METRIC
MIL-V-85603(AS)
10 AUGUST 1989

MILITARY SPECIFICATION

VOLTMETER, DC, AIRCRAFT, DIGITAL DISPLAY GENERAL SPECIFICATION FOR

This specification is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense

1 SCOPE

1 1 Scope This specification establishes the requirements for the design, performance, manufacture, and acceptance of voltmeters for indicating the available capacity of storage batteries in aircraft and providing a warning signal when the available capacity becomes dangerously low

1 2 Military part number The military part number of the voltmeter will be designated in the specification sheet

2 APPLICABLE DOCUMENTS

2 1 Government documents

2 1 1 Specifications and standards The following specifications and standards form a part of this specification to the extent specified herein Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation

SPECIFICATIONS

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD), Code 53, Lakehurst, New Jersey 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

AMSC N/A FSC 6625

MILITARY

MIL-P-116	Preservation, Methods of
MIL-P-7788	Panels, Information, Integrally Illuminated
MIL-C-14806	Coating, Reflection Reducing, for Instrument Cover Glasses and Lighting Wedges
MIL-P-15024	Plates, Tags and Bands for Identification of Equipment
MIL-L-25467	Lighting, Integral, Red, Aircraft Instrument, General Specification for
MIL-C-38999	Connector, Electrical Circular, Miniature, High Density Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environmental Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for
MIL-I-45208	Inspection System Requirements
MIL-L-85762	Lighting, Aircraft, Interior, AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) Compatible

STANDARDS

FEDERAL

FED-STD-595	Colors

MILITARY

MIL-STD-130	Identification Marking of U S Military Property
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-2073-1A	DOD Material Procedures for Development and Application of Packaging Requirements
MS33639	Cases, Instrument, Clamp-Mounted, Aircraft

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center (Attn NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099)

2.2 Non-Government publications The following documents form a part of this document to the extent specified herein Unless otherwise specified, the

issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C1036-85 Standard Specification for Flat Glass (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents These documents also may be available in or through libraries or other informational services)

2 3 Order of precedence In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained

3 REQUIREMENTS

3 1 Specification sheet The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet In the event of conflicts between the requirements of this specification and the specification sheet, the latter shall govern (If a requirement specified herein is not required for a specific voltmeter, it shall be so indicated in the specification sheet for that voltmeter (e g., Fungus - N/A))

3.2 First article When specified, a sample(s) shall be subjected to the first article inspection in accordance with 4 4

3.3 Materials Materials used in the manufacture of voltmeters shall be of high quality and suitable for the intended purpose Materials conforming to contractor's specifications may be used provided the specifications contain provisions for adequate testing and provided the life, performance, and reliability specified herein are achieved The use of the contractor's specifications does not constitute waiver of Government inspection

3.3 1 Metals

3 3 1.1 Corrosion and fungus resistance Materials shall be of a corrosion and fungus resisting type or suitably processed to withstand the environmental test requirements specified herein and in MIL-STD-810

3.3 1.2 Magnesium. Neither magnesium nor magnesium alloy parts shall be used.

3.3 2 Nonmetallic materials. Nonmetallic materials shall be flame resistant, shall not support combustion, and shall be nontoxic when exposed to flame or when used under any operating or environmental condition specified herein.

3.4 Design and construction. The voltmeter shall be a single package and shall be designed and constructed to conform to the requirements specified herein and the applicable specification sheet and shall be capable of demonstrating conformance to all the tests specified herein and in the specification sheet.

3 4.1 Power The voltmeter shall be powered entirely from the battery bus and power consumption shall be not greater than 10 watts.

3.4 2 Digital readouts The voltmeter shall contain segmented digital readouts to display the aircraft battery voltage to a tenth of a volt and a battery low voltage warning, and the voltmeter digital display configuration shall be in accordance with the specification sheet The characters shall conform to the requirements of the specification sheet and shall be white, color number 37875 of FED-STD-595.

3 4 3 Connector The electrical connector shall be specified in the specification sheet and shall meet the requirements as specified in MIL-C-38999

3 4 4 Case The voltmeter case shall be environmental resistant and in accordance with MS33639 and the specification sheet The bezel and that part of the case visible from the cockpit side of the instrument panel shall be finished in lusterless black, color number 37038 of FED-STD-595 The remainder of the case may be finished in black and shall be protected to withstand the environmental test conditions specified herein

3 4 5 Caution advisory switch The voltmeter shall contain a switch to activate a pair of lamps, 28 volts at 0 04 ampere each, on the cockpit advisory panel The switch closure shall not occur until the battery voltage has been at or below 18 0 volts for 10 seconds ± 1 second The switch shall reopen when the battery voltage is raised to 18.5 volts for 10 seconds ± 1 second

3.4 6 Digital low voltage warning The voltmeter shall contain a low voltage warning display and be so designed that the digital low voltage display will appear when the aircraft battery or batteries exhibit an output voltage level specified by the specification sheet The digital low voltage display shall exhibit the following duty cycle blink at a rate of 4 ± 1 time(s) per second for 1 ± 0 10 minute and remain activated in a steady state condition for an additional 10 ± 1 minute(s) The digital low voltage warning display shall continue to repeat the duty cycle until the low voltage condition no longer exists or the battery bus voltage degrades to the point where the voltmeter becomes inoperable The low voltage warning display shall conform to any additional requirements specified in the specification sheet

3 4 7 Overload protection The voltmeter shall be overload protected so that a 60 VDC input voltage applied to the voltmeter for an indefinite period of time shall not result in damage to the voltmeter or degradation of performance.

3.4.8 Integral lighting. The voltmeter shall be integrally lighted red in accordance with MIL-L-25467, integrally lighted Instrument and Panel Lighting (IPL) white in accordance with MIL-P-7788, the color shall be in accordance with MIL-L-25467, MIL-P-7788, or Night Vision Imaging System compatible in accordance with MIL-L-85762. The lighting circuitry and brightness shall be in

accordance with the requirements of MIL-L-25467. The integral lighting and lamp voltage shall be as specified in the specification sheet (see 4.10).

