NOT MEASUREMENT SENSITIVEI
MIL-PRF-28800F
24 June 1996
SUPERSEDING:
MIL-T-28800E
3 SEPTEMBER 1991

PERFORMANCE SPECIFICATION

TEST EQUIPMENT FOR USE WITH ELECTRICAL AND ELECTRONIC EQUIPMENT, 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 test equipment (see 6.5.2.14) used in testing and calibrating electrical and electronic equipment. The test equipment may be of commercial design and includes general purpose, special purpose, peculiar, console mounted, automatic test equipment (ATE), and calibration standards. This specification should also be used for built-in test equipment (BITE) (see 6.5.2.6) when the requirements for built-in test (BIT) (see 6.5 .2.5) are not included in the system specification. Detailed requirements for particular test equipment should be tailored in a purchase description (see 6.5.2.22) for that equipment.

1.1.1 Usage. The requirements of this specification are to be invoked according to class and may be tailored based on the installation and intended use of the equipment. An Appendix is provided to assist the specification writer with a checklist approach to the development of a purchase description invoking MIL-PRF-28800.

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 03R42, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160 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

1.2 Classification. Test equipment specified herein is categorized by class (requirements arising from the intended operational environment). The class shall be assigned, in the purchase description, by the most severe environmental condition expected for the equipment. Other environmental requirements may be derated from the most severe environmental requirement. The purchase description will identify environmental conditions that exist from a less severe class. The purchase description will specifify other features that extend beyond defined class definitions. **(Note: This requires that the developer of the purchase description define the most severe class even if only one aspect of the environmental performance is of that class, while all other aspects are of a less severe class.)**

1.2.1 Class. Test equipment covered by this specification is categorized by performance characteristics required for an intended location of use and the most severe prevailing environmental conditions of such locations. Test equipment classes are specified in the following paragraphs (a through d) and the performance characteristics required for each class are summarized in Table 2.

a. Class 1. Class 1 equipment is designed for hostile operational environments where the environmental conditions are extremes of world climatic variation. Examples include test equipment for use in the vicinity of aircraft in tracked and wheeled vehicles, or for typical above-deck applications.

b. Class 2. Class 2 equipment is designed for rugged operational environments where the environmental conditions are routinely encountered in an unprotected, uncontrolled climate. Test equipment for use as a portable (see 6.5.2.20) instrument in more than one location that has a substantial degree of environmental protection maybe considered as Class 2.

c. Class 3. Class 3 equipment is designed for operational environments where conditions are routinely encountered in a diverse, controlled climate. Examples include test equipment for bench-top, rack-mount and occasional portable use in diverse, environmentally controlled locations.

d. Class 4. Class 4 equipment is designed for benign operational environments where the environmental conditions are controlled and protected. Examples include test equipment for use in a filly protected and environmentally controlled service area such as a laboratory.

1.2.2 Enclosure. The enclosure provides protection for the contained system components during storage, handling, and use compatible with the contained class of equipment. A commercial-off-the-shelf (COTS) enclosure, normally provided by the manufacturer, that meets the requirements of Section 3 is acceptable unless otherwise specified.

1.2.3 Color. Unless otherwise specified, the color shall be the color normally provided by the manufacturer.

1.2.4 Configuration. When the purchase description invokes more than one class of this specification, the different configurations (see 6.5.2. 10) should be identified. Selection criteria for each class of equipment is specified in Table 2.

1.3 Navy shipboard use. Electronic test equipment furnished to the Navy that uses material restricted for Navy use (see 3.2.3. 1), or that exceeds the size limitations (see 3.6.1.1) of this specification, requires approval by the Navy prior to procurement.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this document. This section does not include documents cited in other sections of this document 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 documents cited in sections 3 and 4 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplemented thereto, cited in the solicitation (see 6.2).

STANDARDS

MILITARY

MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 191 11-5094.)

2.3 Non-Government publications. The following documents form a part of this specification 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 (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSVISA-S82.01	Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment (General Requirements)
ANSI/ISA-S82.02	Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment (Electrical and Electronic Test and Measuring Equipment)
ANSI-Y32.2	Graphic Symbols For Electrical and Electronic Diagrams
ANSI-Y32.16	Standard Reference Designations for Electrical and Electronics Parts and Equipment

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D3951	Standard Practice for Commercial Packaging
ASTM D4169	Standard Practice for Performance Testing of Shipping Containers and Systems

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

COMITE INTERNATIONAL SPECIAL DES PERTURBATIONS RADIOELECTRIQUES (CISPR)

CISPR 11:1990 Limits and Methods for Measurement of Electromagnetic Disturbance Characteristics of Industrial, Scientific and Medical (ISM) Radio Frequency Equipment

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA RS-310 Racks, Panels and Associated Equipment

(Application for copies should be addressed to Electronic Industries Association, 2500 Wilson Blvd, Arlington, VA 22201.)

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

ANSI/IEEE-STD-488.1	Standard Digital Interface for Programmable Instrumentation
ANSI/IEEE-STD-488.2	Standard Codes, Formats, Protocols, and Common Commands

(Applications for copies should be addressed to the IEEE Standard Sales, 345 East 47th Street, New York, NY 10017.)

INTERNATIONAL ORGANIZATION OF STANDARDIZATION (IS0)

IS0 7779	Acoustics – Measurement of airborne noise emitted by computer and business equipment

(Applications for copies should be addressed to the International Organization of Standardization, CH-1211, Geneva, Switzerland.)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC-1000-4-2	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment Part 2: Electrostatic Discharge Requirement
IEC-1000-4-3	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment Part 3: Radiated Electromagnetic Field Requirement
IEC-1000-4-4	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment Part 4: Electrical Fast Transient/Burst Requirement
IEC-1000-4-6	Electromagnetic Compatibility for Electrical and Electronic Equipment Part 6: Immunity to Conducted Disturbances Induced by Radio Frequency Fields
IEC-1010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use (General Requirements)

(Applications for copies should be addressed to the Bureau Central de la Commission Electrotechnique Internationale, 3, rue de Varembe, Geneva, Switzerland.)

UNDERWRITERS LABORATORIES (UL)

UL 1950	Safety Information Technology Equipment, Including Electrical Business Equipment

(Application for copies should be addressed to the Underwriters Laboratories, 1285 Walt Whitman Road, Melville, NY 11747.)

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 purchase descriptions), 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 Equipment sample requirements. When specified (see 6.2), sample equipment shall be provided for inspections as specified in 3.1.1 through 3.1.3.

3.1.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 4.2 and 6.3).

3.1.2 Bid sample. When specified (see 6.2), a bid sample shall be subjected to bid sample inspection (see 4.3 and 6.4).

3.1.3 Conformance inspection. When specified (see 6.2), a sample shall be subjected to conformance inspection (see 4.4).

3.2 Equipment components. Parts, materials, and processes shall be as specified in 3.2.1 through 3.2.3.3 and shall permit the equipment to comply with all applicable requirements of its class.

3.2.1 Finish. Unless otherwise specified the equipment shall be the finish normally provided by the manufacturer.

3.2.2 Interchagneability. Manufacturers shall designate a model number for units provided. All units and the replaceable assemblies, subassemblies, and parts comprising the unit shall be interchangeable on a noninterference basis with all such designated models provided. The contractor shall immediately inform the procuring activity of any conflict between the interchangeability requirements of this specification and the purchase description.

3.2.3 Restricted materials. Restricted materials shall be as specified in 3.2.3.1 through 3.2.3.3.

3.2.3.1 Material restricted for Navy use. Regardless of other requirements, the materials and parts specified in a through c shall not be used in equipment for the Navy unless otherwise specified.

a. Mercury, including mercury batteries.
b. Radioactive material.
c. Lithium electrochemical cells.

3.2.3.2 Other restricted materials and gases. Test equipment shall not contain materials that promote the premature failure of the equipment or that present a health hazard under normal use or storage conditions as specified in 3.2.3.2.1 through 3.2.3.2.5.

3.2.3.2.1 Organic materials. Test equipment shall not contain materials prone to organic decay or that act as a nutrient for the growth of multicelled organisms.

3.2.3.2.2 Flammable materials. Test equipment shall not contain materials that ignite into flames at operating or storage temperatures.

3.2.3.2.3 Explosive materials. Test equipment shall not contain materials that explode at operating or storage temperatures.

3.2.3.2.4 Carcinogens. Certain chemicals have been identified in the Occupational Safety And Health Act (OSHA) as cancer-producing substances (carcinogens). Before using any materials that might contain these chemicals, the materials shall be evaluated in accordance with 3.10.

3.2.3.2.5 Helium. Helium shall not be used as pressurizing gas in sealed units containing electron tubes. When necessary to use helium for leak detection purposes, exposure shall be limited to the time necessary for the test, followed by thorough purging.

3.2.3.3 Combination of materials. The equipment shall contain no combination of materials that cause deterioration of any material contained in the equipment due to the effects of outgassing.

3.3 Desire and construction. The test equipment shall be designed and constructed to permit compliance with all applicable requirements of its class and the performance, accuracy, and other requirements in the purchase description.

3.3.1 Operator adjustments and controls. Operator adjustments and controls shall be as specified in 3.3.1.1 and 3.3.1.2.

3.3.1.1 Operator adjustments. The equipment shall include built-in adjustments or compensating devices for any function or parameter that would exceed the specified tolerance within the calibration interval defined in 3.12. Under all specified service conditions the variation of any adjustment or control shall produce the desired control action to bring the equipment within tolerance.

3.3.1.2 Operator controls. Operating controls and indicators shall be readily accessible to the operator from the front of the equipment. The readings presented on the controls and indicators shall be available to the operator without conversion or calculation.

3.3.2 Connectors, electric. Provision shall be made to ensure that connectors will be mated only with the appropriate counterparts. Where design considerations require close proximity of connectors of similar configuration, the mating connectors shall be suitably coded or marked. The live or hot side of unmated connectors shall be protected against shorting.

3.3.3 Wiring, internal. Internal wiring practices shall be such that the wiring shall not be darnaged during normal maintenance and calibration.

3.3.4 Internal cooling. The equipment shall be capable of operating without interruption for at least 24 hours at the maximum operating temperature for the class that it is designed.

3.3.4.1 Cooling devices. Cooling devices used in the equipment shall be an integral part of the equipment and not degrade any aspect of performance or safety.

3.3.5 Front panel display indicators. Front panel display indicators designed to present change-of-state information to the operator shall be distinguishable at a distance of 1 m in a maximum ambient light level of 100 foot-candles (fc) and a minimum light level of 1 fc. All display indicators shall be discernible at viewing angles from O degrees to 45 degrees.

3.3.6 Self-test capability. When specified, the equipment shall be able to provide automatic diagnostic self-test (see 6.5.2.26) information. The information provided shall indicate whether the equipment is operating within the performance specification. If the equipment exceeds the performance specification bounds, the information provided by the self-test shall identify the associated lowest replaceable unit (LRU) failure causing the malfunction.

3.4 Digital interface. When specified, a digital interface shall be provided. The measurement information to be transferred by the digital interface shall be as specified. The digital interface shall have the programmable capability to control each device function including all ranges, modes, and levels. Primary power control and other nonmeasurement functions need not be controllable through the digital interface.

3.4.1 ANSI/IEEE-STD-488 interface requirements. If an ANSI/IEEE-STD-488 digital interface is specified, it shall comply with ANSI/IEEE-STD-488.1 and with the specified portions of ANSI/IEEE-STD-488.2. The interface functions and subset identifications specified in a through j shall be considered for determining equipment requirements.

a. Source handshake SH1.
b. Acceptor handshake AH1.
c. Talker T1 or TE1.
d. Listener L1 or LE1.
e. Service request SR1.
f. Remote local RL1.
g. Parallel poll PP0.
h. Device clear DC1.
i. Device trigger DT1.
j. Controller C0.

3.5 Electrical power sources and connections. Electrical power sources and connections shall be as specified in 3.5.1 through 3.5.2.9.

3.5.1 Electrical power source. The equipment shall operate from the input power conditions specified in 3.5.1.1 through 3.5.1.2.6. When multiple power source requirements are invoked, the equipment shall operate within each required range without changing manually operated devices such as tapped transformers (variable setting transformers) and other similar devices for compensation. When multiple power source requirements are invoked, all selectable power setting controls shall be externally accessible.

3.5.1.1 Power consumption. The maximum power for operation shall be as specified in the purchase description.

3.5.1.12 Nominal and alternate power source. The equipment shall operate at 120 Vrms single-phase 50 Hz and 60 Hz source (see Table 1). Alternate power source requirements that maybe required for equipment are specified in a through e.

a. 50 Hz, 60 Hz, and 400 Hz single-phase 120 Vrms.
b. 50 Hz, 60 Hz, and 400 Hz single-phase with voltage selectable from a 100/120/220/240 Vrms range.
c. 50 Hz, 60 Hz, and 400 Hz single-phase 120/240 Vrms (see 3.5.1.2.4).
d. DC internal power source (see 3.5.1.2.5).
e. DC external power source (see 3.5.1.2.6).

Equipment designed to operate from both external and internal power sources shall conform to specified performance and accuracy requirements when operated from the external source with the internal battery removed. There shall be an external indication of the selected power range.

TABLE 1. Power source.

Voltage (Vrms)			
	Steady-state	Transient-state	Interruption
Nominal	108 to 132	84 to 108 132 to 156	0 to 84
Alternate (see 3.5.1.2.4)	216 to 264	168 to 216 264 to 312	0 to 168
Frequency (Hz)			
	Steady-state	Transient-state	Interruption
Nominal	47.5 to 52.5	45 to 47.5 52.5 to 57	0 to 45
	57 to 63	54 to 57 63 to 66	0 to 54
Alternate (see 3.5.1.2.4)	380 to 420	360 to 380 420 to 440	0 to 360

3.5.1.2.1 Steady-state conditions. The performance and accuracy of the equipment shall not be adversely affected when operated under any combination of conditions a through c. Tolerance values are derived from, and referenced to, the nominal values specified for voltage and frequency.

a. The steady-state voltage-tolerance shall be ±10%.
b. The steady-state frequency-tolerance shall be ±5%.
c. The deviations in waveform (see 6.5.1a) characteristics shall be as in 1 through 4:

1. Waveform deviation factor of ±10 percent or less.
2. Total harmonics of ±10 percent or less.
3. Individual harmonics of ±5 percent or less.
4. Crest factor of 1.27 to 1.56.

3.5.1.2.2 Transient-state conditions. Operation of the equipment during voltage and frequency transients shall be in accordance with a and b for transients that recover to within the steady-state tolerance band within 500 ms. The equipment performance maybe impaired during the transient. Transient values are derived from, and referenced to, the nominal values specified for voltage and frequency.

a. Voltage transients within the range of ±10 percent to ±30 percent shall not cause the operation of the equipment to be impaired for longer than 30 seconds following the transient and not cause loss of information stored in a volatile memory. Testing shall be in accordance with 4.5.5.6.3.

b. Frequency transients within the range of ±5 percent to ±10 percent shall not cause the operation of the equipment to be impaired for longer than 30 seconds following the transient and not cause loss of information stored in a volatile memory. Testing shall be in accordance with 4.5.5.6.4.

3.5.1.2.3 Interruption of power source. Voltage or frequency interruptions shall not cause damage to the equipment. A power source interruption is when the voltage falls in the range of O to 70% of nominal or frequency falls in the range of 0 to 90% of nominal. Equipment performance is not required during interruption of the power source. After power interruptions of any duration, the equipment shall automatically resume operation at either the last operating condition before interruption, or a default power-up condition.

3.5.1.2.4 Alternate signal-phase sources. When the equipment is designed to operate from a 240 Vrms nominal, or 400 Hz nominal alternate single-phase source, the tolerance and times of the steady-state, transient-state, and interruption of power source requirements shall apply to the alternate power source.

3.5.1.2.5 DC internal power source. When specified, the equipment shall be designed to operate from self-contained batteries.

3.5.1.2.5.1 Battery restrictions. Battery restrictions shall apply as stated in paragraphs a and b:

a. For Army applications, maximum use will be made of standard, nomenclature battery-power sources. The use of nonstandard, nonnomenclatured batteries requires the approval of the cognizant Army procuring activity.

b. For Navy applications, the use of lithium and mercury batteries is restricted and shall not be used in equipment unless specifically required and approved by the procuring Navy activity. If a restricted type of battery is approved, technical manuals shall reference substitute battery types, and all necessary modifications to use the substitute batteries. The Equipment shall incorporate safety precautions of UL1950 and a label containing the following caution and information shall be affixed to the outside of the unit:

THIS UNIT CONTAINS LITHIUM BATTERIES Battery Manufacturer: Battery Part Number:

for lithium batteries, or for mercury batteries;

THIS UNIT CONTAINS MERCURY BATTERIES Battery Manufacturer: Battery Part Number:

3.5.1.2.5.2 Battery state indicator. An indicator shall be provided to indicate when the capacity of batteries used for primary power is low. The approximate remaining operating time for the low battery state shall be specified in the equipment operating manual.

3.5.1.2.5.3 External battery pack. When the equipment is required to operate from an external portable battery pack, the battery pack shall be as specified in the purchase description.

3.5.1.2.6 DC external power source.. Equipment operation from an external dc source shall be as specified in the purchase description.

3.5.2 Electrical power connections. The requirements specified in 3.5.2.1 through 3.5.2.9 shall apply to equipment rated at 10A rms, or less. Power connectors and connections for equipment rated above 10A rms shall be as specified in the purchase description. When single-phase operation is specified, the equipment shall operate with a ground at the primary power source on either or neither side of the single phase input power line.

3.5.2.1 Multiphase equipment. Except as specified for leakage current (see 3. 10), equipment requiring multiphase power shall be as specified in the purchase description.

3.5.2.2 Input power cable. Unless specified, the input power cable shall be a detachable power cable normally provided by the manufacturer. When equipment is specified for operation from 120 Vrrns and 240 Vrms power sources, separate 120 Vrms and 240 Vrms power cables shall be provided.

3.5.2.3 Input power switch. The operator shall be able to energize the equipment from the front panel. A standby capability maybe incorporated to activate and deactivate the equipment. If such a capability is provided, suitable warnings shall be placed in the operating and service manuals and on the equipment to warn the operator of possible shock hazards during servicing, due to partially activated power supplies.

3.5.2.4 Power selection switch. When the configuration of the equipment requires a power selection switch, the equipment shall be provided set to operate at 115 Vrms or 120 Vrms. A safety mechanism shall be incorporated to prevent the accidental switching between voltage selections.

