters			
DC voltmeters	MR3**500DCVVR 5/ 6/	All self-contained through 500 V 2/	11
	MR3**800DCVVR 5/	All self-contained through 800 V 2/	11
DC microammeters and milliammeters	MR3**020DCUAR 3/ 5/	20 μA up to but not including 100 μA 2/	12
	MR3**100DCUAR 4/ 5/	100 through 500 μA 2/	12
	MR3**001DCMAR 5/	More than 500 μA and less than 10 mA and all kilovoltmeters 2/	12
	MR3**500DCMAR 5/	10 through 999 mA 2/	12
DC ammeters	MR3**010DCAAR 5/	All self-contained 2/	12
	MR3**100DCAAR 5/	All external shunt 2/	12
AC voltmeters	MR3**300ACVVR 5/	All 60-Hz voltmeters 2/	13
AC voltmeters (rectifier)	MR3**200ACVVR 5/	All rectifier voltmeters 2/	26

See footnotes at end of table.

TABLE XIII. Single-type submission of meters - Continued.

Kind of meter	Type designation of meter for inspection	Ranges covered	Spec Sheet
3.5-inch meters - Continued			
AC milliammeters	MR3**500ACMAR 5/	All 60-Hz milliammeters 2/	14
AC ammeters	MR3**005ACAAR 5/	All 60-Hz ammeters 2/	14
DB meters	MR3**125SPECR 5/	MR36*125SPECR 2/ 5/	---
4.5-inch meters			
DC voltmeters	MR4**500DCVVR 7/	All self-contained voltmeters 2/	23
DC microammeters	MR4**050DCUAR 7/	MR4**050DCUAR 2/ 7/	17
DC milliammeters	MR4**001DCMAR 7/	More than 500 μA and less than 10 mA and all kilovoltmeters 2/	23

1/ The asterisk is to be replaced by a letter designating the color scheme (see 1.2.2.2).
2/ Includes all meters having 0 between the two ends of the scale whose arithmetic sum is within the range of values, for which qualification is granted.
3/ If a microammeter with a range higher than 20 μA is submitted for qualification and qualifies, the qualified ranges shall extend from the range of meter inspected through 100 μA.
4/ If a microammeter with a range higher than 100 μA is submitted for qualification and qualifies, the qualified ranges shall extend from the range of meter inspected through 500 μA.
5/ The asterisks are to be replaced by a number (4 or 6) designating the style (see 1.2.2.1.2) and one of the letters designating the color scheme (see 1.2.2.2).
6/ Samples of MR3**500DCVVR may be omitted if samples of MR3**800DCVVR are furnished and cases are identical.
7/ The asterisks are to be replaced by a number (3, 4, or 6) designating the style (see 1.2.2.1.2) and one of the letters designating the color scheme (see 1.2.2.2).

30.2 Combined submission. Qualification of a combined submission covers qualification of the meter types listed in column 3 of table XIV. The meter types, to which qualification is extended, shall be of the same general construction and materials as the qualified meter type. Qualification of the color scheme of any type meter shall provide qualification of that color scheme to other meters having unusual features such as extraordinary compensation requirements, special internal-resistance requirements, multiple ranges, or other special characteristics not covered by this specification.

TABLE XIV. Combined submission of meters. (Qualification contingent upon previous or concurrent qualification of similar types.)