3 4.9 Dial. The voltmeter dial shall conform to the requirements of the specification sheet and as specified herein.

3 4.10 Cover glass. The cover glass shall be in accordance with ASTM 1036-85 and MIL-C-14806.

3 4 10 1 Cover glass mounting The distance between the front surface of the case (mounting flange) and the outside surface of the cover glass and the distance between the dial plate and the inside surface of the cover glass shall be the minimum practicable All visible marking shall be within 7 62 millimeters distance from the inner most glass surface, preferably the smallest practical distance.

3 4 11 Internal heater The voltmeter shall be so designed that if temperature sensor controlled internal heaters are required to meet the performance requirements of the specification sheet and as specified herein, the internal heaters shall be suitable over the temperature range of -54°C to +71°C when the temperature remains constant or varies at a rate of 1°C per second

3 4 12 Maintainability and repairability The voltmeter shall require no maintenance or servicing to meet the requirements of this specification. The voltmeter shall be constructed to hinder disassembly or access to any internal components and shall not contain any internal provisions for repair or maintenance

3 5 Performance

3 5 1 Electrical performance The voltmeter shall meet the following performance requirements when connected in accordance with the specification sheet (see 4 8 1)

a Whenever the potential of the source is between 15.0 and 35 0 volts, the voltmeter shall have an accuracy of ± 0 10 volt over the temperature range of +71°C to -32°C, at temperatures between -37°C to -54°C the voltmeter shall have an accuracy of ± 0 20 volt

b Whenever the potential of the source is greater than the low voltage warning threshold voltage as specified in the specification sheet, the digital low voltage warning display shall not be visible

c Whenever the potential of the source is less than or equal to the low voltage warning threshold voltage as specified in the specification sheet, the digital low voltage warning display shall be visible and remain visible until the low voltage condition no longer exists or the battery bus voltage degrades to the point that the voltmeter becomes inoperable.

d. When the potential of the source is 18.0 volts or less for 10 seconds ± 1 second, the caution advisory switch closure shall occur. When the potential is increased to 18.5 volts or more for 10 seconds ± 1 second, the caution advisory switch shall open.

e. The voltmeter shall be overload protected so that 60 VDC input voltage shall not result in damage to the voltmeter or degradation of the voltmeter accuracy. This test shall be performed prior to and at the conclusion of the environmental phase of the test program only except as may be required by the qualifying activity.

3 5.2 Visibility of displays The digital voltmeter display and the digital low voltage warning display, when activated, shall be readily discernible when viewed with direct sunlight, 10,000 foot-candles, as measured at the displays incident on the dial The digital low voltage warning display, when inactive, shall not be discernible under these same conditions (see 4 8.2)

3.5.3 Visibility of dial The digital displays and all other specified markings on the dial shall be visible from any point within the frustum of a cone whose side makes an angle of 30 degrees with a perpendicular to the dial and whose small diameter is the aperture of the case (see 4.8.3)

3 5 4 Warm-up time The warm-up time over the temperature range of -32°C to +71°C shall not exceed 5 seconds The warm-up time over the temperature range of -37°C to -54°C shall not exceed 30 seconds (see 4 8 4)

3.5 5 Life test The voltmeter shall withstand the 250-cycle life test (see 4 8.5)

3 6 Environmental The voltmeter, when subjected to the following environmental conditions, shall show none of the following

a Dimensional distortion beyond specified limits or cracking of cases, covers, or mounting brackets

b Breakdown of insulation, loosening or stripping of metal plating or protective coatings from any component part, or corrosion of metal parts.

c Mechanical failure of any part

d Fungus growth.

e Deterioration of voltmeter identification markings

f Degradation of electrical performance beyond specified limits

3 6 1 Acceleration The voltmeter shall be able to withstand the acceleration forces of Tables 513 3-I and 513.3-II of MIL-STD-810 as applicable to carrier based aircraft, or as specified by the specification sheet (see 4 8 6)

3.6 2 Temperature (see 4.8.7).

a. Operating. The voltmeter shall be capable of operating continuously over the range of -54°C to +71°C when the temperature remains constant or varies at a rate of 1°C per second.

b. Nonoperating The voltmeter in a nonoperating condition shall withstand constant temperatures of -62°C to +95°C.

3.6.3 Temperature shock. The voltmeter shall be able to withstand rapid changes in atmospheric temperature over the temperature range of -40°C to +85°C without causing any degradation in performance (see 4.8.8).

3.6 4 Shock (see 4.8 9).

3 6 4.1 Basic design The voltmeter shall not suffer damage or subsequently fail to provide the performance specified when subjected to a total of 18 impact shocks of 20g, consisting of three shocks in each direction along each of the three mutually perpendicular axis Each shock pulse shall be a 1/2 sine wave having a peak amplitude of 20g and a pulse width of 11 ± 1 milliseconds The "g" value shall be within ± 10 percent when measured with a 0.2 to 250Hz filter, and the maximum "g" shall occur at approximately 5.5 milliseconds

3 6 4.2 Crash safety The voltmeter shall be subjected to a total of 12 impact shocks of 40g, consisting of two shock in each direction along each of the three mutual perpendicular axis Each shock pulse shall be a 1/2 sine wave having a peak amplitude of 40g and a pulse width of 11 ± 1 milliseconds The "g" value shall be within ± 10 percent when measured with a 0.2 to 250Hz filter, and the maximum "g" shall occur at approximately 5 5 milliseconds There shall be no failure of the mounting attachments, and the voltmeter shall remain in place and not create a hazard However, bending and distortion, also degradation of performance requirements shall be permitted

3 6.5 Vibration The voltmeter shall operate as prescribed when required during vibration testing and there shall be no evidence of mechanical or electrical degradation when the voltmeter is tested after the completion of the vibration tests The voltmeter shall be subjected to the vibration tests of MIL-STD-810, Method 514 3, Procedure I, Test Condition I-3 2 12, Figure 1 and Figure 2 herein (see 4 8 10)