3.5.2.5 Excessive current drain protection. Automated safety mechanisms shall be incorporated to automatically disconnect the equipment in the event of current being drawn that is in excess of the equipment rating. As specified, the mechanism" shall be from the front for Class 1 equipment or from an exterior panel for equipment of Class 2, Class 3, and Class 4.

3.5.2.6 Indicators. Visual indication shall be provided on the front panel to indicate when the equipment is energized.

3.5.2.7 Battery operating and recharge time. When battery operation is required, the operating and recharge time shall be as specified in the purchase description.

3.5.2.8 Battery charger. When specified, the equipment shall provide an internal battery charger capable of charging the internal batteries when the equipment is connected to the specified ac power source. The charging circuit shall not load the internal battery when the equipment is disconnected from the ac power source; if mechanical or electrical disconnection of the charging circuit is required by the design, such disconnection shall be provided for by means other than manual switching. When rechargeable batteries and charger are required, an automatic protective device shall be included to prevent overcharging the batteries.

3.5.2.9 Battery compartment. When specified, an externally accessible, covered battery compartment shall be provided on equipment powered from internal batteries. The compartment shall only provide access to the battery. The battery compartment shall provide protection from external sources that could damage the battery, protect the equipment from deteriorated batteries, and provide access to clean the compartment. The battery polarity, voltage, and type shall be marked in a prominent place on or adjacent to the battery compartment.

3.6 Enclosure physical characteristics. The physical characteristics of the equipment enclosure shall be as specified in 3.6.1 through 3.6.4.14.1.

3.6.1 Dimensions. Dimensions shall be as specified in the purchase description. The required dimensions for the height, width, and depth may be specified for both maximum and partial dimensions (see 6.5.2.12).

3.6.11 Maximum dimensions, Navy shipboard applications. For Navy use in shipboard applications, the maximum dimensions shall not exceed a size capable of passage through hatches 508 mm wide by 965 mm high, reduced further by round comers on a 254 mm radius and through circular openings 635 mm in diameter.

3.6.2 Weight. The maximum weight shall be as specified in the purchase description.

3.6.3 Mechanical stability. The equipment shall be designed to preclude tipping during normal handling and operation. Testing shall be in accordance with 4.5.7.4. This requirement is not applicable to test equipment smaller than 2000 cc with a weight less than 2.5 kg, and excludes equipment that has a depth of 4.5 or more times the height, or that has a height of less than 100 mm.

3.6.3.1 Enclosure attitude. Equipment shall be mechanically stable when positioned in its normal attitude on a bench for horizontal viewing of the front panel, and when placed in its alternate attitude on the floor or deck for vertical viewing of the front panel. The size and weight limitations of 3.6 apply to this requirement.

3.6.4 Enclosure requirement. The degree of protection provided by the enclosure shall allow the complete equipment to pass those environmental tests appropriate to the specified environmental class.

3.6.4.1 Cover. When specified, the enclosure shall have a cover.

3.6.4.2 Latches. When latches are incorporated in the design of the equipment they shall incorporate a quick-opening mechanism.

3.6.4.3 Stacking provisions. Equipment enclosures shall have a geometric configuration that permits stacking without harm to the enclosure or its contents. The maximum stacking height (expressed as a quantity of equipment in excess of one) shall be as specified.

3.6.4.4 Component protection. Panels shall be designed to conform to the bench handling requirement of 3.8.5.3.

3.6.4.5 Handles. Unless otherwise specified, one or more handles shall be provided. The number and location of handles shall be such that the load distribution per handle shall not exceed 20 kg. Handles shall be located above the equipment center of gravity to ensure carrying stability. Handles shall permit compliance with the enclosure attitude provisions specified in 3.6.3.1.

3.6.4.6 Accessory stowage. When specified, the enclosure shall have provisions for the stowage of all accessories, (see 6.5.2.1). Stowage shall not adversely affect the carrying stability of the equipment and shall be contained in a manner that prevents damage to the accessories or equipment during transit. Stowed items shall be available without disturbing enclosure seams.

3.6.4.7 Corners. All comers shall be designed to preclude injury to personnel or damage to material. All comers shall be adequately reinforced to protect the instrument from damage during the environmental conditions specified for the enclosure.

3.6.4.8 Connections and controls. Unless otherwise specified, all external electrical connections (except power connections) and operating controls shall be on the instrument panel. Electrical power connections shall be on the rear.

3.6.4.9 Chassis fasteners. Unless otherwise specified, the chassis shall be securely fastened within the enclosure conforming to the maintainability requirements of 3.14.3.

3.6.4.10 Pressure equalizing valve. Unless otherwise specified for Class 1 equipment, a mechanism for equalizing air pressure within the enclosure, when the enclosure is sealed, shall be provided. The mechanism provided shall not protrude beyond the enclosure.

3.6.4.11 Enclosures, console cabinet. When specified, the equipment shall be fitted with a console cabinet. The console cabinet enclosure shall provide protection for the contained equipment from the specified environmental conditions. Access to the interior of the enclosure shall be provided. When specified work surfaces for personnel shall be provided. The console cabinet enclosure shall be designed so that they can be lifted and transported by fork lift vehicles when the equipment is in its normal upright position. Additional requirements for transportability shall be defined in the purchase description.

3.6.4.12 Work surfaces, console cabinet. When specified, the equipment fitted with a console cabinet shall have work surfaces provided. Personnel work surfaces shall be constructed of nonconducting material. Any work surface that projects from the console cabinet shall not be damaged during or interfere with transport or shipping.

3.6.4.13 Rack-mounting requirements. Enclosures that are required to be rack-mounted and enclosures required to accommodate rack-mountable equipment shall be in accordance with EIA RS-310 for 482.6 mm standard panel width.

3.6.4.14 Convertible/rack-mountable equipment. When specified, the equipment shall be capable of being rack-mounted. All convertible/rack-mountable equipment shall conform to the requirements of its class when configured for rack-mounting use in accordance with 3.6.4.14.1.

3.6.4.14.1 Rack-mount conversion. Conversion shall be accomplished by use of a kit that converts the enclosure for rack-mounting, but will not prevent return to the original configuration. The rack-mount conversion kit shall include all hardware required to configure the equipment for rack-mounting. When the height of the front panel is not a multiple of the preferred panel height increment, or when the width is less than rack-width, the conversion kit shall include filler panels to provide the preferred height and width in accordance with 3.6.4.13. No part of the equipment shall protrude above or below the front panel when the enclosure is rack-mounted.

3.7 Transit case. When specified, the equipment shall be fitted with a transit case. The transit case shall provide protection for the contained test equipment from the specified environmental conditions. The transit case is not an integral part of the test equipment. The transit case need not provide for operational capability of the equipment when enclosed. The physical characteristics of the transit case shall be as specified in 3.7.1 through 3.7.6.

3.7.1 Cover, transit case. The transit case shall have a cover that canto be closed and fastened. Fasteners shall allow for quick opening. If the cover is removable, fasteners shall not interfere with cover removal.

3.7.2 Stacking provisions, transit case. Unless otherwise specified, the transit case shall have a geometric configuration that permits stacking without harm to the enclosure or its contents. The maximum stacking height (expressed as a quantity of equipment in excess of one) shall be as specified in the purchase description.

3.7.3 Handles, transit case. Unless otherwise specified, one or more handles shall be provided. The number and location of handles shall be such that the load distribution per handle shall not exceed 20 kg. Handles shall be located above the equipment center of gravity to ensure carrying stability. Handles shall permit compliance with the enclosure attitude provisions specified in 3.6.3.1.

3.7.3.1 Handles, hard transit case. Unless otherwise specified, a transit case shall include hinged metal handles with sufficient internal clearance to allow a block 44 mm by 106 mm in cross section with edges rounded to a 24 mm radius to pass through them. The grip portion of the handles shall be of a nonmetallic material at least 89 mm in length with a 19 mm diameter or other approved cross section that is shaped to fit the hand comfortably. Handles shall stop open at 90 degrees, and shall be returned to a closed position by a spring-loaded or retaining mechanism when not in use. Handles shall be recessed or protected. A handle located on the top of the enclosure shall be recessed to facilitate stacking.

3.7.3.2 Handles, soft transit case. When a soft transit case is specified, one or more handles shall be provided. A shoulder strap maybe provided in addition to the required handles. Handles shall be attached to the case in a manner to ensure serviceability over the life of the equipment under normal conditions of use.

3.7.4 Accessory stowage, transit case. The transit case shall have provisions for the stowage of accessories (see 6.5.2.1), operating instructions, removable power cables, signal leads, and designated spares. Stowage shall not adversely affect the carrying stability of the equipment and shall be contained in a manner that prevents damage to the accessories or equipment during transit.

3.7.5 Corners, transit case. All hard edged comers shall be designed to preclude injury to personnel or damage to material. All comers shall be adequately reinforced to protect the instrument from damage during the environmental conditions specified for the enclosure.

3.7.6 Pressure equalizing valve, transit case. Unless otherwise specified, airtight transit cases shall have a mechanism for equalizing air pressure within the enclosure, when the enclosure is sealed. The mechanism provided shall not protrude beyond the transit case enclosure.

3.8 Environmental requirements. Environmental performance requirements shall be as specified in 3.8.1 through 3.8.13 and Table 2.

3.8.1 Environmental conditions. Equipment shall conforrn to the specified pefrormance when subjected to the environmental conditions of this specification. Combinations of environments beyond those covered by the specified test procedures (see 4.5) shall be as specified in the purchase description.

3.8.1.1 Warm-up. Unless otherwise specified, the equipment shall comply with the specified performance requirements after a 20 minute warm-up period preceded by a 2-hour not operating temperature stabilization period, or as specified in the applicable test method.

3.8.2 Temperature and humidity. The temperature ranges and humidity limits for both operating and not operating conditions shall be as specified in 3.8.2.1 to 3.8.2.3.2. A RH of 95 percent (with the applicable tolerance) does not include conditions of precipitation.

3.8.2.1 Temperature not operating. Test equipment shall conform to the specified performance and accuracy after being stored at temperatures specified for the applicable class in 3.8.2.1.1 to 3.8.2.1.2.

3.8.2.1.1 Temperature not operating, Class 1 and Class 2. Class 1 and Class 2 test equipment shall be subjected to not operating temperatures in the range -51 to 71 degrees Celsius.

3.8.2.1.2 Temperature not operating, Class 3 and Class 4. Class 3 and Class 4 test equipment shall be subjected to not operating temperatures in the range -40 to 71 degrees Celsius.

TABLE 2. Summary identification of environmental requirements by class.

Environmental conditions	CLASS [1]			
	1	2	3	4
Temperature, not operating (°C) (3.8.2.1 and 4.5.5.1)	-51 to 71	-51 to 71	-40 to 71	-40 to 71
Temperature, operating (°C) (3.8.2.2 and 4.5.5.1)	-40 to 55 [2]	-10 to 55	0 to 50	10 to 40
Relative humidity [7] (percent) (3.8.2.3 and 4.5.5.1)	5 to 95 ±5 [3,4]	5 to 95 ±5 [5,6]	5 to 95 ±5 [5,6]	5 to 95 ±5 [5,6]
Altitude, not operating (3.8.3 and 4.5.5.2)	4600 m	4600 m	4600 m	4600 m
Altitude, operating (3.8.3 and 4.5.5.2)	4600 m	4600 m	4600 m	4600 m
Vibration limits (3.8.4.1 and 4.5.5.3.1)	Random 10-2000 Hz	Random 10-500 Hz	Random 5-500 Hz	Random, 5-500 Hz
Bounce, loose cargo (3.8.4.3 and 4.5.5.3.3)	[8]	[8]	[8]	[8]
Shock, functional (3.8.5.1 and 4.5.5.4.1)	30G [9]	30G [9]	30G [9]	30G [9]
Transit Drop (3.8.5.2 and 4.5.5.4.2)	Yes	[10]	[10]	[10]
Bench handling (3.8.5.3 and 4.5.5.4.3)	Yes	Yes	Yes	Yes
Shock, high impact (3.8.5.4 and 4.5.5.4.4)	[8]	[8]	[8]	[8]
Watertight 0.9 m (3.8.6.1 and 4.5.5.5.1)	Yes	[8]	[8]	[8]
Splashproof (3.8.6.2 and 4.5.5.5.2)	Yes	[8]	[8]	[8]
Dripproof (3.8.6.3 and 4.5.5.5.3)	N/A	[8]	[8]	[8]
Fungus resistance [11](3.8.7 and 4.5.6.1)	Yes	Yes	Yes	Yes
Salt exposure, enclosure [11] (3.8.8.1 and 4.5.6.2.1)	48 hours	48 hours	48 hours	48 hours
Salt exposure, structural parts (3.8.8.2 and 4.5.6.2.2)	48 hours	48 hours [11]	48 hours [11]	48 hours [11]
Explosive atmosphere (3.8.9 and 4.5.6.3)	Yes	N/A	N/A	N/A
Dust resistance (3.8.10 and 4.5.6.4)	Yes	N/A	N/A	N/A
Solar radiation (3.8.13 and 4.5.6.8)	[8]	[8]	N/A	N/A

Notes:

[1] See 3.8 for complete environmental requirements.

[2] 20 minute operation at 71°C.

[3] 85 ±5 percent RH above 30°C.

[4] 60 ±5 percent RH above 40°C.
[5] 75 ±5 percent RH above 30°C.
[6] 45 ±5 percent RH above 40°C.
[7] RH not controlled below 10°C.
[8] Must be invoked by the purchase description when required.
[9] Half-sine shock pulse (see 3.8.5.1).
[10] See 3.8.5.2, 4.5.5.4.2 and Table 13.
[11] Verification testing must be invoked by the purchase description.

3.8.2.2 Temperature operating. Test equipment shall conform to the specified performance and accuracy while being operated at temperatures specified for the applicable class in 3.8.2.2.1 to 3.8.2.2.4.

3.8.2.2.1 Temperatue operating. Class 1. Class 1 test equipment shall be subjected to operating temperatures in the range -40 to 55 degrees Celsius. Class 1 test equipment shall be required to operate for 20 minutes (see 6.5.2.16), at 71 degrees Celsius.

3.8.2.2.2 Temperature operating. Class 2. Class 2 test equipment shall be subjected to operating temperatures in the range -10 to 55 degrees Celsius.

3.8.2.2.3 Temperature operating. Class 3. Class 3 test equipment shall be subjected to operating temperatures in the range O to 50 degrees Celsius.

3.8.2.2.4 Temperature operating. Class 4. Class 4 test equipment shall be subjected to operating temperatures in the range 10 to 40 degrees Celsius.

3.8.2.3 Humidity. Test equipment shall conform to the specified performance and accuracy for conditions where the relative humidity is 5 to 95±5 percent in the temperature range of 10 to 30 degrees Celsius, and as specified, for the applicable class in 3.8.2.3.1 to 3.8.2.3.2. At temperatures below 10 degrees Celsius, the humidity is uncontrolled, but the equipment shall conform to the specified performance (after the specified warm-up period) and shall withstand the effects of humidities up to 100 percent.

3.8.2.3.1 Humidity. Class 1. Class 1 test equipment shall be subjected to conditions where the relative humidity is 5 to 85±5 percent in the temperature range of 30 to 40 degrees Celsius, and where the relative humidity is 5 to 60±5 percent in the temperature range above 40 degrees Celsius.

3.8.2.3.2 Humidity. Class 2, Class 3 Class 4. Class 2, Class 3 and Class 4 test equipment shall be subjected to conditions where the relative humidity is 5 to 75±5 percent in the temperature range of 30 to 40 degrees Celsius, and where the relative humidity is 5 to 45±5 percent in the temperature range above 40 degrees Celsius (as appropriate for the specified class).

3.8.3 Altitude. Test equipment of Classes 1, 2, 3, and 4 shall conform to the specified performance and accuracy requirements when operated at an altitude of 4600 meters and after return from an altitude of 4600 meters when tested in accordance with 4.5.5.2.

3.8.4 Vibration. Vibration shall be as specified in 3.8.4.1 or 3.8.4.2 and 3.8.4.3.

3.8.4.1 Vibration, random. Test equipment of Classes 1, 2, 3 and 4 shall conform to specified performance and accuracy requirements after the random vibration conditions specified in Table 3 when tested in accordance with 4.5.5.3.1.

TABLE 3. Random vibration profile by class.

Class	Duration per axis (minutes)	Frequency (Hz)	Slope (dB/Octave)	PSD (g^2/Hz)
1	60	10-1000 1000-2000 2000	0 -6 –	.04 – .01
2	30	10-500	0	.03
3, 4	10	5-100 100-137 137-350 350-500 500	0 -6 0 -6 –	.015 – .0075 – .0039

3.8.4.2 Vibration, sinusoidal. When specified, the equipment of Classes 1,2,3 and 4 shall conform to specified performance and accuracy requirements after the sinusoidal vibration conditions specified in Table 4 when tested in accordance with 4.5.5.3.2.

TABLE 4. Swept sinusoidal vibration profile by class.

Class	Frequency increments (Hz)	Displacement peak-to-peak (mm)	Resonance search time per increment (minutes[1])	Cycling time per axis (minutes)	Resonance dwell time per axis (minutes)
1, 2	5 to 15 16 to 25 26 to 55	1.5 1.0 0.5	5 5 5	15	10
3, 4	5 to 55	0.33	15	15	10

Notes:
[1] Search times specified shall be for a low frequency to high frequency to low frequency sweep of the applicable increment.

3.8.4.3 Bounce, loose cargo. When specified, the equipment shall conform to the specified performance and accuracy requirements after being tested in accordance with 4.5.5.3.3.

3.8.5 Shock, mechanical. The mechanical shock requirements shall be as specified in 3.8.5.1 through 3.8.5.4.

3.8.5.1 Shock, functional. Classes 1, 2, 3, and 4 shall conform to the specified performance and accuracy requirements after being subjected to the 30g half-sine shock test of 4.5.5.4.1.

3.8.5.2 Transit drop. Equipment that have the enclosure act as the transit case, equipment that is specified to include a transit case, and all Class 1 equipment shall conform to the specified performance and accuracy requirements after being tested in accordance with 4.5.5.4.2. When a soil transit case is specified, only those with shoulder straps shall be subjected to this test. The equipment shall remain inside the transit case throughout this test.