Type designation of meter				Meter type qualified	S/S
For combined submission	S/S	Similar	S/S		
2.5-inch meters 1/					
MR26*106SPECR, MR26*153SPECR, or MR26*162SPECR	9	MR26*020DCUAR 3/	5	MR26*105SPECR, MR26*106SPECR, MR26*107SPECR, MR26*152SPECR, MR26*153SPECR, MR26*154SPECR, MR26*161SPECR, MR26*162SPECR, MR26*163SPECR	9
MR26*109SPECR, MR26*155SPECR, or MR26*165SPECR	9	MR26*001DCMAR	5	MR26*108SPECR, MR26*109SPECR, MR26*110SPECR, MR26*111SPECR, MR26*112SPECR, MR26*113SPECR, MR26*155SPECR, MR26*156SPECR, MR26*157SPECR, MR26*158SPECR, MR26*159SPECR, MR26*160SPECR, MR26*164SPECR, MR26*165SPECR, MR26*166SPECR, MR26*167SPECR, MR26*168SPECR, MR26*169SPECR	9
MR26*114SPECR	9	MR26*010DCAAR	5	MR26*114SPECR, MR26*115SPECR, MR26*116SPECR, MR26*117SPECR, MR26*118SPECR, MR26*119SPECR	9
MR26*131SPECR	9	MR26*300DCVVR	4	MR26*131SPECR, MR26*5T5DCVVR	9, 4
MR26*300AFVVR	6	MR26*300ACVVR	6	All 400-Hz voltmeters	
MR26*300AEVVR	6	MR26*300ACVVR	6	All 800-Hz voltmeters	
MR26*500AFMAR	7	MR26*500ACMAR	7	All 400-Hz milliammeters	
MR26*500AEMAR	7	MR26*500ACMAR	7	All 800-Hz milliammeters	
MR26*005AFMAR	7	MR26*005ACAAR	7	All 400-Hz ammeters	
MR26*005AEAAR	7	MR26*005ACAAR	7	All 800-Hz ammeters	
3.5-inch meters 2/					
MR3**106SPECR, MR3**153SPECR, or MR3**162SPECR	16	MR3**020DCUAR 3/	12	MR3**105SPECR, MR3**106SPECR, MR3**107SPECR, MR3**152SPECR, MR3**153SPECR, MR3**154SPECR, MR3**161SPECR, MR3**162SPECR, MR3**163SPECR,	16
MR3**109SPECR, MR3**155SPECR, or MR3**165SPECR	16	MR3**001DCMAR	12	MR3**108SPECR, MR3**109SPECR, MR3**110SPECR, MR3**111SPECR, MR3**112SPECR, MR3**113SPECR, MR3**155SPECR, MR3**156SPECR, MR3**157SPECR, MR3**158SPECR, MR3**159SPECR, MR3**160SPECR, MR3**164SPECR, MR3**165SPECR, MR3**166SPECR, MR3**167SPECR, MR3**168SPECR, MR3**169SPECR,	16

See footnotes at end of table.

TABLE XIV. Combined submission of meters. (Qualification contingent upon previous or concurrent qualification of similar types.) – Continued

Type designation of meter				Meter type qualified	S/S
For combined submission	S/S	Similar	S/S		
3.5-inch meters - Continued 2/					
MR3**114SPECR	16	MR3**010DCAAR	12	MR3**114SPECR, MR3**115SPECR, MR3**116SPECR, MR3**117SPECR, MR3**118SPECR, MR3**119SPECR,	16
MR3**120SPECR	16	MR3**005ACAAR	12	MR3**120SPECR, MR3**121SPECR,	16
MR3**131SPECR	16	MR3**2H2DCVVR	14	MR3**131SPECR, MR3**5T5DCVVR,	16,11
MR3**300AFVVR	13	MR3**300ACVVR	11	All 400-Hz voltmeters	
MR3**300AEVVR	13	MR3**300ACVVR	13	All 800-Hz voltmeters	
MR3**500AFMAR	14	MR3**300ACVVR	13	All 400-Hz milliammeters	
MR3**500AEMAR	14	MR3**500ACMAR	14	All 800-Hz milliammeters	
MR3**005AFAAR	14	MR3**005ACAAR	14	All 400-Hz ammeters	
MR3**005AEAAR	14	MR3**005ACAAR	14	All 800-Hz ammeters	

1/ The asterisk is to be replaced by a letter designating the color scheme (see 1.2.2.2).
2/ The asterisks are to be replaced by a number (4 or 6) designating the style (see 1.2.2.1.2) and one of the letters designating the color scheme (see 1.2.2.2).
3/ If a microammeter with a range higher than 20 μA is submitted for qualification and qualifies, the qualified ranges shall extend from the range of the meter inspected through 100 μA.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - SH
Air Force - 99
DLA – CC

Preparing activity:
DLA - CC

(Project 6625-2006-002)

Review activities:
Army - AR, AT, AV, CR4, EA, MI
Navy - AS, CG, MC, OS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.