3.6 6 Temperature-altitude. The voltmeter shall be able to withstand the combined effects of temperature and altitude as will be encountered during service life The altitude will vary from sea level to 21,336 meters with pressure remaining constant or varying at a rate of 12 7 millimeters of mercury per second (see 4 8.11)

3 6 7 Humidity The voltmeter shall withstand the effects of humidities up to 100 percent, including conditions wherein condensation takes place in and on the equipment The voltmeter shall withstand the above conditions during continuous operation, intermittent operations, short-time operations, and exposure in a nonoperating condition (see 4 8 12)

3 6 8 Fungus The voltmeter shall withstand, in both operating and nonoperating condition, extended exposure to fungus growth as encountered in tropical climates (see 4 8 13)

3.6.9 Salt spray. The voltmeter shall be able to withstand exposure to salt spray when subjected to the test of MIL-STD-810 (see 4.8 14)

3.6.10 Electromagnetic interference (EMI). The voltmeter shall meet the electromagnetic interference requirements of MIL-STD-461 for Class A1 category A1b equipment (see 4.8.15).

3 6.11 Magnetic effect. The voltmeter, when operating or nonoperating, shall not cause more than a 3-degree deflection of a short-bar magnetic compass at a distance of 139 7 millimeters or greater and in a horizontal magnetic field with an intensity of 0 17 to 0 19 oersted (see 4.8.16).

3.7 Dielectric strength. The voltmeter shall meet the requirements of the dielectric strength test (see 4.9).

3 8 Dimensions The voltmeter shall conform to the dimensional requirements of the specification sheet and as specified herein (see 4.11)

3 9 Weight The weight of the voltmeter shall be not greater than the specified requirement of the specification sheet (see 4 11)

3 10 Colors The voltmeter shall be finished in colors conforming to FED-STD-595 as listed in Table I (see 4 11)

Table I Colors of finishes

Item	Color number
DC Volts	37875 (white)
Digits (voltage display)	37875 (white)
Digits (low voltage warning)	37875 (white)
All else (including exterior of case)	37038 (black)

3 11 Markings (see 4 11)

3 11 1 Connectors and terminals Markings of external electrical connections shall be as specified on the applicable specification sheet

3 11 2 Identification of product The voltmeter shall be marked in accordance with MIL-STD-130

3 11 3 Nameplate Each voltmeter shall contain a standard size type A, B, C, G, or H nameplate in accordance with MIL-P-15024, securely attached. The manufacturer's name or trademark shall be in letters not larger than other letters appearing on the nameplate The nameplate shall contain the following information

Military Part No. D85603/as appropriate
National Stock No.
Manufacturer's Part No.
Contract or Order No.
Voltmeter S/N
Mfg.
Date Mfg.
Warranty Expiration Date
Manufacturer's name or trademark
Inspector's stamp
US

3.12 Reliability The voltmeter shall have mean flight hours between failure (MFHBF) of not less than 10,000 hours during the first 5 5 years of its service life (see 4.8.5)

3.13 Workmanship. Voltmeters shall be manufactured and assembled in accordance with MIL-STD-454, Requirement 9 (see 4.11)

4 QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4 1 1 Responsibility for compliance All items must meet all requirements of sections 3 and 5 The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material

4 2 Classification of inspection The inspection requirements specified herein are classified as follows.

a First article inspection (see 4 4)

b First article verification inspections (see 4 5)

c Quality conformance inspection (see 4.7).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in 4.8.

4.3.1 Inspection system requirements. The inspection system requirements shall be in accordance with MIL-I-45208

4 3.2 Standard conditions Unless otherwise specified herein, all tests shall be conducted under the following conditions.

a. Temperature: Room ambient (25°C ± 5°C).

b. Pressure. Normal atmospheric (approximately 760.0 millimeters Hg)

c Relative humidity Room ambient (40 to 90 percent)

4 3 3 Test readings Unless otherwise specified herein, electrical power shall be applied to the voltmeter during all tests The voltmeter shall not require external vibration or tapping to meet the performance requirements specified herein

4 3 4 Attitude Unless otherwise specified herein, the voltmeter shall be tested in its normal operating position.

4.4 First article inspection First article inspection shall be performed at a Government laboratory (see 6 3) on sample units produced with equipment and procedures normally used in production The voltmeters will be considered to have conformed to the first artic' inspection upon successful completion of the tests of Table II The first article inspection shall consist of all the tests of Table II performed in the order listed or as otherwise specified by the acquiring activity (see 6.3)

4 4 1 First article samples The first article samples shall consist of four voltmeters representative of the production equipment The sample units shall be identified in the same manner as production units

4.4.2 Failure and retest Failure of a first article sample to pass any of the examinations or tests specified herein shall be cause for the Government to refuse to conduct additional testing until the defects revealed by the inspection have been corrected With the approval of the Government, a retest may be allowed with an increase in the number of first article samples if specified by the acquiring activity The cost of retesting shall be borne by the contractor

Table II. First article inspection.

Inspection	Requirement Paragraph	Test Method Paragraph	Sample Number 1	2	3	4	Number of Defects Permitted
Electrical performance	3 5 1	4 8 1	X	X	X	X	0
Visibility of displays	3 5 2	4 8 2	X	X	X	X	0
Visibility of dial	3 5 3	4.8 3	X	X	X	X	0
Warm-up time	3 5.4	4 8.4	X	X	X	X	0
Life test	3.5 5, 3 12	4 8.5				X	0
Acceleration	3 6 1	4 8 6	X				0
Temperature	3.6 2	4 8.7			X		0
Temperature shock	3 6 3	4.8.8	X				0
Shock	3 6 4	4 8 9		X			0
Vibration	3.6.5	4.8 10		X	X		0
Temperature-altitude	3.6 6	4 8 11		X			0
Humidity	3.6.7	4 8.12	X				0
Fungus	3 6 8	4 8 13		X			0
Salt spray	3 6 9	4 8 14			X		0
Electromagnetic interference	3.6.10	4 8.15			X		0
Magnetic effect	3.6.11	4 8 16	X	X	X		0
Dielectric strength	3 7	4 9	X	X	X	X	0
Integral lighting	3 4 8	4.10	X	X	X	X	0
Dimensions	3 8	4.11	X	X	X	X	0
Weight	3.9	4 11	X	X	X	X	0
Colors	3 10	4.11	X	X	X	X	0
Markings	3 11	4.11	X	X	X	X	0
Workmanship	3.13	4.11	X	X	X	X	0