3.8.5.3 Bench handling. The equipment shall conform to the specified performance and accuracy requirements and there shall be no damage to any controls, indicators, or fuseholders, after being tested in accordance with 4.5.5.4.3.

3.8.5.4 Shock, high impact. When specified, the equipment shall be subjected to the high impact shock test. The high impact shock test shall be defined in the purchase description.

3.8.6 Water resistance. Water resistance shall be as specified in 3.8.6.1 through 3.8.6.3.3 and summarized in Table 5.

3.8.6.1 Watertight. Watertight performance of equipment and transit case shall be as specified in 3.8.6.1.1 through 3.8.6.1.4.

3.8.6.1.1 Watertight, Class 1. Class 1 equipment installed shall conform to the specified performance and accuracy requirements after being tested in accordance with 4.5.5.5.1 under the conditions 0.9 meter submergence.

3.8.6.1.2 Watertight, Classes 2, 3, and 4. Unless otherwise specified, equipment of classes 2, 3, and 4 need not be watertight.

3.8.6.1.3 Watertight, air tight transit case. When a transit case is specified and is also specified as air tight then the transit case shall be watertight. Equipment housed in air tight transit cases shall be tested with the equipment in the transit case in accordance with 4.5.5.5.1 under the conditions of 0.9 meter submergence. The equipment shall conform to the specified performance and accuracy requirements after the test is completed.

3.8.6.1.4 Watertight, transit case. When a transit case is specified, unless it is specified as air tight, it need not be watertight.

3.8.6.2 Slashproof. Splashproof performance of equipment and transit case shall be as specified in 3.8.6.2.1 through 3.8.6.2.2.

3.8.6.2.1 Splashproof, Class 1. Class 1 equipment shall conform to the specified performance and accuracy requirements after being tested in accordance with 4.5.5.5.2 under the conditions where if the equipment, if covers are present, has the covers removed.

3.8.6.2.2 Splashproof, Classes 2, 3, and 4. Unless otherwise specified, equipment of classes 2,3, and 4 need not be splashproof.

3.8.6.3 Dripproof. Dripproof performance of equipment and transit case shall be as specified in 3.8.6.3.1 through 3.8.6.3.3.

3.8.6.3.1 Dripproof, Classes 2, 3, and 4. Unless otherwise specified, equipment of classes 2,3, and 4 need not be dripproof. Testing of this requirement is not applicable for Class 1 equipment.

3.8.6.3.2 Dripproof, hard transit case. When a hard transit case is specified, the transit cases shall be tested with the equipment in the transit case in accordance with 4.5.5.5.3. The equipment shall conform to the specified performance and accuracy requirements after the testis completed. Testing of this requirement is not applicable for air tight transit cases.

3.8.6.3.3 Dripproof, soft transit case. Unless otherwise specified, if a soft transit case is specified, it need not be dripproof.

TABLE 5. Water resistance

Require-ment	Class 1 equipment	Classes 2, 3, and 4 equipment	Transit Case - General	Transit Case - air tight	Transit Case - hard	Transit Case - soft
Watertight	Submergence 0.9 m	[1]	[1]	Submergence 0.9 m	[1]	N/A
Splashproof	YES	[1]	N/A	N/A	N/A	N/A
Dripproof	N/A	[1]	[1]	N/A	YES	[1]

Note:
[1] When specified.

3.8.7 Fungus resistance. Equipment shall not contain materials that provide nutrients for the growth of fungus. When a transit case is specified it shall not contain materials that provide nutrients for the growth of fungus. When specified, verification of fungus resistance and fungus-inert material shall be in accordance with 4.5.6.1.

3.8.8 Salt atmosphere. Salt atmosphere shall be as specified in 3.8.8.1 and 3.8.8.2.

3.8.8.1 Exposure, enclosure. Test equipment shall conform to the specified performance and accuracy requirements after being tested for exposure in accordance with 4.5.6.2.1.

3.8.8.2 Exposure, structural.. Material used for the fabrication of panels and structural parts shall conform to all applicable requirements after being exposed for 48 hours to a 5 percent salt atmosphere in accordance with 4.5.6.2.2. Unless otherwise specified, testing of samples of panels and structural parts for class 1 equipment shall be required.

3.8.9 Explosive atmosphere, Class 1. The operation of Class 1 equipment shall not cause ignition of an ambient-explosive-gaseous mixture with air when tested in accordance with 4.5.6.3.

3.8.10 Dust exposure, Class 1 and hard transit cases. Class 1 equipment and equipment in hard transit cases, shall conform to all requirements after exposure to dust when tested in accordance with 4.5.6.4.

3.8.11 Magnetic environment, DC field (Navy). For Navy use, when specified, the equipment shall be tested in accordance with the 20 Oersted dc test of 4.5.6.6.

3.8.12 Acoustic noise. Unless otherwise specified, equipment shall not generate acoustic noise in excess 70 dBA sound pressure level (SPL) when measured at the operator and bystander positions, in accordance with ISO 7779.

3.8.13 Solar radiation. When specified, Class 1 and Class 2 equipment shall conform to the applicable requirements after exposure to solar radiation when tested in accordance with 4.5.6.8.

3.9 EMC. EMC control for all classes of test equipment shall be in accordance with Table 6 when tested in accordance with 4.5.6.5. When specified, the requirements and tests of MIL-STD-1686C shall be invoked for the electrostatic discharge immunity requirement.

3.10 Safety. The equipment shall comply with the safety requirements of IEC 1010. For safety ground all accessible surfaces of the equipment shall be at ground potential. The power cable shall include a safety ground conductor. This is also true of drawer assemblies; disconnecting the safety ground shall also disconnect the power conductors.

TABLE 6. Test equipment EMC requirements.

Description of requirement	Test Limit [1]
Conducted emissions, power leads	CISPR 11, Class A, 150 kHz to 30 MHz
Conducted immunity, power leads	IEC 1000-4-6, 3 V AC-RMS, 150 KHz to 80 MHz, 80% amplitude modulation with 1 KHz sine wave
Conducted immunity,power leads, spikes	IEC 1000-4-4, 1 KV peak for AC Lines, 0.5 KV peak for Signal, Control, and DC Lines, 5 nS Tr (T-rise) and 50 nS Th (T-hold), 5 KHz repetition frequency.
Radiated emissions, electric field	CISPR 11, Class A, 30 MHz to 1000 MHz
Radiated immunity, electric field	IEC 1000-4-3, 3 V/m, 80 MHz to 1000 MHz, 80% amplitude modulation with 1KHz sine wave
Electrostatic discharge immunity	IEC 1000-4-2, 4 kV contact discharge, 8 kV air discharge

Note:
[1]IEC 1326-1 when implemented if applicable, shall consolidate references for EMC. When this standard and limits are approved it shall replace the listed specifications. An amendment to MIL-PRF-28800F shall be issued after the IEC 1326-1 draft is approved and evaluated for applicability.

3.11 Marking and identification. Marking and identification of test equipment shall be as specified in 3.11.1 through 3.11.4.

3.11.1 Marking. Test equipment shall be marked in a manner that does not adversely affect safety or performance.

3.11.1.1 Reference designations. Reference designations shall be used to identify each part for its particular circuit application. Subminiaturized and nonrepairable assemblies need not be marked with reference designations. Reference designator usage shall be in accordance with ANSI Y32.2 and ANSI Y32.16.

3.11.1.2 Warning markings. Warning markings shall warn of the location, the nature, and the extent of a hazard. Letters of warning markings shall be of clearly legible gothic capitals. Warning markings shall have high contrast between the letter and background colors. The markings shall be as permanent as normal life expectancy of the test equipment, and located as close as possible to the point of danger. Warning markings indicating circuits of more than 500 Vdc or Vrms shall read:

DANGER HIGH VOLTAGE (maximum applicable voltage) VOLTS

Markings shall be in accordance with the requirements of ANSI/ISA-S82.01-1 994 or ANSI/ISA-S82.02-1994 or both as applicable, that requires the warning and caution markings specified in a through c:

a. The precautionary signal word shall beat least 2.5 mm high.
b. The text shall beat least 1.5 mm high and contrasting in color to background.
c. If molded or stamped in a material, the text shall be at least 2.0 mm high and, if not contrasting in color, a depth or raised height of at least 0.5 mm.

3.11.1.3 Battery warning label. Equipment containing batteries shall be provided with a battery warning label attached to the equipment. Battery warning labels shall be:

WARNING

REMOVE BATTERIES BEFORE SHIPMENT OR INACTIVE STORAGE OF 30 DAYS OR MORE
NOTE: DO NOT REMOVE INTERNAL MEMORY BACKUP BATTERIES.

3.11.1.4 Panel markings and processes. Panel markings shall enable the operator to identify the functions and use of all items requiring operator intervention.

3.11.2 Equipment Identification. Equipment identification shall include those items specified in a through e and 3.11.2.1 and 3.11.2.2.

a. Manufacturer name.
b. Equipment model number.
c. Equipment name.
d. Place of manufacture.
e. Serial number.

3.11.2.1 Identification date. When specified, an equipment identification plate shall be affixed to the equipment and shall contain the information provided in a through c. The identification plate shall be permanently affixed.

a. Joint Equipment Type Designation System (JETDS) nomenclature (when assigned).
b. National stock number,
c. Contract number.

3.11.2.2 Identification plate supplemental information. When accessories are required to make the equipment meet the requirements of the purchase description and the combination is given a part or model number designation that differs from that of the main unit, the identification plate shall also contain the information in a and b. Whether a configuration model designation is assigned or not, all major accessories shall be marked as in c:

a. Consists of: [part number of main unit and all accessories (excluding cables and adapters) comprising the equipment configuration].
b. Model configuration number: (Model number assigned to the equipment configuration).
c. Part of (or p/o): (Model number assigned to the equipment configuration, or main unit model number, as applicable), s/n: (serial number assigned to the equipment comprising the set or the serial number of the primary instrument if a separate s/n is not assigned to the set).

3.11.3 Identification date, transit case. When a transit case is specified, an identification plate shall be provided for the transit case that contains information items identified in 3.11.2 and when specified the information items in 3.11.2.1. The transit case identification plate shall be permanently affixed to the transit case. The location of the identification plate on the transit case shall be as specified (see 6.2).

3.11.4 Reusable pouch or container. When specified, a reusable pouch or container shall be provided. Containers shall be marked “accessories for use with” (test equipment nomenclature or model number), or, “maintenance aids for use with” (test equipment nomenclature or model number), as applicable. If assigned, the test equipment nomenclature shall be used in lieu of the model number.

3.11.5 Nomenclature assignment. When specified, the nomenclature assignment shall be provided by the Government.

3.12 Calibration interval. Unless otherwise specified, the minimum interval between calibrations shall be 12 months. At the end of this interval, a minimum of 85 percent of the units shall remain in tolerance.

3.13 Reliability. Unless otherwise specified, the design of the equipment shall be such that under normal use and operation the equipment does not fail within 1500 hours of operation with a statistical certainty of 95%. The manufacturer shall provide a summary of maintenance or warranty records to establish the validity of the statistical assertion. Records of the actual equipment model shall be used, unless the Government authorizes the substitution of records from a similar model, due to the lack of sufficient supporting documentation on the offered equipment. The manufacturer shall be able to reasonably establish the claim that the offered equipment shall provide reliability similar to the model used to provide substitute records.

3.14 Maintainability. Maintainability shall be as specified in 3.14.1 through 3.14.4 (see 4.5.7.1).

3.14.1 Fault isolation. The design of the equipment shall permit isolation of faults, and repair down to the component item or lowest replaceable unit with the maintenance provisions furnished (see 6.5.2.18).

3.14.2 Preventive maintenance. Preventive maintenance shall not require more than 15 minutes per a 30-day period. Preventive maintenance shall not require breaking of the equipment seams where calibration seals would normally be placed.

3.14.3 Maintenance provisions. Equipment shall be as specified in a through d to facilitate maintenance:

a. Accessibility for maintenance. The equipment shall be designed to ensure that maintenance access can be accomplished utilizing ordinary tools. The equipment shall be constructed so that no damage to any component shall occur and no permanent distortion to any structural member shall be caused during maintenance and calibration.

b. Maintenance and calibration aids. When specified, circuit board extenders, special adapters, special tools (see 6.5.2.27), and patch cables required for maintenance or calibration shall be provided. They shall be identified as a set with a unique part number and national stock number. Stowage shall be in a reusable pouch or container.

c. Accessibility for repair. The equipment shall be designed so that subassemblies and chassis components can be removed without removing other hardwired subassemblies or components. Printed circuit cards shall be removable without the need to unsolder cables and interconnecting wiring. Printed circuit cards designed primarily to distribute power and signals to other printed cards are excluded from this requirement. When motherboards are used they shall be accessible from both sides to facilitate troubleshooting or repair.

d. Accessibility for adjustment. The equipment design shall permit adjustments to be made without removing any component, printed circuit cards, or subassembly. The use of extender cards is permitted.

3.14.4 Washability. When specified, the equipment shall conform to all requirements after being washed, and there shall be no evidence of deterioration when tested in accordance with 4.5.7.1.2.

3.15 Environmental stress screening **(Applicable to Class 1 ONLY).** When specified (for Class 1 equipment), the equipment shall be subjected to the applicable environmental stress screening requirements of a and b:

a. Random vibration. Random vibration shall be performed in accordance with the process specified in 4.5.3.lc.

b. Temperature cycling. Temperature cycling shall be performed in accordance with the process specified in 4.5.3.1d.

4. VERIFICATION

4.1 Classification of inspections. The inspections specified herein are classified as specified in a through C:

a. First article inspection (see 4.2).
b. Bid sample inspection (see 4.3).
c. Conformance inspection (see 4.4).

4.2 First article. The first article inspection shall be performed on five units. First article examinations and tests are classified into groups in accordance with Table 7,4.2.1 through 4.2.1.6. The test methods, procedures, and conditions used for first article inspection shall be performed on the units as specified in 4.5 and a through c:

a. Failure criteria. Failure of any Group A through Group E test shall be counted as a major defect (see 6.5.2.15).
b. Test sequence. The test sequence shall be as specified in 4.2.1 through 4.2.1.6 for Groups A through F. If the purchase description does not specify Group B testing, the test sequence shall proceed from Group A to Groups C and D to Group E. The Group D testing maybe performed concurrently with, or sequentially after, the Group C testing
c. Test conditions and control settings. The test conditions and control settings shall be in accordance with 4.5.1.

4.2.1 First article inspection. First article inspection shall be in accordance with 4.2.1.1 through 4.2.1.6.

4.2.1.1 First article inspection, Group A. The five units shall be subjected to the inspection specified in 4.5.3.

4.2.1.2 First article tests, Group B. The five units that have satisfactorily passed the Group A inspection shall be subjected to the Group B tests of 4.5.4. If the purchase description does not specify Group B testing, the test sequence shall proceed from Group A to Groups C and D, as applicable, in accordance with 4.3b.

4.2.1.3 First article tests, Group C. Three units that have satisfactorily passed the required tests in accordance with 4.3.1.2 shall be subjected to the Group C tests of 4.5.5.

4.2.1.4 First article tests, Group D. Two units that have satisfactorily passed the required tests in with 4.3.1.2 shall be subjected to the Group D tests of 4.5.6.

4.2.1.5 First article tests, Group E. Units that have satisfactorily passed the Group D tests shall be subjected to the Group E tests of 4.5.7. When the number of units required for Group E testing exceeds the number required for Group D, the additional units shall be selected from units that have passed the Group C tests. The number of units tested shall be as specified in a through f:

a. Maintainability. One unit shall be tested. When the washability test is invoked, the test shall be performed on the unit prior to the maintainability demonstration.

b. Acoustic noise. One unit shall be tested only if the equipment contains a motor (such as a fan or blower) or other audible noise source.

c. Dimensions and weight. Two units shall be tested.

d. Mechanical stability. Two units shall be tested, except units smaller than 2000 cc with a weight less than 2.5 kg need not be tested.

e. Equipment emanations. Two units shall be tested, except X-radiation tests need not be performed unless the equipment is designed to have operating potentials of 10 kilovolts (kV) or greater, or could have potentials of 10 kV or greater due to the failure of any one component.

f. Additional tests. Additional Group E tests shall be as specified in the purchase description.

4.2.1.6 First article tests, Group F. The Group F tests shall be performed by evaluating the manufacturers data to establish that within 95°/0 statistical certainty no equipment failures shall occur within at least 1500 hours of operation under normal conditions.

4.3 Bid sample. Procurement of equipment by the bid sample method requires the submission of a bid sample to the procuring activity when required in the solicitation. The bid sample shall consist of two units with accessories and instruction manuals, and clear and concise rationale showing how the reliability and maintainability characteristics of the equipment comply with the requirements of the solicitation. If readjustment of the equipment is anticipated at the conclusion of any environmental test and prior to the resumption of environmental testing, the rationale for readjustment should identify the environmental tests that should be followed by such readjustment. The bid sample shall be representative of equipment specified by the requirements of the solicitation. Bid sample examinations and tests are classified into groups in accordance with Table 7,4.3.1 through 4.3.1.6. The test methods, procedures, and conditions used for bid sample inspection shall be performed on the units as specified in 4.5 and a through c:

a. Failure criteria. Failure of any Group A through Group E test shall be counted as a major defect (see 6.5.2.15).

b. Test sequence. The test sequence shall be as specified in 4.3.1 through 4.3.1.6 for Groups A through F. If the purchase description does not specify Group B testing, the test sequence shall proceed from Group A to Groups C and D to Group E. The Group D testing maybe performed concurrently with, or sequentially after, the Group C testing

c. Test conditions and control settings. The test conditions and control settings shall be in accordance with 4.5.1.

TABLE 7. Examinations and tests.

Examination or test	Requirement paragraph	Inspection paragraph
Group A:		
Preoperational inspection	3	4.5.3.1
Level A performance	3.3	4.5.3.2
Leakage current	3.10	4.5.3.2.1
Group B:		
Level B performance	As required in the purchase description	4.5.4 [2]
Group C:		
Temperature and humidity	3.8.2	4.5.5.1
T/H not operating	3.8.2.1	4.5.5.1.1
Temperature operating	3.8.2.2	4.5.5.1.1
Altitude	3.8.3	4.5.5.2
Vibration	3.8.4	4.5.5.3
Vibration, random	3.8.4.1	4.5.5.3.1
Vibration, sinusoidal	3.8.4.2	4.5.5.3.2 [2]
Bounce, loose cargo	3.8.4.3	4.5.5.3.3 [1, 3]
Shock, mechanical	3.8.5	4.5.5.4
Shock, functional	3.8.5.1	4.5.5.4.1
Transit drop	3.8.5.2	4.5.5.4.2 [3]
Bench handling	3.8.5.3	4.5.5.4.3
Shock, high impact	3.8.5.4	4.5.5.4.4 [1, 3]
Water resistance	3.8.6	4.5.5.5
Watertight	3.8.6.1	4.5.5.5.1 [4]
Splashproof	3.8.6.2	4.5.5.5.2 [5]
Dripproof	3.8.6.3	4.5.5.5.3 [2]
Electrical power	3.5	4.5.5.6
Input power consumption	3.5.1.1	4.5.5.6.1
Voltage and frequency variation	3.5.1.2.1	4.5.5.6.2
Voltage-transient	3.5.1.2.2	4.5.5.6.3
Frequency-transient	3.5.1.2.2	4.5.5.6.4
Power source interruption	3.5.1.2.3	4.5.5.6.5
Verification, Group C	3.8.1	4.5.5.7

TABLE 7. Examinations and tests. (continued).

Examination or test	Requirement paragraph	Inspection paragraph
Group D:		
Fungus resistance	3.8.7	4.5.6.1 [2]
Salt fog	3.8.8	4.5.6.2 [2]
Exposure, enclosure	3.8.8.1	4.5.6.2.1 [2]
Exposure, structural parts	3.8.8.2	4.5.6.2.2 [6]
Explosive atmosphere	3.8.9	4.5.6.3 [2,7]
Dust	3.8.10	4.5.6.4 [2, 7]
EMC	3.9	4.5.6.5
Magnetic environment	3.8.11	4.5.6.6 [2]
Verification, Group D	3.8.1	4.5.6.7
Solar radiation	3.8.13	4.5.6.8 [2, 8]
Group E:		
Maintainability [1]	3.14	4.5.7.1
Washability	3.14.4	4.5.7.1.2 [2]
Acoustic noise	3.8.12	4.5.7.2
Dimensions	3.6.1	4.5.7.3
Weight	3.6.2	4.5.7.3
Mechanical stability	3.6.3	4.5.7.4
Equipment emanations	3.10	4.5.7.5 [2]
Packaging	5.1	4.5.7.6
Group F:		
Reliability	3.13	4.5.8.1 [2]

Notes:

[1] Tests are to be detailed in the purchase description if required.

[2] To be performed only when the testis required by the purchase description.

[3] Required for Class 1 (also see 4.5.5.4.2).

[4] Required for Class 1 and air tight transit cases.

[5] Required for Class 1 with covers removed.

[6] Required for Class 1 (also see 4.5.6.2.2).

[7] Class 1.

[8] Classes 1 and 2.

4.3.1 Bid sample inspection. Bid sample inspection shall be in accordance with 4.3.1.1 through 4.3.1.6.

4.3.1.1 Bid sample inspection, Group A. The two units shall be subjected to the inspection and tests specified in 4.5.3.

4.3.1.2 Bid sample tests, Group B. The two bid sample units that have satisfactorily passed the Group A inspection shall be subjected to the Group B tests of 4.5.4. If Group B testing is not required, the test sequence shall proceed from Group A to Groups C and D as applicable, in accordance with 4.3b.

4.3.1.3 Bid sample tests, Group C. One bid sample unit that has satisfactorily passed the required tests in accordance with 4.3.1.2 shall be subjected to the Group C tests of 4.5.5.

4.3.1.4 Bid sample tests, Group D. One bid sample unit that has satisfactorily passed the required tests in accordance with 4.3.1.3 shall be subjected to the Group D tests of 4.5.6.

4.3.1.5 Bid sample tests, Group E. The unit that has satisfactorily passed the Group C test and the unit that has satisfactorily passed the Group D tests shall be subjected to the Group E tests of 4.5.7. The number of units tested shall be as specified in a through f:

a. Maintainability. When specified in the solicitation, one unit shall be tested.
b. Acoustic noise. One unit shall be tested. Equipment that does not contain a motor (such as a fan or blower) or other audible noise source will not be tested.
c. Dimensions and weight. Two units shall be tested.
d. Mechanical stability. Two units shall be tested, except units smaller than 2000 cc with a weight less than 2.5 kg shall not be tested.
e. Equipment emanations. Two units shall be tested, except X-radiation tests shall not be performed unless the equipment is designed to have operating potentials of 10 kV or greater, or could have potentials of 10 kV or greater due to the failure of any one component.
f. Additional tests. Additional tests shall be performed when specified in the solicitation.

4.3.1.6 Bid sample tests, Group F. The Group F tests shall be performed by evaluating the manufacturers data to establish that within 95% statistical certainty no equipment failures shall occur within at least 1500 hours of operation under normal conditions.

4.4 Conformance inspection. The test methods, procedures, and conditions specified in a through c and in 4.5 are required for Conformance inspection.

a. Failure criteria. Failure of any Group A through Group E test shall be counted as a major defect (see 6.5.2.15).

b. Test sequence. The test sequence shall be as specified in 4.4.1 through 4.4.1.5.1 for Groups A through E, prior to the start of the Group F verification test of 4.4.1.6. If the purchase description does not require Group B testing, the test sequence shall proceed from Group A to Groups C and D to Group E. The Group D testing maybe performed concurrently with or sequentially after the Group C testing.

c. Test conditions and control settings. The test conditions and control settings shall be in accordance with 4.5.1.

4.4.1 Production inspection. Production inspection shall be in accordance with 4.4.1.1 through 4.4.1.6.

4.4.1.1 Production inspection, Group A. Each unit shall be subjected to the Group A inspection of 4.5.3 to ensure qualitatively the proper functioning of the equipment, including all operating controls, and conformance with safety requirements.

4.4.1.2 Production control tests, Group B. The Group B tests of 4.5.4 shall be performed on units that have passed Group A inspection. If the purchase description does not specify Group B testing, the test sequence shall proceed from Group A to Groups C and D as applicable, in accordance with 4.4b.

4.4.1.2.1 Production control sampling. From each lot (see 6.5.2.17) that has passed production inspection (see 4.4.1.1), a random sample shall be selected and subjected to the Group B tests. As a minimum, the contractor shall inspect a sample quantity of units in accordance with the sampling defined herein. Sample size depends on classification of the characteristic as shown in Table 8. If a defect is found in any sample, the entire lot shall be rejected and screened by the contractor for the defect found. When the Group D testing is to be performed concurrently with the Group C testing, or when required for additional Group E tests, the Group B sample size shall be increased to provide the required samples for Groups C, D, and E testing.

4.4.1.3 Environmental and electrical power tests, Group C. The Group C tests of 4.5.5 shall be performed on units that have passed the required tests in accordance with 4.4.1.2.

4.4.1.3.1 Environmental and electrical power sampling. From each 1ot, a random sample of units that have passed the required tests in accordance with 4.4.1.2 shall be selected and subjected to the Group C tests. Sample size shall be in accordance with Table 8. If one or more defects is found, the entire lot shall be rejected and screened 100 percent by the contractor for the defect found.

4.4.1.4 Environmental tests, Group D. The Group D tests of 4.5.6 shall be performed on units that have passed the required test in accordance with 4.4.1.3.

TABLE 8. Lot size vs sample size.

Lot size	Group B	Group C	Group D
2 to 8	All	3	2
9 to 15	8	3	2
16 to 25	8	3	3
26 to 50	8	5	5
51 to 90	8	6	5
91 to 150	12	7	6
151 to 280	19	10	7
281 to 500	21	11	9
501 to 1200	27	15	11
1201 to 3200	35	18	13
3201 to 10000	38	22	15
10001 to 35000	46	29	15
35001 to 150000	56	29	15

4.4.1.4.1 Environmental sampling. From each lot, a random sample of units that have passed the required tests in accordance with 4.4.1.3 shall be selected and subjected to the Group D tests. Sample size shall be in accordance with Table 8. If one or more defects is found, the entire lot shall be rejected and screened 100 percent by the contractor for the defect found.

4.4.1.5 Other tests, Group E. The Group E tests of 4.5.7 shall be performed on units that have passed the required tests in accordance with 4.4.1.4.

4.4.1.5.1 Other tests sampling. From the first production lot that has passed the required tests in accordance with 4.4.1.4, a random sample shall be selected and subjected to the Group E tests specified in a through f:

a. Maintainability. One unit shall be randomly selected and tested.
b. Acoustic noise. For units that contain a motor (such as a fan or blower) or other audible noise source, one unit shall be randomly selected and tested.
c. Dimensions and weight. Four units shall be randomly selected and tested.
d. Mechanical stability. For units of 2000 cc or larger, with a weight of 2.5 kg or more, one unit shall be randomly selected and tested.

e. Equipment emanations. One unit shall be randomly selected and tested, except X-radiation tests need not be performed unless the equipment is designed to have operating potentials of 10 kV, or greater, or could have potentials of 10 kV or greater, due to circuit malfunction resulting from the failure of any component, including related sequential failures.

f. Additional tests. Sampling shall be as specified in the purchase description.

4.4.1.6 Reliability tests, Group F. The Group F tests shall be performed by evaluating the manufacturers data to establish that within 95% statistical certainty no equipment failures shall occur within at least 1500 hours of operation under normal conditions.

4.5 Examination and test methods. The test methods, procedures, conditions, and failure criteria specified in 4.5.1 through 4.5.8.1 shall be applied. Equipment operation shall be verified in accordance with a and b:

a. Satisfactory operation check. Wherever this specification requires a satisfactory operation check (see 6.5.2.24) to be performed, the parameters and the limits of acceptability shall be as specified in the purchase description.

b. Satisfactory operation test. Wherever this specification requires a satisfactory operation test (see 6.5.2.25) to be performed, the parameters shall be as specified in the purchase description.

4.5.1 Conditions and control settings. Conditions and control settings shall be as specified in 4.5.1.1 through 4.5.1.2.

4.5.1.1 Test conditions. Unless otherwise specified in the detailed test herein, the inspection of 4.5 shall be performed under the conditions of a through e. Ambient conditions within the specified ranges need not be controlled. For equipment having a specified warmup or stabilization period after turn-on, formal measurements and observations shall be made only after the specified interval (see 3.8.1.1).

a. Temperature: 25° ±10°C.
b. Humidity: 20 to 70 percent RH.
c. Altitude: 0 to 4600 m.
d. Power: Nominal or alternate power source specified for the equipment,
e. Attitude: Normal operating position.

4.5.1.1.1 Measurements of test conditions. All measurements of the test conditions shall be made with instruments of the accuracy specified in 4.5.1.1.3.

4.5.1.1.2 Tolerance of test conditions. The tolerance of test conditions shall be as specified in a through e:

a. Temperature. The test item shall be totally surrounded by an envelope of air (except at necessary support joints). The temperature of the test section measurement system and the temperature gradient throughout this envelope, that is measured close to the test item, shall be within ±2°C of the test temperature and shall not exceed 1°C per m or a maximum of 2.2°C total (equipment not operating).

b. Pressure. Pressure shall be measured with an accuracy of ±5 percent of the measured value.

c. Humidity. Relative humidity at the chamber control sensor shall be ±5 percent RH of the measured value.

d. Acceleration. Acceleration shall be measured to within ±10 percent.

e. Time. Elapsed time shall be measured with an accuracy of ±1 percent.

4.5.1.1.3 Accuracy of test instrument calibration. The accuracy of instruments and test equipment used to control or monitor the test parameters shall be verified prior to and following each test and then calibrated at predetermined intervals.

4.5.1.2 Control settings. The control settings shall be as determined by the approved equipment test procedure (see 6.5.2.2) or the purchase description.

4.5.2 Performance of test. Tests shall be performed in accordance with 4.5.2.1 through 4.5.2.6.

4.5.2.1 Pretest qualification. Prior to proceeding with the environmental tests, the test item shaIl be operated under standard ambient conditions (see 4.5.1.1) to evaluate the performance characteristics of the equipment, defined in the purchase description. This testis used to establish the level of performance of the equipment at the outset of testing, prior to any environmental tests. This test is performed before, during, and after the environmental tests, whenever a satisfactory operational test is required. Degradation of the equipment performance shall be noted if it exceeds any bound established in the purchase description.

4.5.2.2 Installation of test item in test facility. The test item shall be installed in the test facility in a manner that will simulate service usage, making connections and attaching instrumentation as necessary. Plugs, covers, and inspection plates not used in operation, but used in servicing, shall remain in place. When mechanical or electrical connections are not used, the connections normally protected in service shall be covered. For tests where temperature values are controlled, the test chamber shall be at standard ambient conditions when the test item is installed. The test item shall be operated to determine that no malfunction or damage was caused due to faulty installation or handling. The requirement for operation following installation of the test item in the test facility is applicable only when operation is required during exposure to the specified test.

4.5.2.3 Performance check during test. When operation of the test item is required during the test exposure, suitable tests shall be performed to determine whether the test exposure is producing changes in performance when compared with pretest qualification.

4.5.2.4 Post-test inspection. At the completion of each environmental test, the test item shall be inspected in accordance with pretest qualification (see 4.5.2.1).

4.5.2.5 Failure criteria. Failure criteria shall be as specified in a and b:

a. The item shall have failed the test when any of the conditions specified in 1 through 7 occur:

1. Monitored functional parameters deviate beyond acceptable limits established in 4.5.2.1.

2. Catastrophic or structural failure.

3. Mechanical binding or loose parts, including screws, clamps, bolts, and nuts, that results in component failure or a hazard to personnel safety.

4. Malfunction.

5. Degradation of performance beyond limits established in the purchase description.

6. Any additional deviations from acceptable criteria established before the test.

7. Deterioration, corrosion, or change in tolerance limits of any internal or external parts that could in any manner prevent the test item from conforming to operational service or maintenance requirements.

b. Additional or different failure criteria shall be as specified in the purchase description.

4.5.2.6 Test equipment. Test equipment used for inspections and tests shall be as specified in the purchase description or approved equipment test procedure (see 6.5.2.2). The test equipment shall be properly maintained and calibrated.

4.5.3 Group A inspection and test. Group A inspection shall consist of the preoperational inspection of 4.5.3.1 and the Level A performance tests of 4.5.3.2.

4.5.3.1 Preoperational inspection. Prior to the beginning of the Level A test (see 4.5.3.2), the preoperational inspection specified in a and b shall be performed on all equipment. When specified (for Class 1 ONLY), the examinations specified in c and d shall be performed.

a. Mechanical and visual examination. The equipment shall be given a thorough mechanical and visual examination and test to determine that all materials, workmanship, and safety characteristics comply with the specified requirements.

b. Electrical circuit configuration. The equipment shall be examined or tested to confirm that the wiring is correct. Where applicable, the tests shall include the requirements specified in 1 and 2:

1. All intramodule wiring shall be tested to assure correctness.

2. The module grounding system shall be examined or tested to ensure proper separation of shield, signal, and framework grounds, and metal-to-metal contact for panels and components that serve as electromagnetic shields.

c. Environmental stress screening (random vibration) **(Applicable to Class 1 ONLY).** Prior to conducting the temperature cycling, random vibration shall be performed on each unit. Random vibration may be performed at the module, drawer, end item level, or line replaceable unit (LRU). All the hardware, including cables and connectors, shall be exposed to vibration. The vibration shall be random, or subject to procuring activity approval, pseudo-random or complex waveform vibration, for an accumulated time of 1 hours in the axis most susceptible to vibration excitation. All items being screened shall be hard-mounted (without shock isolators) and subjected to the vibration conditions of Fig. 1. The control accelerometer shall be located next to one of the mounting points of the item being screened. Equipment having a bandwidth of not greater than 10 Hz for vibration frequencies up to 500 Hz, and 100 Hz for vibration frequencies above 500 Hz shall be used for the control and analysis of the power spectral density (PSD). The item being screened shall be energized during vibration, and appropriate input signals shall be applied to observe any abnormal conditions of the output functional characteristics. All failures occurring during the process shall be corrected and the screening resumed.

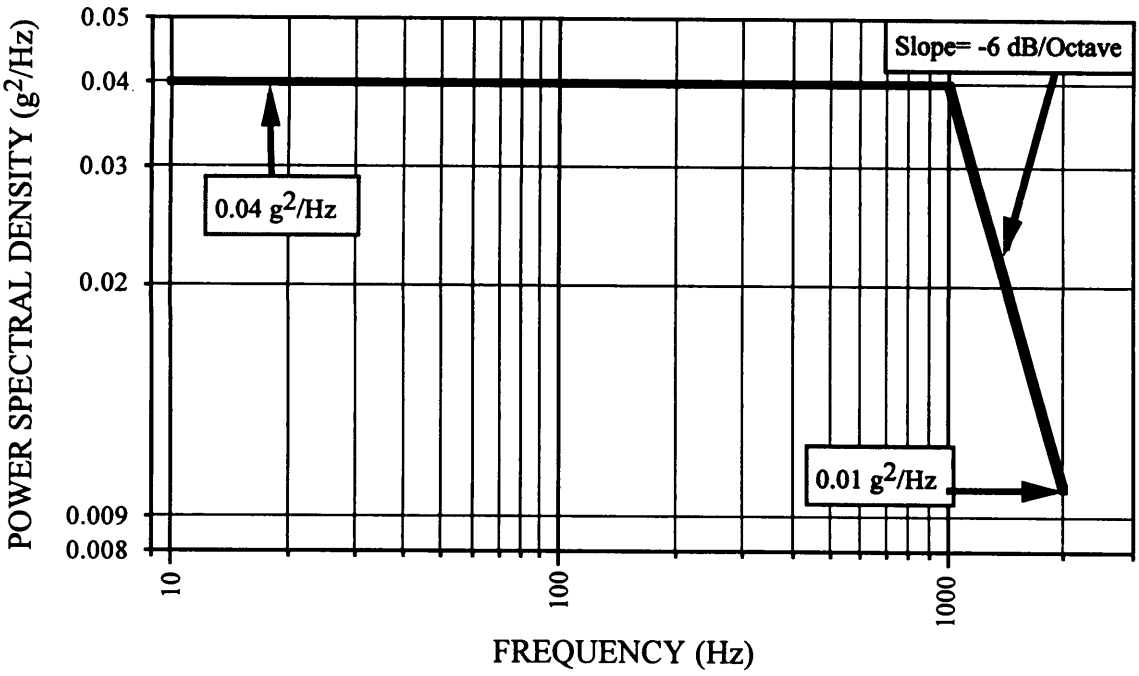


Fig 1 —Random vibration environmental screening curve **(ONLY FOR CLASS 1)**

d. Environmental stress screening (temperature cycling) **(Applicable to Class 1 0NLY).** Each equipment shall be subjected to the temperature cycling shown in Fig. 2. The number of cycles required shall be determined by the electrical and electronic parts count in Table 9. The temperature rate of change shall be not less than 5°C per minute. Equipment power shall be turned on and off at the indicated times. When practical, the equipment drawers, panels, and enclosures shall be opened or removed for maximum exposure to the changing temperature. The last temperature cycle shall be failure free. The dwell time shall be 80 percent of the time required for the largest electrical or electronic part to become temperature stabilized. Temperature stabilization will have been attained when the temperature of the part of the item being screened considered to have the longest thermal lag reaches a temperature within 2.0°C of the specified temperature, except that any critical component will be within 1°C. Exceptions may occur in large items. When changing temperatures, the temperature of the chamber air may be adjusted up to 5°C beyond the desired end point for a period of up to 1 hour to reduce stabilization time, provided that the stabilization requirements of this paragraph are ultimately attained relative to the specified end point temperature, and provided the extended chamber temperatures will not cause damage to the item being screened. Failures occurring prior to the last original temperature cycle shall be repaired and the cycling continued. If failures occur during the last original temperature cycle, Table 10 shall be used to determine the number of additional cycles required.