4 5 Verification of first article Each voltmeter of the same part number delivered as a qualified item under this specification, shall be numbered sequentially in the order that it is delivered To meet the delivery requirement for the first 50 voltmeters, 51 shall successfully complete the required quality conformance inspection, 50 of which shall be shipped as directed by the applicable contract(s), and one voltmeter selected at random by the Government inspector shall be forwarded to the qualifying activity (see 6 3 and 6 3.1) To meet the delivery for each succeeding 150 voltmeters, 151 voltmeters shall successfully complete the tests directed by the applicable contract(s), one voltmeter selected at random shall be forwarded as above The span of serial numbers and the contract numbers of the production units from which each verification sample was selected shall be recorded and this information included with the sample The sample shall be shipped no later than the final unit in the production group from which selected The samples forwarded to the qualifying activity will be inspected and tested for conformance to this specification. Tests shall be conducted as specified in Table II for any one of the first article verification samples at the discretion of the qualifying activity. All first article verification samples become Government property when accepted by the Government inspector for shipment to the qualifying activity.

4.5.1 Rejection and retest of first article and first article verification samples. Samples which have been rejected or returned to the manufacturer for

any reason during first article or first article verification tests may be reworked or have parts replaced to correct defects Before resubmitting the samples, full particulars concerning the rejection and the corrective action taken by the manufacturer must be submitted in writing by the manufacturer to the qualifying activity Tests shall not be resumed until such a report is received. If the manufacturer does not correct and return to the qualifying activity components rejected during verification testing within 5 weeks after he receives them or does not submit within 2 weeks a program acceptable to the qualifying activity for the correction of deficiencies noted, the component will be disqualified

4 6 Disassembly and inspection At the conclusion of tests, each sample will be disassembled as necessary to inspect for evidence of wear, defects, and overheating The presence of such evidence shall be cause for rejection Disassembly and inspection shall be performed at the discretion of the qualifying activity or as may be required by the contract(s)

4 7 Quality conformance inspection Quality conformance inspections shall consist of inspection of the product for delivery Each voltmeter offered for delivery shall be subjected to the tests specified in Table 3 Data from these tests shall be recorded and available for examination by authorized Government representatives for a period of one year after delivery of the voltmeters

Table III Quality conformance inspection

Inspection	Requirement Paragraph	Test Method Paragraph
Integral lighting	3 4 8	4 10
Electrical performance	3 5 1	4 8 1
Visibility of displays	3 5 2	4 8.2
Visibility of dial	3 5 3	4 8.3
Warm-up time	3 5 4	4 8.4
Dielectric strength	3 7	4 9
Dimensions	3 8	4 11
Weight	3.9	4 11
Colors	3.10	4 11
Markings	3 11	4 11
Workmanship	3 13	4 11

If a voltmeter fails to pass quality conformance inspection, the manufacturer shall notify the acquiring activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which are manufactured under essentially the same materials and processes, and which are considered subject to the same failure Acceptance and shipment of the voltmeter shall be discontinued until corrective action, acceptable to the acquiring activity, has been taken. After the corrective action has been taken, quality conformance inspection shall be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the acquiring activity). Final acceptance and shipment shall be withheld until the quality conformance inspection has shown that the corrective action was successful. In the event of failure after reinspection further rework and resubmission shall not be allowed.

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

4.8 Methods of inspection.

4 8 1 Electrical performance. The voltmeter shall be inspected to determine compliance with the electrical performance requirements of 3.5 1 as follows Each voltmeter shall be connected to a source of power and the input voltage varied over the range of 15 volts to 35 volts The voltmeter shall display the input voltage to within ± 0 10 volt over the temperature range of +71°C to -32°C, and display the input voltage to within ± 0.20 volt at temperatures between -37°C to -54°C The voltmeter readings shall be recorded in 1-volt intervals between 15 0 and 35 0 volts With the input voltage to the voltmeter adjusted above the voltage warning threshold as defined by the specification sheet but not exceeding 60 volts, the low voltage warning display shall not be visible. The input voltage to the voltmeter shall be gradually reduced to the low voltage warning threshold as defined by the specification sheet, at this point, the low voltage warning display shall be visible and exhibit the following duty cycle. Blink at a rate of 4 ± 1 time(s) per second for 1 ± 0.10 minute(s) and remain activated in a steady state condition for an additional 10 ± 1 minute(s) The digital low voltage warning display shall continue to repeat the duty cycle until the low voltage condition no longer exists or the voltmeter input voltage degrades to the point where the voltmeter becomes inoperable When the voltage is reduced to 18 0 volts, the caution advisory switch shall close in no less than 9 seconds nor more than 11 seconds, creating a short circuit between the specified connector pins The voltage shall then be raised to 18.5 volts or more at which time the switch shall open within 10 seconds ± 1 second (see 3 5.1).

4 8 2 Visibility of displays The digital displays, when activated, shall be subjected to direct sunlight, 10,000-foot-candle, and measured at the display incident on the dial and the displays shall be readily discernible. The low voltage warning display, when inactive, shall not be discernible (see 3.5 2).