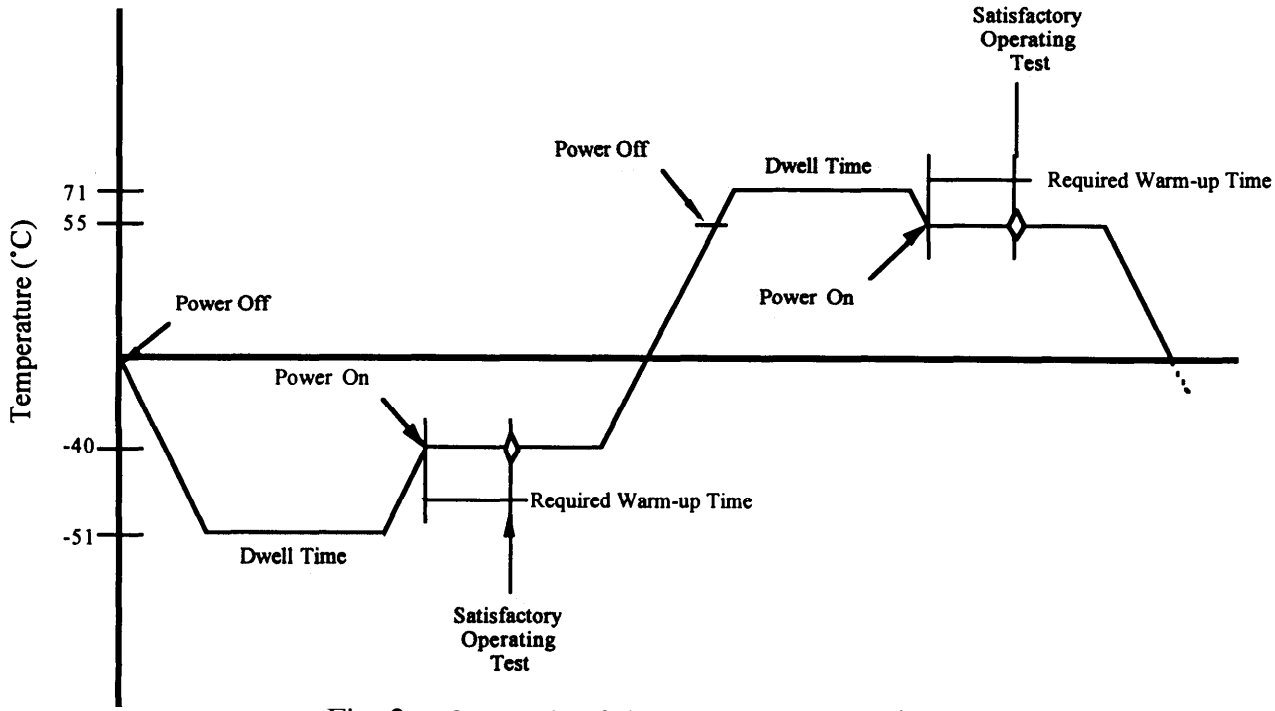


Fig. 2 —One cycle of the temperature screening curve

TABLE 9. Test cycles.

Electrical and electronic parts count	Number of temperature cycles
500 or less	3
501 to 1000	4
1001 to 2000	6
2001 to 3000	8
3001 or more	10

TABLE 10. Additional test cycles.

Percentage of total parts reworked or replaced [1]	Equipment parts count		
	500 or less	501 to 2000	2001 or more
0 to 0.1 percent	None	Repeat 1 cycle	Repeat 1 cycle
0.1 to 1 percent	Repeat 1 cycle	Repeat 1 cycle	Repeat 2 cycles
1 to 5 percent	Repeat 1 cycle	Repeat 2 cycles	Repeat 4 cycles
Over 5 percent	Repeat 2 cycles	Repeat 4 cycles	Repeat 6 cycles
	Last cycle shall be failure-free		

Notes:
[1] Each reworked solder joint or resoldered lead shall count as one part replaced.

4.5.3.2 Level A performance tests. The Level A performance tests for evaluating equipment performance shall be as required both herein and in the approved equipment test procedure, except that when an approved equipment test procedure is not provided or authorized for use, conformance to the performance requirements of the purchase description shall be verified (see 6.5.2.2). These tests shall be performed on each item of equipment and shall be conducted under the test conditions of 4.5.1.1 (see 6.5.2.19 and 6.5.2.19.1).

4.5.3.2.1 Leakage current test. The leakage current test shall be in accordance with UL1950, for Class I, stationary, pluggable Type A equipment.

4.5.4 Group B tests. The Group B tests consist of the Level B performance tests and shall be performed as specified herein and in the purchase description or approved equipment test procedure. These tests shall be performed and conducted under the test conditions of 4.5.1.1 (see 6.5.2.19 and 6.5.2.19.1).

4.5.5 Group C tests. The Group C tests shall be performed as specified in 4.5.5.1 through 4.5.5.7 and in the purchase description or approved equipment test procedure (see 6.5.2.2). These tests shall be performed under the test conditions of 4.5.1.1.

4.5.5.1 Temperature and humidity tests. The temperature and humidity tests shall be performed in accordance with 4.5.5.1.1 through 4.5.5 .1.1.2.. Figures 3 and 4 show the T/H tests for Class 1. Figures 5 and 6 show the T/H tests for Class 2. Figures 7 and 8 show the T/H tests for Class 3. Figures 9 and 10 show the T/H tests for Class 4. No rust or corrosive contaminants shall be imposed on the test item by the test facility (T/H chamber).

4.5.5.1.1 Procedure T/H. Install the test item in the test facility in accordance with 4.5.2.2. During the tests specified in 4.5.5.1.1.1 the RH need not be controlled. RH of 95 percent (with the applicable tolerance) does not include conditions of precipitation. The rate of temperature change shall be 1 °C to 5 °C per minute. The temperature limits and RH are specified by class in Table 11. Precipitation is not authorized during the T/H test.

TABLE 11. Temperature limits

Class	Temperature limits	
	Nonoperating equipment (°C)	Operating equipment (°C at percent RH)
1 [1]	-51 to 71	-40 to 71 at 5 to 60 -40 to 40 at 5 to 85 -40 to 30 at 5 to 95
2	-51 to 71	-10 to 55 at 5 to 45 -10 to 40 at 5 to 75 -10 to 30 at 5 to 95
3	-40 to 71	0 to 50 at 5 to 45 0 to 40 at 5 to 75 0 to 30 at 5 to 95
4	-40 to 71	10 to 40 at 5 to 75 10 to 30 at 5 to 95

Note:

[1] For Class 1 equipment, 20 minute intermittent operation at 71°C after the required warm-up period; 15 minutes not operating.

4.5.5.1.1.1 Temperature test procedure. The temperature test procedure consists of a five independent tests (a through e) that can be performed in any sequence, except as indicated for test a. The profiles provided in Fig. 3 (for Class 1), Fig. 5 (for Class 2), Fig. 7 (for Class 3), and Fig. 9 (for Class 4) demonstrate only one possible sequence of testing. The detailed test procedure at the time of

testing shall define the actual test sequence. The humidity during the test is uncontrolled for all tests except test (d), where the humidity shall be controlled within the range of 5 to 20 percent relative humidity (with the applicable tolerance), to simulate an arid environment. The testing maybe interrupted after any test, a through e. Performance of the satisfactory operation test shall occur at the end of each temperature test period, adding whatever time is required to perform the satisfactory operation test. (This means that the total time required to perform the temperature testing will be the cumulative total consisting of: the time required for each temperature test, the time required to perform a satisfactory operation test at each temperature test, and any interruption period).

Test (a). Place the test item in the test chamber in accordance with 4.5.2.2. This testis the initial operation verification test. With the temperature at the room ambient the equipment is operating for 2 hours, after which the satisfactory operational test is performed. Test (a) shall always be performed first in the test sequence.

Test (b). The temperature is maintained at -40 °C (for Class 1), -10 °C (for Class 2), 0 °C (for Class 3), or 10 °C (for Class 4). The equipment is not operating for 4 hours. Operate the test item for the warmup period recommended by the manufacturer. Perform the satisfactory operation test and compare the results with test (a) in accordance with 4.5.2.1. No alignment or adjustment of other than the operating controls shall be permitted throughout the test specified.

Test (c). The temperature is maintained at -51 °C (for Classes 1 and 2), or -40 °C (for Classes 3 and 4). The equipment is not operating for 4 hours. Following the 4 hour cold storage soak, the temperature is raised to 23 °C. For an additional 4 hours the equipment is maintained at these conditions. Operate the test item for the warmup period recommended by the manufacturer. Perform the satisfactory operation test and compare the results with test (a) in accordance with 4.5.2.1. No alignment or adjustment of other than the operating controls shall be permitted throughout the test specified.

Test (d). The humidity during this test is controlled at within the range of 5 to 20% (with the applicable tolerance). The temperature is maintained at 55 °C (for Classes 1 and 2), 50 °C (for Class 3), or 40 °C (for Class 4). The equipment is operating for 4 hours. Following the 4 hour arid heat operating soak, perform the satisfactory operation test and compare the results with test (a) in accordance with 4.5.2.1. No alignment or adjustment of other than the operating controls shall be permitted throughout the test specified.

Test (e – Class 1). The temperature is maintained at 71 °C. The equipment is not operating for 4 hours. The equipment is then turned on and operated for 20 minutes after the required warm-up period. The temperature is maintained at 71 °C. During the 20 minute operating period perform the satisfactory operation test (shortened as necessary to fit in the 20 minute operation period) and compare the results with test (a) in accordance with 4.5.2.1. No alignment or adjustment of other than the operating controls shall be permitted throughout the test specified.

Test (e – Classes 2, 3, and 4). The temperature is maintained at 71 °C. The equipment is not operating for 4 hours. Following the 4 hour hot storage soak, the temperature is lowered to 23 °C. For an additional 4 hours the equipment is maintained at these conditions. Operate the test item for the warmup period recommended by the manufacturer. Perform the satisfactory operation test and compare the results with test (a) in accordance with 4.5.2.1. No alignment or adjustment of other than the operating controls shall be permitted throughout the test specified.

Class 1 Sample Temperature Testing Profile (including arid climate test)

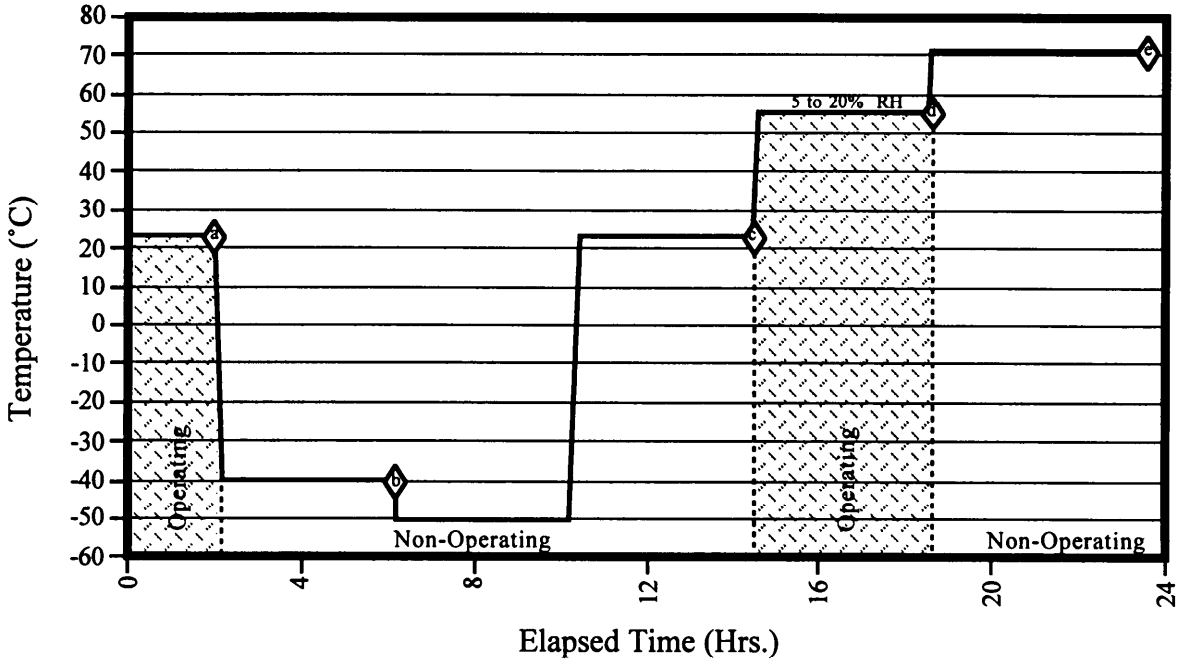


Fig.3 – Sample temperature testing profile for Class 1 (including the arid climate test)

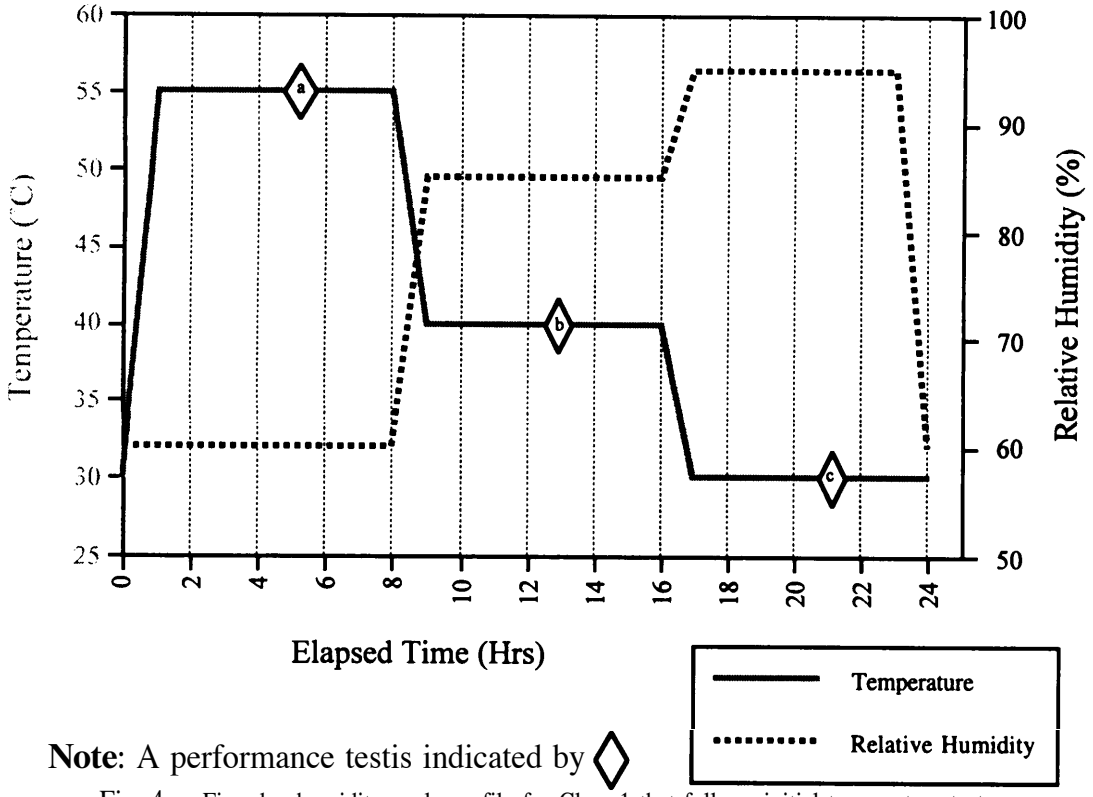
4.5.5.1.1.2 Procedure, humidity cycle. The humidity cycle testing follows immediately after the testing of 4.5.5.1.1. This procedure consists of 5 days of temperature humidity cycling, with each days cycle consisting of the profile displayed in Fig. 4 (for Class 1), Fig. 6 (for Class 2), Fig. 8 (for Class 3), or Fig. 10 (for Class 4). Satisfactory operational tests are performed at the times indicated on the figures with a diamond symbol, noted as (a), (b), and (c) (as applicable). The following Notes 1 through 4 apply:

Note 1. A satisfactory operational test (at normal room ambient conditions) shall be conducted prior to and at-the-conclusion of the five-day humidity test.

Note 2. During the humidity cycle, the equipment is only operating during the warm-up period and the satisfactory operational test.

Note 3. The Satisfactory Operation Tests (SOT), as annotated by (a), (b), and (c) shall each be performed at least once each during the 5 days of humidity cycling, at the indicated times. SOT (a) and (b), as appropriate, shall be performed at any of cycles 2, 3, 4, or 5. SOT (c) shall be performed at least at Cycle 5. SOT's may also be performed at any, or all cycles at the indicated times.

Note 4. To accommodate varying times for completing satisfactory operational tests, the cycle timing after a test maybe adjusted to allow a return back to the regular profile timing. However, a minimum 4 hour dwell time prior to period of operation should be observed.



Note: A performance testis indicated by ◊

Fig. 4 – Five day humidity cycle profile for Class 1 that follows initial temperature test

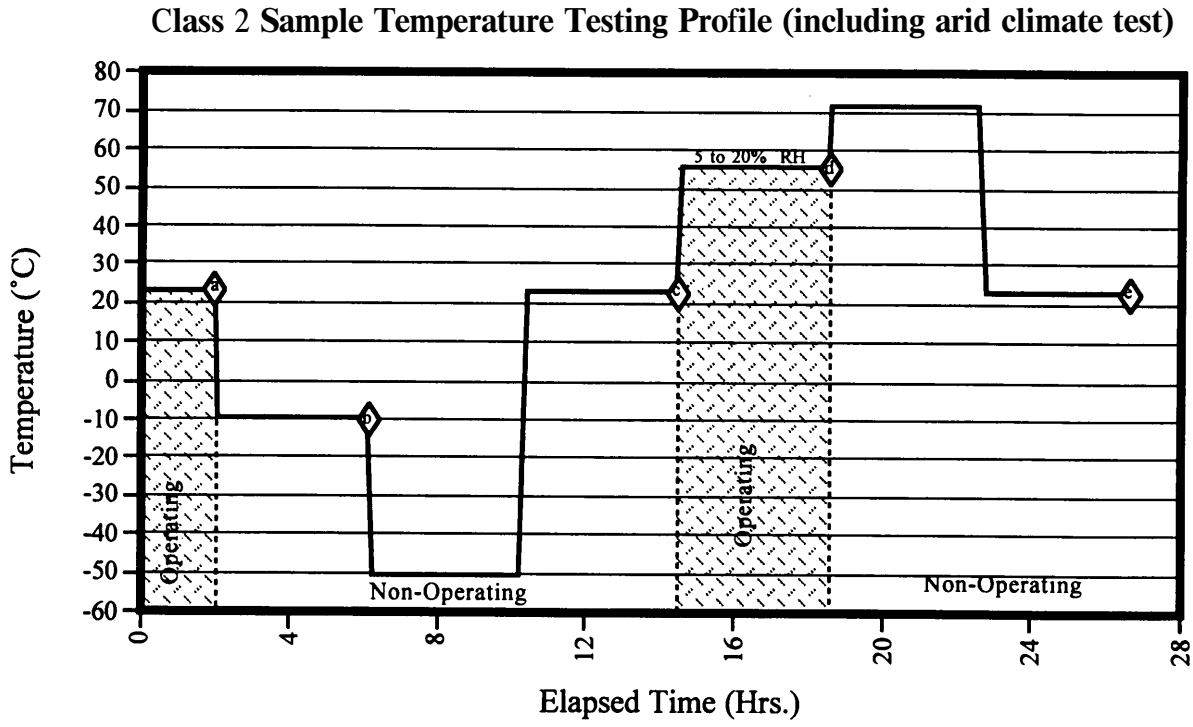
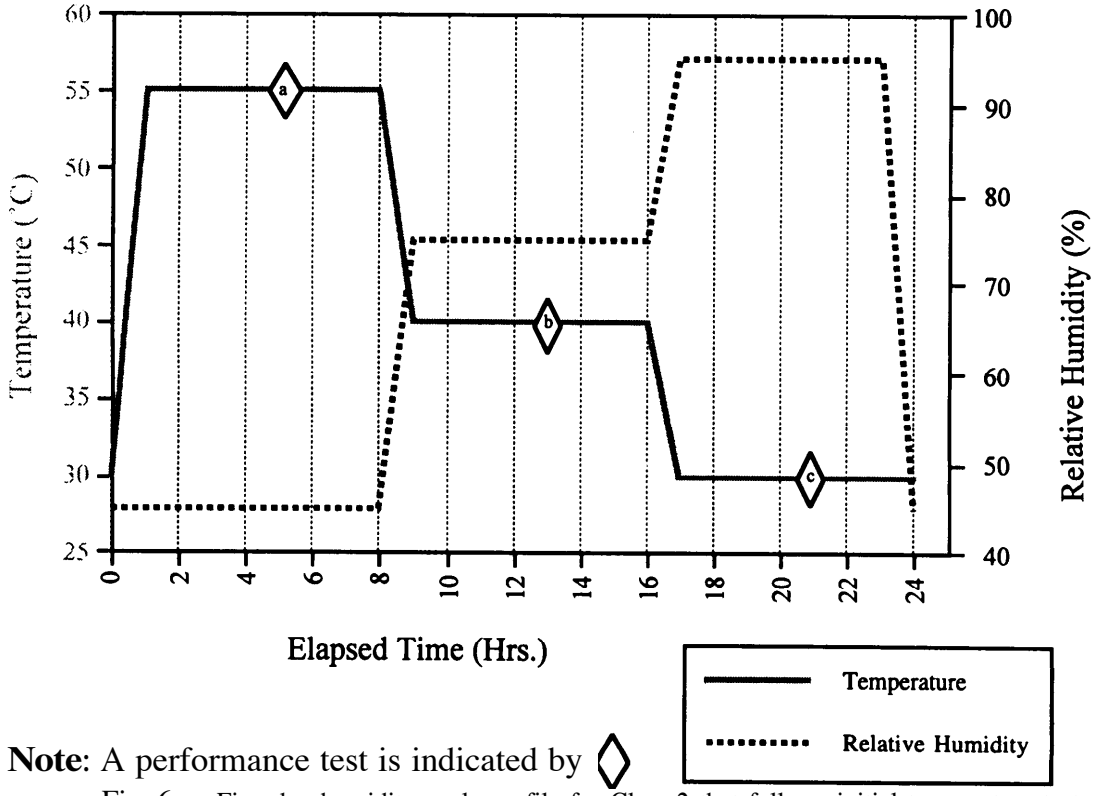


Fig. 5 — Sample temperature testing profile for Class 2 (including the arid climate test)



Note: A performance test is indicated by ◊

Fig. 6 — Five day humidity cycle profile for Class 2 that follows initial temperature test

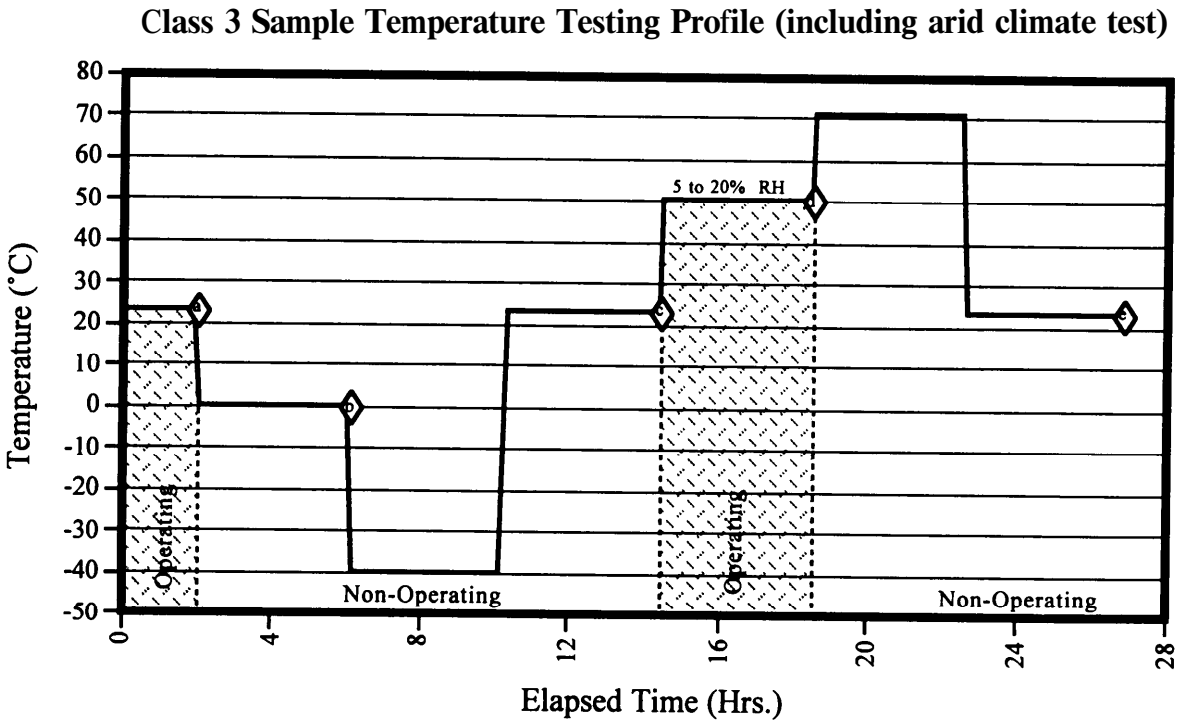
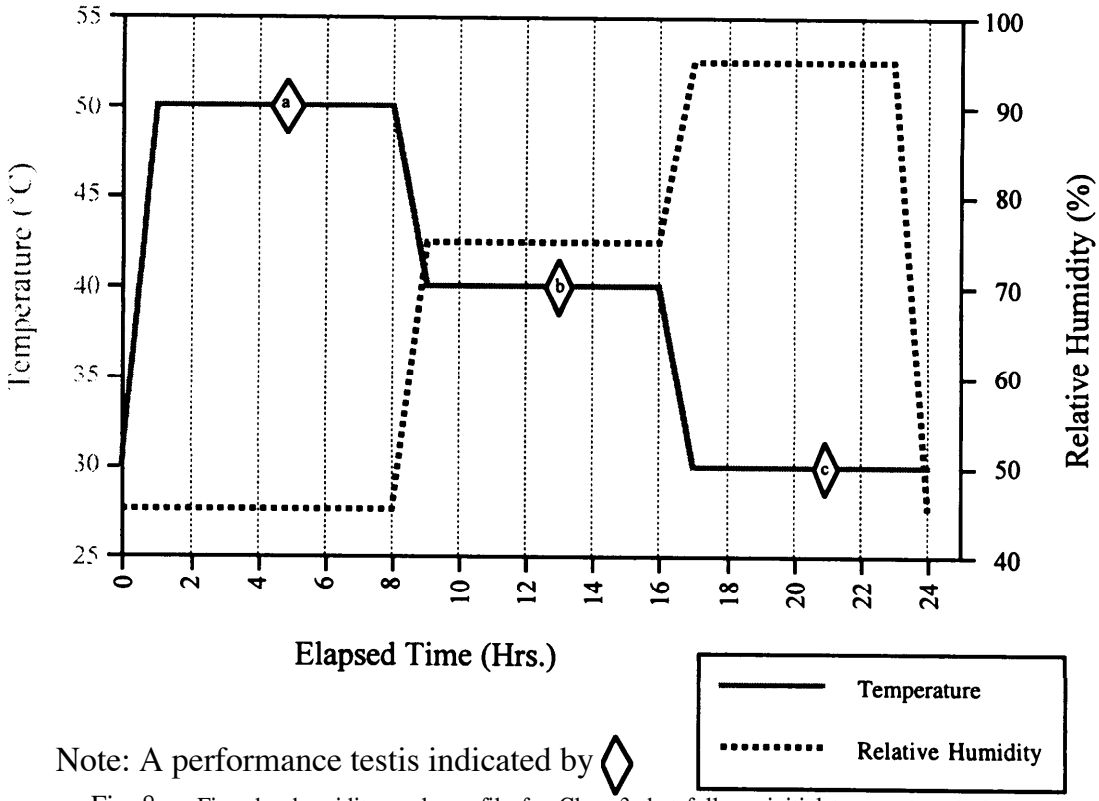


Fig. 7 — Sample temperature testing profile for Class 3 (including the arid climate test)



Note: A performance testis indicated by ◊

Fig. 8 — Five day humidity cycle profile for Class 3 that follows initial temperature test

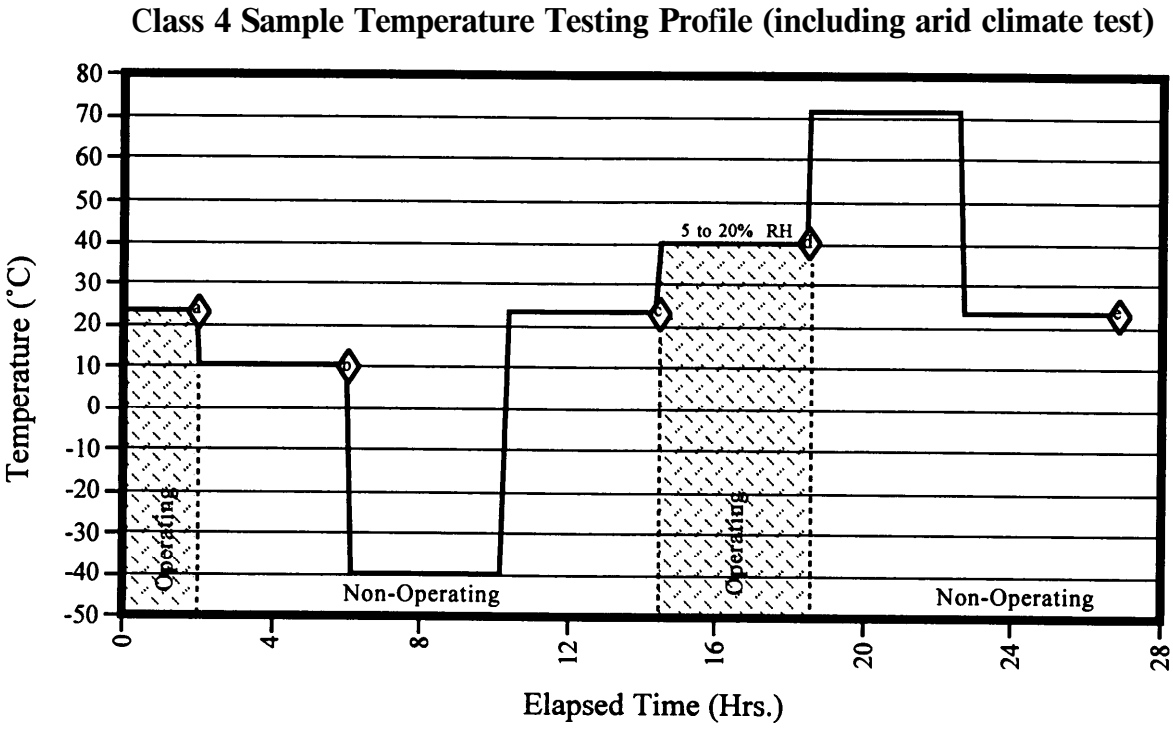
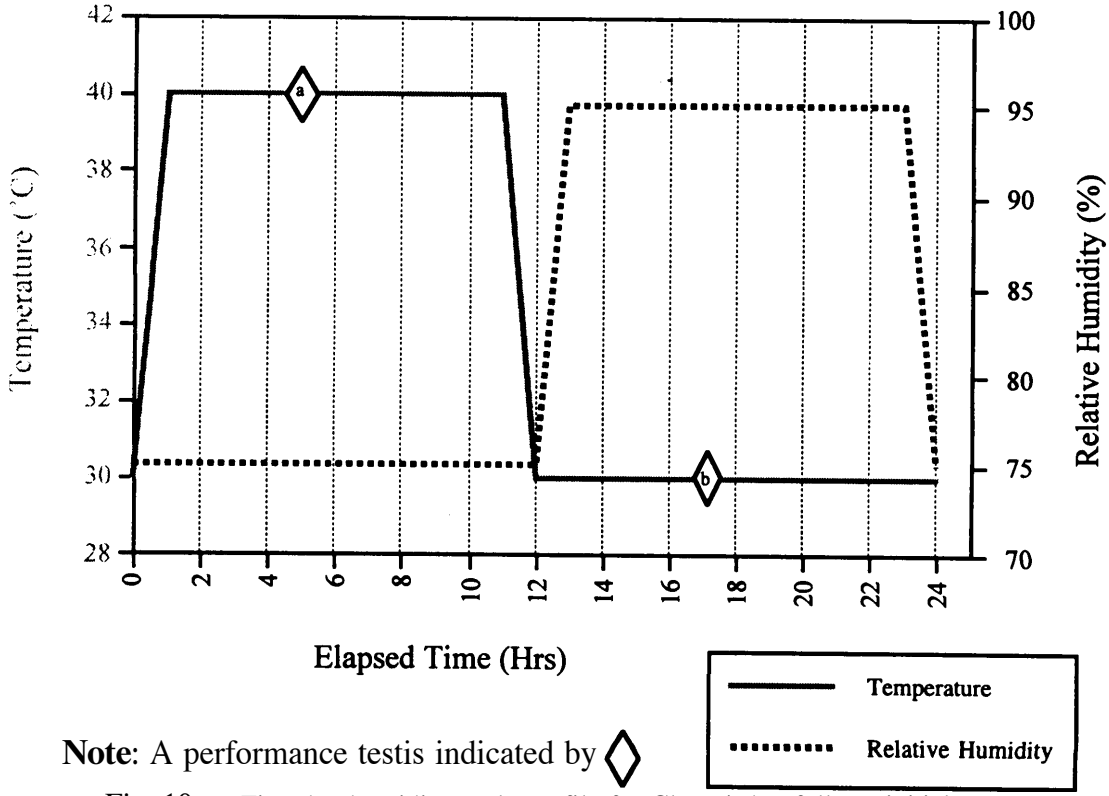


Fig. 9 — Sample temperature testing profile for Class 4 (including the arid climate test)



Note: A performance testis indicated by ◊

Fig. 10 — Five day humidity cycle profile for Class 4 that follows initial temperature test

4.5.5.2 Altitude test. The altitude test shall be performed as specified in Steps 1 through 5 at the simulated altitude.

Step 1. Prepare the test item in accordance with 4.5.2 and maintain the temperature within the specified operating range for the duration of the test. The equipment shall be configured in a mode that can easily be accessed for measurement of conformance to specification. A performance test shall be made at this starting point to determine conformance to specification for the equipment.

Step 2. Decrease the chamber pressure to 4600 mat a rate not to exceed 600 meters per minute. Maintain this pressure for not less than 1 hour and then perform a satisfactory operational check. The equipment shall also be tested to withstand an altitude of 4600 m, not operating for 1 hour.

Step 3. Length of time required for operation and measurements: Warm-up or stabilization time as specified in 3.8.1.1, plus a minimum of 2 hours operation as in the satisfactory operation check.

Step 4. With the test item not operating, return the chamber to standard ambient conditions at a rate not to exceed 600 meters per minute.