4 8.3 Visibility of dial The digital displays and all other specified markings on the dial shall be inspected to insure the visibility requirements of 3 5.3 are met (see 3 5 3)

4.8.4 Warm-up time The voltmeter shall be de-energized for not less than 30 minutes prior to conducting this test The input source voltage circuit shall be adjusted to 20 0 volts. The voltmeter shall then be energized and the time to stabilize shall be noted The time to stabilize shall not exceed 5 seconds (+71°C to -32°C), and 30 seconds (-37°C to -54°C) This test may be combined with 4 8.1 (see 3 5 4)

4.8.5 Life test. The voltmeters shall be subjected to a 250-cycle life test to be conducted as follows (see 3.5.5, 3.12).

Step 1. The voltmeters shall be mounted to simulate an installed condition and placed in a temperature chamber.

Step 2 All circuitry shall be energized for 3.5 hours during which time the source voltage circuit shall be uniformly varied from 32 volts to

17 volts and back to 32 volts. At the end of the energizing period, all circuitry shall be de-energized for 30 minutes. This shall constitute one life cycle. One cycle after another shall be repeated until a total of 250 cycles have been completed.

Step 3. During the 30-minute de-energized period of each sixth cycle, the chamber temperature shall alternately be either lowered to -54°C or raised to 71°C. After these 30-minute cooling and heating periods, the chamber temperature shall be returned to ambient temperature during the next energizing period

Step 4 At the end of each 7-day period, the voltmeters shall be subjected to and meet the requirements of 3.5.1, 3 10, and 3 11 These tests may be conducted during a 3-1/2-hour energized period At the end of the 250 cycles, the voltmeters shall be subjected to and meet the requirements of 3.5 1, 3.5.2, 3 5.3, 3.5 4, 3 8, 3.10, and 3.11, and the integral lighting shall conform to the brightness requirements specified by the specification sheet.

4 8 6 Acceleration The voltmeter shall be subjected to the acceleration tests of Meth d 513 3, MIL-STD-810 The forward acceleration, A(g), for Tables 513 3-I and 513 3-II is 4g The voltmeter at the conclusion of this test shall meet the requirements of 3.5 1, 3 5 4, and 3 8 (see 3 6 1)

4.8.7 Temperature (see 3 6 2)

4 8 7 1 Low temperature operation. The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at -32°C for a period of 4 hours At the end of the 4-hour soak and while still at temperature, the voltmeter shall meet the requirements of 3 5.1 and 3 5 4 The voltmeter shall be de-energized and the temperature of the temperature chamber shall be reduced to -54°C for an additional 4-hour period At the end of the 4-hour soak and while still at temperature, the voltmeter snall meet the requirements of 3.5.1 and 3.5 4 After the voltmeter has returned to and stabilized at ambient temperature, it shall meet the requirements of 3 5 1 and 3 5.4

4 8 7 2 High temperature operation The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at +71°C for a period of 4 hours At the conclusion of the 4-hour soak and while at temperature, the voltmeter shall meet the requirements of 3.5.1 and 3 5 4 After the voltmeter has returned to and stabilized at ambient temperature, it shall meet the requirements of 3.5 1 and 3 5 4

4 8 7 3 Low temperature exposure The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at -54°C for a period of 24 hours At the end of the 24-hour soak and while still at temperature, the voltmeter shall meet the requirements of 3 5.1 and 3.5.4. After the voltmeter has returned to and stabilized at ambient temperature, it shall meet the requirements of 3.5.1 and 3.5.4.

4.8.7 4 High temperature exposure. The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at +71°C for a period of 24 hours. At the conclusion of the 24-hour soak and while at temperature, the voltmeter shall meet the requirements of 3 5.1 and 3.5.4

After the voltmeter has returned to and stabilized at ambient temperature, it shall meet the requirements of 3 5 1 and 3.5 4

4.8.7.5 Low temperature storage. The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at -62°C for a minimum period of 24 hours. At the conclusion of the soak period, the voltmeter shall be removed from the temperature chamber and allowed to stabilize at ambient temperature. After the voltmeter has stabilized at room temperature, it shall meet the requirements of 3.5.1 and 3 5 4

4.8.7 6 High temperature storage The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at +95°C for a minimum period of 24 hours At the conclusion of the soak period, the voltmeter shall be removed from the temperature chamber and allowed to stabilize at ambient temperature After the voltmeter has stabilized at room ambient temperature, it shall meet the requirements of 3.5 1 and 3.5 4

4 8 8 Temperature shock The voltmeter shall be placed in a temperature chamber and soaked in a nonoperating condition at -40°C for not less than 4 hours At the conclusion of the soak period and while still nonoperating, the voltmeter shall be placed in a temperature chamber adjusted to +85°C and soaked for an additional 4 hours minimum, and this constitutes one complete cycle The voltmeter shall be subjected to a total of three complete cycles and the time required for the transfer of the voltmeter from one temperature extreme to the other shall not exceed 1 minute. At the conclusion of the third cycle, the voltmeter shall be allowed to stabilize at room ambient conditions and shall meet the requirements of 3 5 1 and 3 5 4 (see 3.6 3)

4.8 9 Shock (see 3.6 4).

4 8 9 1 Basic design The voltmeter shall not suffer damage or subsequently fail to provide the performance specified when subjected to a total of 18 impact shocks of 20g, consisting of three shocks in each direction along each of the three mutually perpendicular axis Each shock pulse shall be a 1/2 sine wave having a peak amplitude of 20 0g and a pulse width of 11 $\pm$ 1 milliseconds. The "g" value shall be within $\pm$ 10 percent when measured with a 0 2 to 250Hz filter, and the maximum "g" shall occur at approximately 5.5 milliseconds At the conclusion of this test, the voltmeter shall meet the requirements of 3.5 1, 3.5 4, and 3.8.