Step 5. Perform the satisfactory operation test after return to the test conditions of 4.5.1.1. Degradation of equipment performance beyond the specified requirements shall constitute a failure.

4.5.5.3 Vibration tests. The vibration tests shall be as specified in 4.5.5.3.1 through 4.5.5.3.3. If an equipment failure occurs, the unit under test may be repaired at the discretion of the procuring activity. If repair is allowed, testing will continue from the point at which the failure occurred until the remaining test period is completed. The portion of the test period prior to the failure will be repeated to evaluate the integrity of the repair. Failure modes that are not related to the original failure will be disregarded during the retest. At the discretion of the procuring activity, a second unit maybe subjected to the test in lieu of retesting the unit that failed.

4.5.5.3.1 Random vibration test. Random vibration shall be as specified in 4.5.5 .3.1.1 through 4.5.5.3.1.3.

4.5.5.3.1.1 Background information. Vibration levels of Fig. 11 shall be applied to equipment of class 1, with durations of 1 hour per axis. Vibration levels of Fig. 12 shall be applied to equipment of class 2, with durations of 30 minutes per axis. Vibration levels of Fig. 13 shall be applied to equipment of classes 3 and 4, with durations of 10 minutes per axis. The equipment shall be powered off during the vibration test. The equipment is to be hard mounted to the table by gripping the equipment's structure. Unless the equipment's feet are integral parts of the structure, they should be removed during the test; if they are integral, the equipment should be fixed so that the vibration is applied to the structural frame of the equipment. At the conclusion of the vibration test, conduct a physical evaluation and a performance

test of the equipment. These exposures are based on the typical size of equipment. When equipments are too large, unnecessarily high loads are induced in mounting and chassis structures while higher frequency vibrations experienced at subassemblies are too low. In these cases the test should be applied to subassemblies. The maximum weight of an item or subassembly should be approximately 36 kilograms.

4.5.5.3.1.2 Test level. The test levels shown in Figs. 11, 12 and 13 are for use in testing class 1, class 2, and classes 3 and 4, respectively.

4.5.5.3.1.3 Test duration. The durations are 60 minutes per axis for class 1. The durations are 30 minutes per axis for class 2. The durations are 10 minutes per axis for classes 3 and 4.

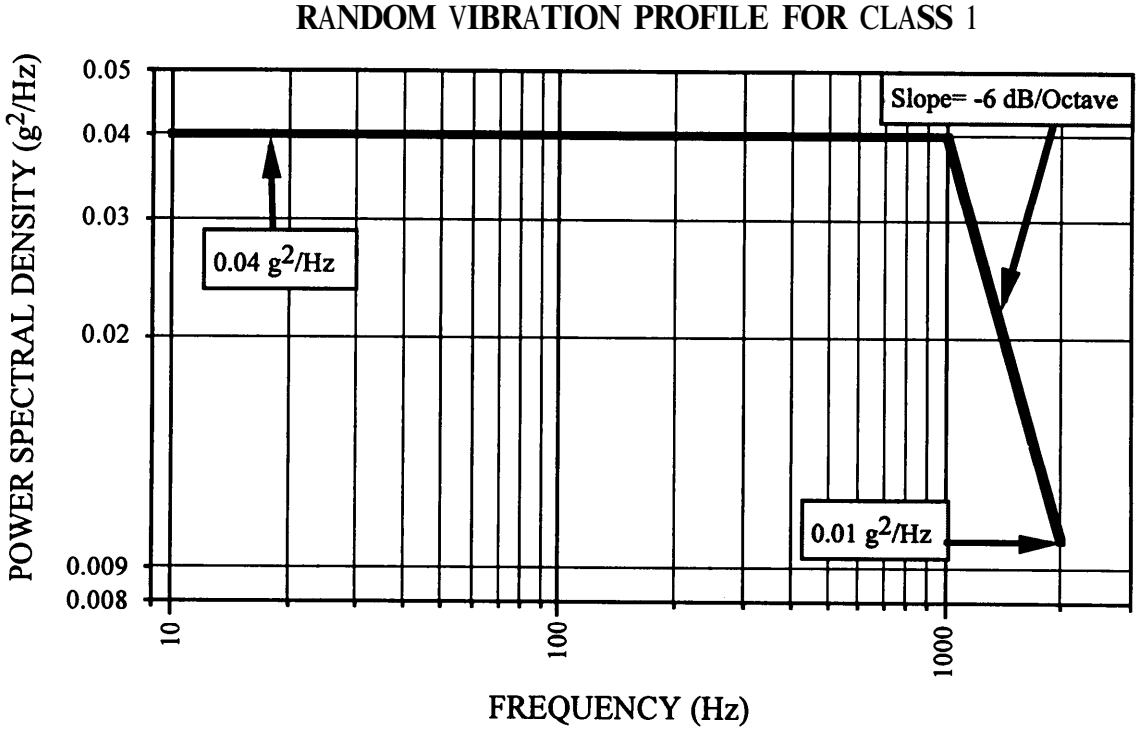


Fig. 11 — Vibration profile for Class 1

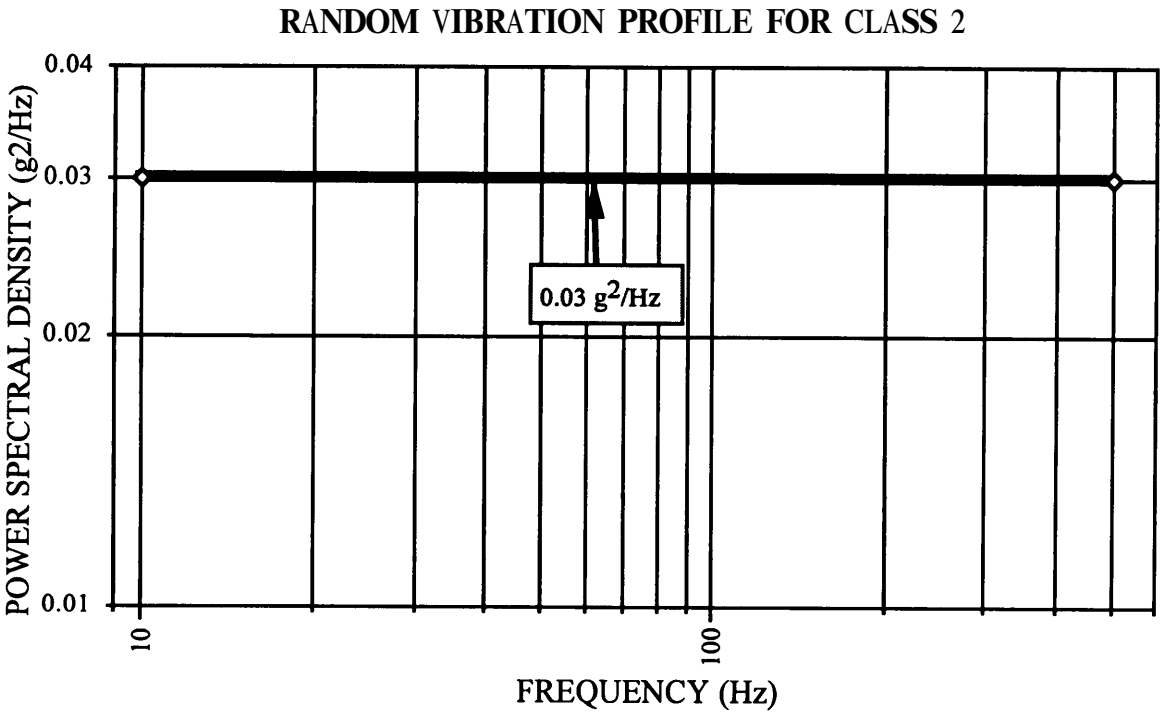


Fig. 12 — Vibration profile for Class 2

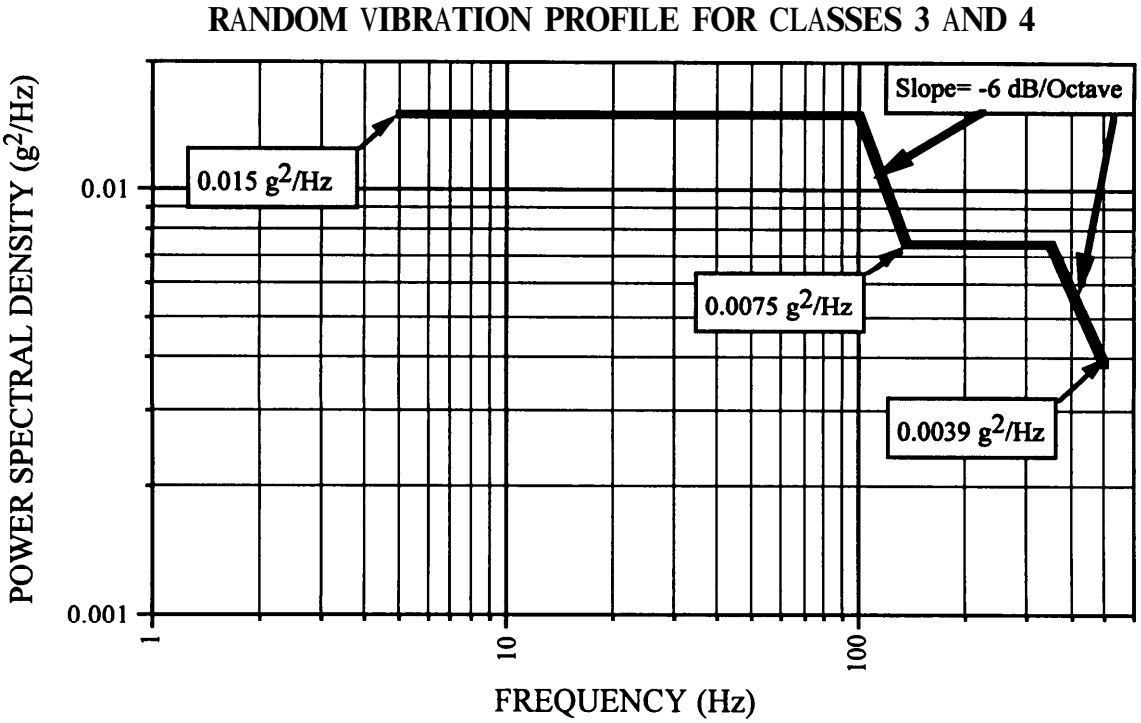


Fig. 13 — Vibration profile for Classes 3 and 4

4.5.5.3.2 Sinusoidal vibration test. When specified, sinusoidal vibration shall be performed on the subject equipment of Classes 1,2, 3, and 4, in lieu of random vibration testing of 4.5.5.3.1. Testing shall be in accordance with Table 12 and the procedure specified in Steps 1 through 5.

Step 1. Method of attachment. The equipment shall be attached or strapped directly to the vibration table or to an intermediate structure designed to be capable of transmitting the specified magnitudes of vibration to the points of equipment attachment, throughout the required test frequency range.

Step 2. During vibration, the equipment shall be operating as in the satisfactory operation check mode.

Step 3. The frequency displacement and time shall be as specified in Table 12. Resonance search, cycling, and dwell test times shall be continuous for the time periods specified. Testing need not be performed below 10 Hz for equipment of Classes 3 and 4.

Step 4. A resonance search, cycling, and resonance dwell shall be conducted in each axis as specified in a through c:

a. Resonance search. A resonance search shall be performed at vibration levels less than those specified in Table 12 but with sufficient amplitude to excite the test item. A difference of 6 dB or more between the excitation source and the test item, or a part thereof, shall indicate the presence of a resonance. If there is an audible or visual indication of resonance or any vibration related malfunction of the equipment, an individual resonance test maybe performed using the full vibratory test level and cycling time specified for the cycling test provided the resonance search time is included in the required cycling time. The test item or a subpart thereof is considered at resonance if the vibration amplitude is more than twice the amplitude of the vibration table.

b. Cycling. The test item shall be vibrated in accordance with the applicable test levels, frequency range, and times specified in Table 12. The frequency of applied vibration shall be swept over the specified range. The specified cycling time is that of an ascending plus a descending sweep and is twice the ascending sweep time.

c. Resonance dwell. The test item shall be vibrated at the most severe resonant frequency determined in the resonance search for that axis. Test levels, frequency ranges, and test times shall be in accordance with Table 12. If a change in the resonant frequency occurs during the test, the frequency shall be adjusted to maintain the peak resonance condition. If no significant resonant response is found, the equipment shall be vibrated for 10 minutes (resonance dwell) at 33 Hz.

Step 5. Perform the satisfactory operation tests.

TABLE 12. Sinusoidal vibration test limits.

Class	Frequency increments Hz	Displacement (mm) peak-to-peak	Resonance search time per increment (minutes [1])	Cycling time per axis (minutes)	Resonance dwell time per axis (minutes)
1, 2	5 to 15 16 to 25 26 to 55	1.5 1.0 0.5	5 5 5	15	10
3, 4	5 to 55	0.33	15	15	10

Notes:

[1] Search times specified shall be for a low frequency to high frequency to low frequency sweep of the applicable increment.

4.5.5.3.3 Loose cargo bounce test. When specified the equipment prepared for field transportation shall be subjected to the loose cargo bounce test as specified in Steps 1 through 3.

Step 1. The test apparatus shall be a package tester capable of 2.54 cm (double amplitude) displacement.

Step 2. The test bed of the package tester shall be covered with a panel of 1.27 cm plywood, with the grain parallel to the drive chain. The plywood shall be secured with six-penny nails, with top of heads flush with or slightly below the surface. Nails shall be spaced at 15.24 cm intervals around all four edges. If the distance between either pair of fences is greater than 61 cm, the plywood shall also be nailed at 7.62 cm intervals in a 15.24 cm square at the center of the test area. Using wooden fences, constrain the test item to a horizontal motion of not more than 5.08 cm in a direction parallel to the axes of the shafts, a distance more than sufficient to ensure the test item will not rebound from fence to fence. For large items, care shall be taken to avoid potential air cushioning effects that may exist between the surface of the package tester and the test item.

Step 3. The test item, as secured in its transit case, equipment case, or as otherwise prepared for field transportation, shall be placed on the package tester within the constraints specified in Step 2 above. The test item will not be operated during vibration. The package tester shall be operated in the synchronous mode with the shafts in phase. (In this mode any point on the bed of the package tester will move in a circular path in a vertical plane perpendicular to the axes of the shafts.) The package tester shall be operated at 2.54 cm double amplitude and 284 rpm ±2 for a total of 3 hours. At the end of each half hour period, turn the test item to rest on a different face, so that at the end of the 3-hour period the test item will have rested on each of its six faces (top, bottom, sides, and ends). At the end of the 3-hour period, the test item shall be operated and inspected and results obtained in accordance with 4.5.2.4. Minor surface abrasion shall not be cause for failure. The package tester shall be operated in the vertical

linear mode (straight up and down in the vertical plane) instead of in the synchronous mode when one of the conditions specified in a and b occurs:

a. Bouncing of the test item is very severe and presents a hazard to personnel.
b. Forward and rear oscillations cannot be reduced. When operated in the vertical linear mode, wooden fences shall be placed on all four sides of the test item to constrain the test items motion to not more than 5.08 cm in either direction.

4.5.5.4 Mechanical shock tests. The shock test specified in 4.5.5.4.1, when required, shall be performed prior to required water resistance tests.

4.5.5.4.1 Functional shock test. Equipment of Classes 1 through 4 shall be subjected to functional shock testing. A half-sine shock pulse with the configuration and tolerance limits shown in Fig. 14 shall be used. The duration (D) of the pulse shall be 11 ms, and the peak shock value (A) shall be 30g. The equipment shall be operating during the test. The equipment shall be given three shocks in each direction and on each axis for a total of 18 shocks. Perform the satisfactory operation test after shock exposure and conduct a physical evaluation.

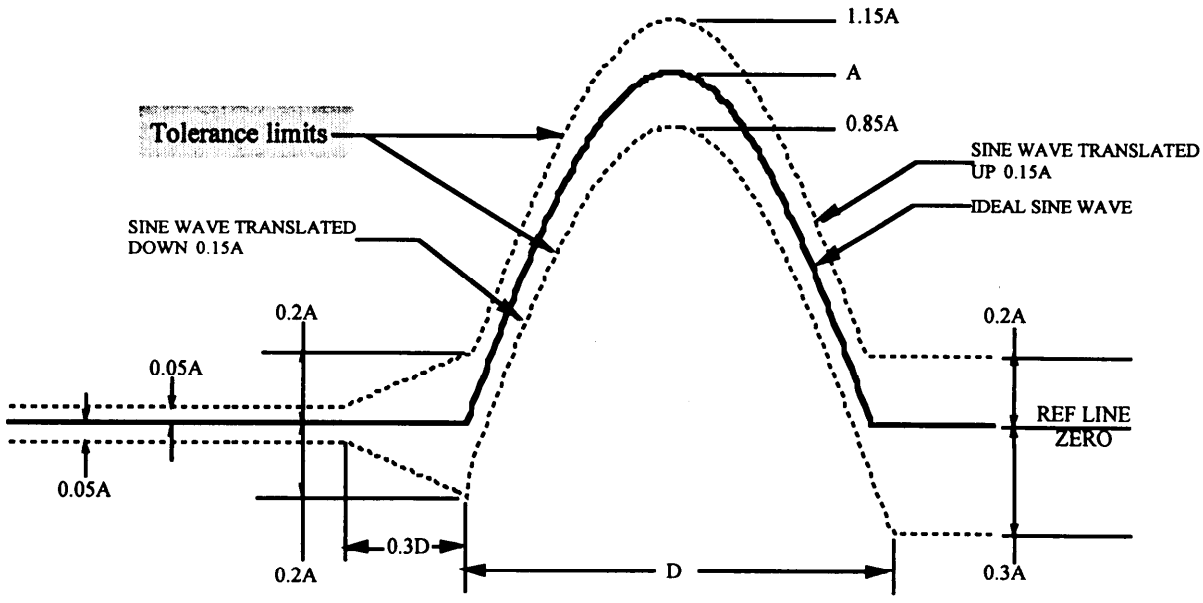


Fig. 14 — Half-sine shock pulse configuration and limits

NOTE: The oscillogram shall include a time about 3D long with a pulse approximately in the center. The acceleration amplitude of the ideal half-sine pulse is A and its duration is D. The measured acceleration pulse shall be contained between the broken line boundaries and the

measured velocity change (that may be obtained by integration of the acceleration pulse) shall be within the limits Vi ±0.1 Vi, where Vi is the velocity-change associated with the ideal pulse, that equals 2 AD/ π. The integration to determine velocity change shall extend from 0.4D before the pulse to 0.lD after the pulse.