4.8 9 2 Crash safety. The voltmeter shall be subjected to a total of 12 impact shocks of 40g, consisting of two shocks in each direction along each of the three mutually perpendicular axis Each shock pulse shall be a 1/2 sine wave having a peak amplitude of 40g and a pulse width of 11 $\pm$ 1 milliseconds The "g" value shall be within $\pm$ 10 percent when measured with a 0.2 to 250Hz filter, and the maximum "g" shall occur at approximately 5 5 milliseconds There shall be no failure of the voltmeter's mounting attachments and the voltmeter shall remain in place and not create a hazard. However, bending, distortion, and degradation of performance requirements shall be permitted. Since this test is considered destructive in nature, it is suggested that this portion of the shock requirements be performed at the end of the test program

4.8.10 Vibration The voltmeter shall operate as prescribed when required during vibration testing and there shall be no evidence of mechanical or electrical degradation when the voltmeter is tested after the completion of the vibration tests. The voltmeter shall be subjected to the vibration tests of

MIL-STD-810, Method 514.3, Procedure I, Test Condition I-3.2.12, Figure 1 and Figure 2 herein (see 3.6.5).

4.8.10.1 Sinusoidal (monitored). MIL-STD-810, Method 514.3, Procedure I, Test Condition I-3.2.12 and Figure 1. The test time for each of the three mutually perpendicular axis shall be 3 hours for a total time of 9 hours. Degradation of the voltmeters electrical or mechanical performance shall be cause for rejection

4 8 10 2 Random non-gunfire (unmonitored) MIL-STD-810, Method 514 3, Procedure I, Test Condition I-3 2 12 and Figure 2 The test time for each of the three mutually perpendicular axis shall be 55 minutes Degradation of the voltmeter electric performance shall be permitted, but degradation of the voltmeter's mechanical performance requirements shall be cause for rejection

4 8 10 3 Random non-gunfire (monitored). MIL-STD-810, Method 514 3, Procedure I, Test Condition I-3.2 12 and Figure 2 The test time for each of the three mutually perpendicular axis shall be 5 minutes After 55 minutes have elapsed as specified in 4 8 10 2, the vibration level of 7 6 grms shall be reduced to 5 4 grms, and the voltmeter shall be monitored for an additional 5 minutes Degradation of the voltmeters electrical or mechanical performance shall be cause for rejection At the conclusion of the tests 4 8 10 1 through 4 8 10 3, the voltmeter shall meet the requirements of 3 5 1 and 3 5 4

4 8 11 Temperature-altitude (see 3 6 6) The voltmeter shall be placed in a temperature chamber adjusted to a temperature of -54°C and operating at an input voltage of 15 0 volts for a soak period of 72 hours At the end of the 72-hour soak period while still at temperature, the chamber shall be adjusted to simulate an altitude of 21,336 meters, and these conditions shall be maintained for an additional 4 hours At the conclusion of the additional 4-hour period, the voltmeter shall meet the requirements of 3 5 1 With the voltmeter in the temperature chamber, adjust the temperature to +71°C and the chamber pressure to ambient At this time, increase the voltmeter input voltage to 35 0 volts and maintain these conditions for 72 hours At the conclusion of the 72-hour soak period, the chamber shall be adjusted to simulate an altitude of 21,336 meters and these conditions shall be maintained for an additional 4 hours and at this time the voltmeter shall meet the requirements of 3.5.1 The temperature chamber shall be returned to ambient temperature and altitude and the input voltage to the voltmeter removed After the voltmeter has stabilized at the ambient conditions, the voltmeter shall meet the requirements of 3 5.1, 3 5 4, 3 10, and 3.11.

4 8 12 Humidity The voltmeter shall be subjected to the humidity test of Procedure I, Method 507 2, Cycle 1 Non-Hazardous Items, MIL-STD-810 At the conclusion of this test, the voltmeter shall meet the requirements of 3 5.1 and 3 5 4 (see 3 6.7)

4 8 13 Fungus resistance The voltmeter shall be subjected to the fungus test of Method 508.3, MIL-STD-810. The test shall be for 28 days. At the conclusion of this test, the voltmeter shall meet the requirement of 3.5 1 and 3.5.4 Growth of fungus on the voltmeter may be cause for rejection. The fungus test of the voltmeter may be deleted if the contractor submits a certificate signed by a company official indicating that the voltmeter will not support fungal growth (see 3 6 8)

4 8 14 Salt spray. The voltmeter shall be subjected to the salt spray test of MIL-STD-810, Method 509.2, Test Condition I-3.2. The voltmeter shall be tested outside the shipping container and in its normal operating condition (mode). The test time shall be 48 hours minimum followed by a minimum drying period of 48 hours. At the conclusion of the test and drying period, the voltmeter shall meet the requirements of 3.5.1, 3.5 4, 3 8, 3 9, 3 10, and 3 11 (see 3 6.9).

4 8 15 Electromagnetic interference The voltmeter shall be tested in accordance with MIL-STD-462 for those tests required by MIL-STD-461 for Class A1, category A1b equipment and the specification sheet (see 3 6 10)

4.8 16 Magnetic effect. The voltmeter de-energized, shall be rotated in a vertical plane about a short-bar magnetic compass with the nearest part of the voltmeter 139 7 millimeters from and magnetically east or west of the center of the compass Starting directly under the compass, the voltmeter shall be held in positions 0, 45, 90, 135, 180, 225, 270, and 315 degrees from the initial position At each of these positions, the voltmeter shall be rotated on its own horizontal axis until it is in the normal upright position The horizontal magnetic field intensity shall be 0 17 to 0 19 oersted. With the voltmeter at any specified position, the compass deflection shall not exceed 3 degrees This test shall be repeated with the voltmeter energized (see 3 6 11).

4 9 Dielectric strength. A voltage and frequency of 500V and 60Hz shall be applied individually from each connector pin to case for not more than 30 seconds except for those connector pins designated to be terminated to the voltmeter case. There shall be no insulation breakdown or permanent damage to the voltmeter as a result of this test. The voltmeter shall meet this requirement prior to and after the completion of the environmental portion of the test program (see 3 7).

4.10 Integral lighting The voltmeter shall be subjected to and pass the tests of MIL-L-25467, MIL-P-7788, or MIL-L-85762 as applicable for color and brightness (illumination) and pass the tests of MIL-L-25467 for stray light and visibility of displays. During these tests, the voltmeter shall be energized so that digital displays are activated (see 3.4.8)

4 11 Examination of product The voltmeter shall be inspected to insure compliance with the requirements for dimensions, weight, color, markings, and workmanship (see 3.8, 3.9, 3.10, 3.11, 3.13).

5 PACKAGING

5 1 Preservation-packaging Preservation-packaging shall be in accordance with MIL-STD-2073, level A or C, as specified in the contract or order (see 6.2).

5.1.1 Level A. For level A packaging, preservation shall be in accordance with MIL-P-116, Method II, without preservation compounds.

5 1.2 Level C. For level C the voltmeter shall be preserved and packaged individually in accordance with the manufacturer's commercial practice.

5.2 Packing. Packing shall be in accordance with MIL-STD-2073, level A, B, or C as specified in the contract or order.

5.3 Marking. Interior and exterior containers shall be marked in accordance with MIL-STD-2073 and MIL-STD-130.

6 NOTES

6.1 Intended use. The digital voltmeter is intended for use in aircraft to provide an indication as to the capacity of the aircraft storage battery by displaying the battery voltage and to generate a warning display at a predetermined voltage.

6 2 Ordering data Acquisition documents should specify the following

a Title, number, and date of this specification

b Military part number

c. Required level of packaging and packing.

d Integral lighting requirement

e Voltmeters which have been subjected to the Quality Conformance tests specified under 4 7 may be delivered on contract provided the sample is representative of production voltmeters currently being accepted

6 3 First article When a first article is required, the voltmeter will be inspected and tested in accordance with Section 4 of this specification The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, test, and approval of the first article.

6 3 1 Forwarding of first article sample Samples for first article testing and the manufacturer's certified quality conformance inspection test reports should be forwarded to the testing laboratory designated in the letter of authorization from the acquiring activity, plainly identified by securely attached, durable tags marked with the following information

a Sample for first article tests
b Voltmeter
c Military part number
d Manufacturer's name and code number
e Manufacturer's part number.
f Place and date of manufacture of sample
g Submitted by (name) (date) for first article tests in accordance with MIL-V-85603 under authorization (reference authorizing letter)

6 4 Engineering changes to a first article qualified item Once a manufacturer's part number has been given a first article approval, the manufacturer is responsible for any changes to the voltmeter which affect its physical or performance characteristics. No changes should be made to a qualified unit without the specific written approval of the acquiring agency The manufacturer should allow sufficient lead time for the qualifying agency to repeat the first article tests if necessary.

6 5 Design guides The following design guidelines based on actual experience should be addressed and considered by the contractor when a

voltmeter is to be developed and proposed in accordance with this specification.

6.5.1 Environmental stress screening. Environmental stress screening of electronic parts should be used where required to achieve the voltmeter MFHBF as specified in 3 12.

6 5 2 Threaded parts All threads should conform to MIL-S-7742. All internal or external parts which are threaded should be positively locked. Accidental loosening of threaded elements shall be prevented by self-locking nuts, safety wiring, or other approved methods

6 5.3 Selection of parts. The voltmeter should not use any gas or vacuum devices, or devices which depend on elevated temperature external to the voltmeter for operation

6.5.4 Magnetic materials. Magnetic materials should not be used.

6 5 5 Semiconductor devices Semiconductor devices should be selected and applied in accordance with MIL-STD-454, Requirement 30 Microelectronic devices should be selected and applied in accordance with MIL-STD-454, Requirement 64

6 5 6 Capacitors Capacitors should be chosen and applied in accordance with MIL-STD-454, Requirement 2

6 6 Definitions. The following definition of terms should apply.

6 6.1 Refurbished Refurbished means that the voltmeter has been completely overhauled, that all component parts meet current parts standards, and that the voltmeter meets all requirements of a new voltmeter

6.6 2 First article inspection Tests conducted on a voltmeter submitted for qualification when the acquisition contract requires a first article approval

6.6 3 Quality conformance inspection Those inspections and tests conducted on each voltmeter manufactured and submitted for acceptance under a production contract

6.7 Manufacturing guides. The appropriate technical requirements contained in the following list of documents should be applied by the manufacturer where applicable in order to achieve and maintain the Government's established policy requiring an acceptable level of manufacturing quality for all electrical/electronic equipment

DOCUMENT	TITLE
MIL-STD-275	Printed Wiring for Electronic Equipment
QQ-P-416	Plating, Cadmium (Electrodeposited)
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-1562	List of Standard Microcircuits

WS-6536	Procedures and Requirements for Preparation and Soldering of Electrical Connections
MS33558	Numerals and Letters, Aircraft Instrument Dial, Standard Form of
MIL-P-55110	Printed Wiring Boards
MIL-E-81910	Electrical Power Generating and Control Equipment, Aircraft, General Specification for
NAV MAT-P-9492	Navy Manufacturing Screening Program

6 8 Subject term (key word) listing

Aircraft Digital Display DC Voltmeter

Digital Readouts

Integral Lighting

Capacity of Storage Batteries

Preparing Activity
Navy - AS
(Project No 6625- N979)

SINUSOIDAL TEST SCHEDULE

(Test times in minutes per axis)

ORDER	# OF EQUIPMENT RESONANCES	0	1	2	3	4
1	Total Dwell Time at Equipment Resonances	0	30	60	90	120
2	Total Cycling Time (5-2000-5 Hz 20 min. log sweep)	180	150	120	90	60
Total Time Each Axis		180	180	180	180	180

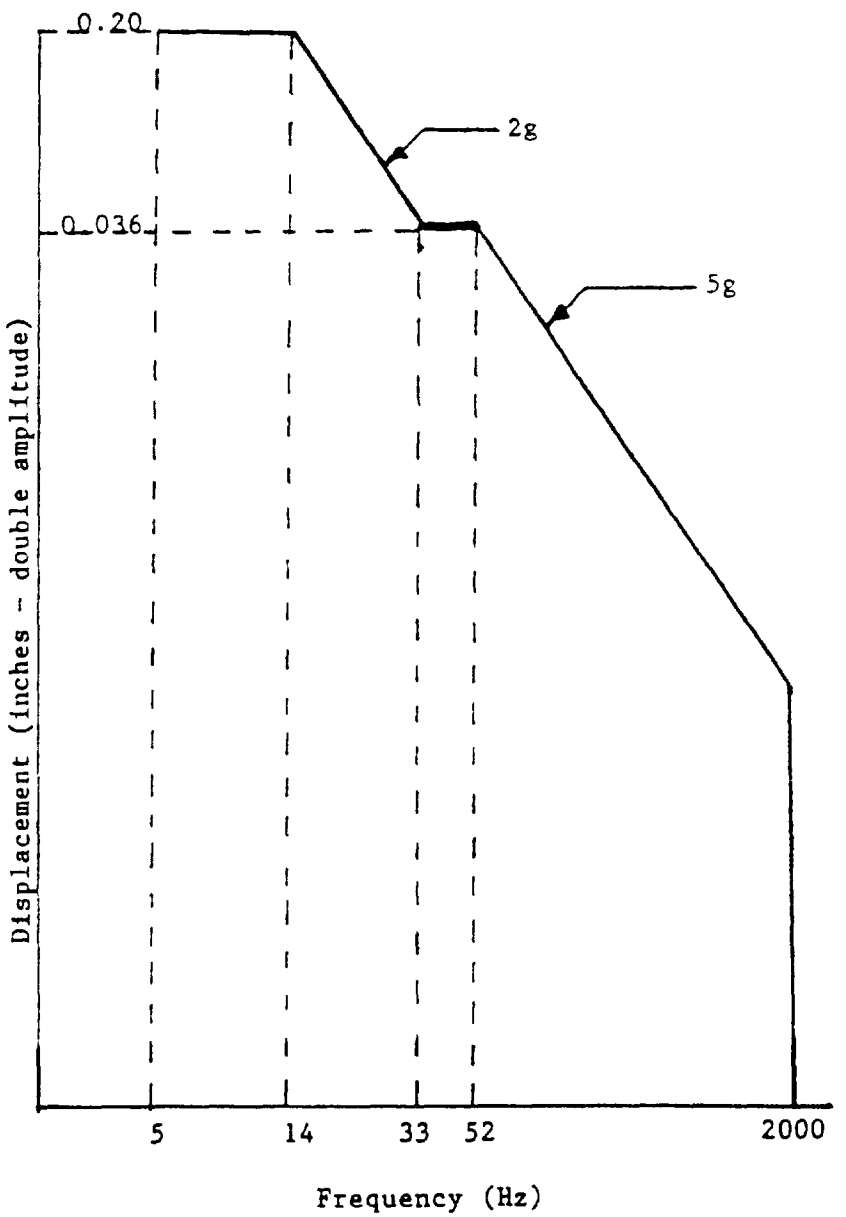
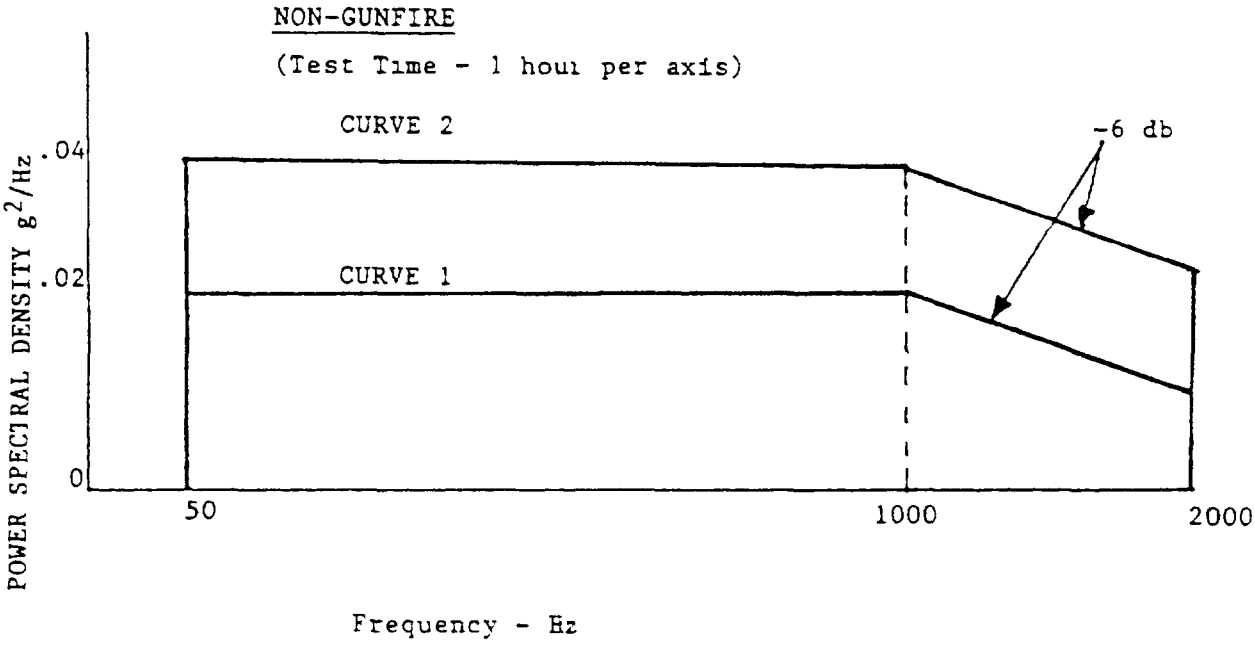


FIGURE 1 - Vibration sinusoidal test requirements



CURVE 1 monitored composite - 5.4 grms
CURVE 2 unmonitored composite - 7.6 grms

FIGURE 2 - Vibration random test requirments

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-V-85603(AS)	

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)* _____

5. PROBLEM AREAS

a. Paragraph Number and Wording

b. Recommended Wording

c. Reason/Rationale for Recommendation

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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NOTE This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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