4.5.5.4.2 Transit drop test. Equipment that have the enclosure act as the transit case, equipment that is specified to include a transit case, and all Class 1 equipment shall be subjected to the transit drop test. The drop height and number of impacts shall be as specified in Table 13. For equipment 454 kg or less, the floor or barrier receiving the impact shall be of 5.08 cm plywood backed by concrete. For equipment over 454 kg, the floor or barrier shall be concrete.

TABLE 13. Transit drop test.

Equipment Class	Drop height	Number of Impacts [1]
Class 1	46 cm	10
Class 2 where the enclosure is intended to act as the transit case	30 cm	10
Classes 3 and 4 where the enclosure is intended to act as the transit case	20 cm	10
All Classes, when airtight transit case is specified [2]	46 cm	10
All Classes, when hard transit case is specified [2]	46 cm	10
All Classes, when soft transit case is specified [2,3]	61 cm	2 per strap

Notes:

[1] The equipment shall be dropped on the 4 bottom comers and 6 faces for the total number of impacts divided between the test items.

[2] Equipment contained in transit case throughout the test.

[3] Only those cases with shoulder straps shall be subjected to this test. The shoulder strap shall be supported at a point sufficient to allow a fall of 61 cm while preventing the enclosure from contacting the impact surface. The equipment shall remain inside the transit case throughout this test.

4.5.5.4.3 Bench handling test. With the equipment operating as in the satisfactory operating check, place the instrument in a suitable position for its servicing on a horizontal, solid wooden bench top at least 4.1 cm thick. The test shall be performed as specified in Steps 1 through 5, in a manner simulating shocks liable to occur during its servicing.

Step 1. Using one edge as a pivot, lift the opposite edge of the chassis until one of the conditions specified in a through c occurs (whichever occurs first):

a. The chassis forms an angle of 45 degrees with the horizontal bench top.

b. The lifted edge of the chassis has been raised 10.16 cm above the horizontal bench top.
c. The lifted edge of the chassis is just below the point of perfect balance.

Let the chassis drop back freely to the horizontal bench top. Repeat, using other practical edges of the same horizontal face as pivot points, for a total of four drops.

Step 2. Repeat Step 1, with the test item resting on other faces until the test item has been dropped for a total of four times on each face on which the test item could reasonably be placed during its servicing.

Step 3. Repeat Steps 1 and 2 with instrument not operating and cabinet or case removed, except for equipment where the case serves as the only chassis or support structure.

Step 4. Examine the instrument for mechanical damage. Damage to the instrument, other than cosmetic, will constitute a failure.

Step 5. Perform the satisfactory operation test.

4.5.5.4.4 High impact shock test. The high impact shock test shall be defined in the purchase description.

4.5.5.5 Water resistance tests. When specified, the water resistance tests specified in 4.5.5.5.1 through 4.5.5.5.3 shall be performed after the required mechanical shock tests.

4.5.5.5.1 Watertight, Class 1 and air tight transit case. With any case cover latched in place and all drains and ports closed, class 1 equipment and equipment in an air tight transit case with the equipment installed, shall be subjected to the submergence test for watertight equipment, submerging the assembly to provide a minimum of 0.9 m of water above the top of the enclosure. The equipment shall be not operating while the cover is latched in place. Perform the satisfactory operation test after submergence.

4.5.5.5.2 Splashproof test, Class 1. With the cover off and the instrument operating, perform the splashproof test and the Water Repellent Tests for a minimum of 5 minutes. Perform the satisfactory operation tests.

4.5.5.5.3 Dripproof test, Classes 2, 3, and 4, and hard transit cases. When equipment of class 2, class 3, or class 4 is specified as dripproof, the following dripproof test shall be performed. When a hard transit case is specified, the following dripproof test shall be performed only when the testis specified. Unless otherwise specified the equipment is not operated during the test. Unless otherwise specified equipment covers (if present) or transit case, shall be closed. The test shall be performed as specified in Steps 1 through 8.

Step 1. The test item (equipment or equipment in transit case) shall be placed in the chamber in its normal operating position on a platform or tilt table in a manner such that it can be oriented horizontally and in any of four directions forward, backward, and to each side to the extent of 15 degrees from the horizontal plane.

Step 2. Attach a spray nozzle with a uniformly distributed full cone spray pattern to a flexible hose and using a container calibrated in liters or an equivalent method, determine the rate of flow out of the nozzle. The requirements for water flow shall be 16.3 ±1 liters per hour for each square foot of area covered by the spray 0.9 m below the nozzle.

Step 3. Position the nozzle 0.9 m above the test item so that the spray is directed downward onto the test item. The test item shall be subjected to a uniform spray over the entire surface being tested. During the test, equipment shall not be operated unless specified (but not equipment in a transit).

Step 4. Direct the spray onto the top of the test item (with platform or tilt table horizontal) for at least 8 minutes. Turn off spray for 4 minutes.

Step 5. Direct the spray downward onto the test item for at least 8 minutes with the platform or table tilted such that the test item is oriented 15 degrees from the horizontal in the forward position. Turn off the spray for 4 minutes.

Step 6. Direct the spray downward onto the test item for at least 8 minutes with the platform or table tilted such that the test item is oriented 15 degrees from the horizontal in the backward position. Turn off spray for 4 minutes.

Step 7. Direct the spray downward onto each remaining side of the test item for at least 8 minutes with the platform or table tilted such that the side being sprayed is oriented 15 degrees from the vertical. Turn off spray for 4 minutes.

Step 8. Return the test item to the horizontal (platform or tilt table horizontal) and perform the satisfactory operation test.

4.5.5.6 Electrical power tests. During the electrical power tests, the equipment performance shall be monitored as specified in 4.5.5.6.1 through 4.5.5.6.5.

4.5.5.6.1 Input power test. The input power test shall be tested by measuring the power consumption of the equipment. Power consumption that exceeds the value specified in the purchase description shall constitute a failure of this test.

4.5.5.6.2 Voltage and frequency variation test. The response of the equipment to input voltage and frequency variations shall be tested as specified in Steps 1 through 4.

Step 1. Connect the power cable of the equipment to a variable voltage and frequency source.

Step 2. Set the output of the variable source at 120 Vrms, 60 Hz.

Step 3. Performance of the equipment outside the limits required in the satisfactory operation check or other tests specified in the purchase description shall constitute a failure of this test.

Step 4. Repeat Steps 2 and 3 for voltages and frequencies required by the purchase description from the variable source as specified in Table 14, using the maximum voltage and minimum voltage limit values. The voltage and frequency shall be maintained for at least 15 minutes at each level specified. This test may be performed at other points within the specified ranges at the discretion of the Government quality assurance representative.

4.5.5.6.3 Voltage-transient test. The equipment performance during voltage transients shall be tested as specified in Steps 1 through 7.

Step 1. Connect the power cable of the equipment to a 60 Hz variable voltage source.

Step 2. Set the output of the source to the maximum voltage for the equipment type as specified in Table 14.

TABLE 14. Variable frequency power supply outputs.

Frequency (Hz)	Minimum voltage (Vrms)	Maximum voltage (Vrms)
47.5	108	132
52.5	108	132
57	108	132
63	108	132
380	108	132
420	108	132

Step 3. Quickly increase the source voltage to a transient value of 156 Vrms, hold for approximately 0.5 second, and quickly return to the starting voltage of Step 2. Monitor equipment performance during and after the transient for compliance with the satisfactory operation check or other tests specified in the purchase description. Performance outside of the specified limits for longer than 30 seconds, shall constitute a failure of this test.

Step 4. Repeat Steps 3 four more times at 2-minute intervals.

Step 5. Set the output of the source to a starting voltage of 108 Vrms.

Step 6. Repeat Step 3 with a transient value of 84 Vrms and the starting voltage specified in Step 5.

Step 7. Repeat Steps 6 four more times at 2-minute intervals.

4.5.5.6.4 Frequency-transient test. The equipment performance during frequency transients shall be tested as specified in Steps 1 through 16.

Step 1. Connect the power cable of the equipment to a 120 Vrms variable frequency source. The output voltage shall be the operating voltage specified for the equipment.

Step 2. Set the output of the source to a starting frequency of 47.5 Hz.

Step 3. Quickly change the source frequency to a transient value of 45 Hz, hold for approximately 0.5 second, and quickly return to the starting frequency of 47.5 Hz. Monitor equipment performance during and after the transient for compliance to the satisfactory operation check or other tests specified in the purchase description. Performance outside of the specified limits for longer than 30 seconds, shall constitute a failure of this test.

Step 4. Repeat Step 3 four more times at 1-minute intervals.

Step 5. Set the output frequency of the source to a starting frequency of 57 Hz.

Step 6. Repeat Step 3 with a transient frequency of 54 Hz and a starting frequency of 57 Hz.

Step 7. Repeat Step 6 four more times at 1-minute intervals.

Step 8. Set the output frequency of the source to a starting frequency of 63 Hz.

Step 9. Repeat Step 3 with a transient frequency of 66 Hz and a starting frequency of 63 Hz.

Step 10. Repeat Steps 9 four more times at 1-minute intervals.

Step 11. Set the output frequency of the source to a starting frequency of 380 Hz.

Step 12. Repeat Step 3 with a transient frequency of 360 Hz and a starting frequency of 380 Hz.

Step 13. Repeat Steps 12 four more times at 1-minute intervals.

Step 14. Set the output frequency of the source to a starting frequency of 420 Hz.

Step 15. Repeat Step 3 with a transient frequency of 440 Hz and a starting frequency of 420 Hz.

Step 16. Repeat Steps 15 four more times at 1-minute intervals.

4.5.5.6.5 Power source interruption test. The power source interruption test shall conform to the requirements of 3.5.1.2.3.

4.5.5.7 Group C verification test. The Group C verification test shall be performed after the required tests of 4.5.5.1 through 4.5.5.6.5 have been completed. The Group C verification test shall consist of the Group A and Group B tests specified by the class and purchase description. Group A and Group B test failure criteria shall apply.

4.5.6 Group D tests. The Group D tests shall be performed as specified herein and in the purchase description or approved equipment test procedure (see 6.5.2.2). These tests shall be performed under the test conditions specified in 4.5.1.1.

4.5.6.1 Fungus resistance test. When specified perform the fungus test in accordance with the following procedure. Pre and post-operation tests are required. The test duration shall be 28 days. Each of the five species must be used in the test: Aspergillus tiger (USDA-QM386), Aspergillus flavus (USDA-QM380), Aspergillus versicolor (USDA-QM432), Penicillium funiculosum (USDA-QM474), and Chaetomium globosum (USDA-QM459). The test conditions shall be conducted with the equipment in a non-operational state. Any fungal growth on the test item must be evaluated by qualified personnel for:

(1) the extent of growth on the components supporting growth,
(2) the immediate effect that the growth has on the physical characteristics of the test item,
(3) the long-range effect that the growth could have on the test item, and
(4) the specific material supporting the growth.

Disturbance of any fungal growth must be kept to a minimum during the operational checkout. Human factors effects must be evaluated. The test shall be performed in a chamber with the temperature 30 “C and the humidity 95%. Following the 28 day incubation and growth period the materials used in the equipment shall be devoid of microbial growth.

4.5.6.2 Salt fog tests. Salt fog tests shall be conducted in accordance with the procedure as specified in 4.5.6.2.1 through 4.5.6.2.3. The test duration shall be 48 hours with the samples being constantly wetted with a 5 ±1 percent salt solution. A 48 hour drying period in a standard ambient atmosphere shall follow.

4.5.6.2.1 Salt fog test, enclosure. When specified for any class or transit cases, the equipment or transit case (with equipment enclosed) shall be submitted to the salt fog test. Class 1 equipment shall have the cover (if a cover is present) removed from the enclosure and placed in the salt fog chamber with the accessories (except the technical manual and those accessories used in the satisfactory operation test) packed in the normal manner in the cover. All classes of equipment (unless a transit case is specified then before the transit case is closed the cables and connectors shall be removed from the equipment in the transit case) shall be not operating but with cables and connectors attached as for the satisfactory operation test. Unused connectors may have caps or covers installed. Perform the satisfactory operation test required in the purchase description before any cleaning is performed. Inspect the equipment to detect evidence of physical degradation. Visible corrosion is permissible if it is removed by suitable cleaning and the equipment is returned to a condition that conforms to the requirements of 4.5.3.1. Perform the satisfactory operation test required in the purchase description. Degradation of equipment performance beyond the requirements of the purchase description shall constitute a failure of this test.

4.5.6.2.2 Salt fog test, structural parts. Unless otherwise specified for Class I equipment and when specified for other classes of equipment, the equipment shall have one or more samples of each material used for the fabrication of panels and structural parts (chassis, rails, braces, and so forth) with finishes as in the completed equipment, subjected to the salt fog test. After exposure, the material shall be inspected to detect any evidence of physical degradation. Visible corrosion is permissible if it is removed by suitable cleaning and the material is, as a result of the cleaning, returned to a condition that conforms to the requirements of 4.5.3.1. Degradation of material beyond the requirements of the intended use shall constitute a failure of this test.

4.5.6.2.3 Salt fog test, procedure. The equipment shall be in its normal operating mode (except for equipment in transit cases), without power applied. The salt concentration shall be 5°/0 sodium chloride. The test chamber temperature shall be 35 °C. Store the equipment (or equipment in its transit case) in a standard ambient atmosphere for 48 hours following the 48 hour salt exposure. At the end of the drying period operational performance tests shall be performed to verify that equipment performance has not deteriorated.

4.5.6.3 Explosive atmosphere test. Class 1 equipment (and any equipment of a different class as identified in the purchase description) shall be subjected to the explosive atmosphere tests in accordance with the procedure of Steps 1 through 16.

Step 1. The test item shall be installed in the test chamber in such a manner that normal electrical operation is possible and mechanical controls may be operated through the pressure seals form the exterior of the chamber. External covers of the test item shall be removed or loosened to facilitate the penetration of the explosive mixture. Large test items maybe tested one or more units at a time by

extending electrical connections through the cable port to the remainder of the associated equipment located externally.

Step 2. The equipment shall be operated to determine if it is functioning properly and to observe the location of any sparking or high temperature components that could cause an explosion.

Step 3. Mechanical loads on driver assemblies and servomechanical and electrical loads on switches and relays may be simulated when necessary if proper precaution is given to duplicating the normal load in respect to torque, voltage, current, inductive reactance, etc. In all instances, it is preferable to operate the equipment as it normally functions in the system during service use.

Step 4. A thermocouple shall be placed on the most massive component of the test item.

Step 5. At least two thermocouples shall be placed on the inside of the test chamber walls. These thermocouples and the thermocouple discussed in step 4 should be instrumented for monitoring outside the test chamber when the chamber is sealed.

Step 6. Seal the chamber with the test item mounted inside.

Step 7. Raise the ambient temperature of the air inside the chamber to that of the highest operating temperature required for the equipment class. Wait until the temperature of the test item and the test chamber inner walls come to within 11 °C of the chamber ambient temperature.

Step 8. Adjust the chamber air pressure to simulate 4600m or as otherwise specified.

Step 9. Slowly introduce the required quantity of n-hexane into the test chamber according to the following formula:

$$\text{Volume of 95\% n- hexane(ml)} = (2.74 \times 10^{-4}) \left[\frac{(\text{net chamber volume in liters}) \times (\text{chamber pressure in pascals})}{(\text{chamber temperature in °K}) \times (\text{specific gravity of n - hexane})} \right]$$

Step 10. Circulate the test atmosphere and continue to reduce the simulated chamber altitude for at least three minutes to allow for complete vaporization of fuel and the development of a homogeneous mixture.

Step 11. At 1000 m above the test altitude, operate the test item. Operation shall be continuous from this step through step 13. Make and break electrical contacts as frequently as reasonably possible.

Step 12. Slowly decrease the simulated chamber altitude by bleeding air into the chamber. Change the simulated altitude at a rate no faster than 100 meters per minute.

Step 13. Stop the altitude at 1000 meters below test altitude or at ground level, whichever is reached first.

Step 14. Check the potential explosiveness of the air-vapor mixture by attempting to ignite a sample of the mixture by a spark-gap or glow plug ignition source having sufficient energy to ignite a 3.82% hexane mixture. If the ignition does not occur, return the chamber to ambient atmospheric pressure, purge the chamber of the fuel vapor, and reinitiate the test at the most recent altitude.

Step 15. If the simulated altitude reached in step 13 is 3000 meters or greater above the site level, continue testing at the next test altitude that is defined as 3000 m below the just completed test altitude. Repeat steps 9-15 using the new test altitude. If the simulated altitude reached in step 13 is below 3000 m, repeat steps 9-14 using site level as the last test altitude and then go to step 16.

Step 16. Document the test results.

4.5.6.4 Dust resistance test, Class 1 and hard transit cases. Class 1 equipment and when specified for equipment in hard transit cases, shall be subjected to the dust resistance test procedure provided in paragraph 4.5.6.4.1. Class 1 equipment shall be tested with the equipment not operating and with the cover on. Equipment in transit cases shall have the transit case closed and secured. The test shall be conducted with small particle silicone flour at an air velocity of 8.9 m/s and a concentration of 10.7 ±7.1 grams per cubic meter (g/m^3). The test duration shall be 6 hours at 23°C followed by 6 hours at the specified high storage temperature. The RH shall not exceed 30 percent. Perform the satisfactory operation test before and after the dust test. Degradation of equipment performance beyond the requirements of the purchase description shall constitute a failure of this test.

4.5.6.4.1 Dust resistance test procedure. Perforrn the following pretest steps:
Step a. Determine from the test plan the variables that are to be used.

Step b. Operate the test chamber without the test item to make sure it is working properly.

Conduct each of the steps 1 through 21.

Step 1. Position the test item in the test chamber as near the center of the test sections as practicable. The test item shall have a minimum clearance of 15 cm from any wall of the test chamber and from any other test item (if more than one item is being tested.) Orient the test item so as to expose the most critical or vulnerable parts to the sand or dust stream.

Step 2. Prepare the test item in its operational configuration.

Step 3. Stabilize the test item at standard ambient conditions as defined in the test plan.

Step 4. Conduct a complete visual examination of the test item with special attention to sealed areas and minute openings.

Step 5. Document the results.

Step 6. Conduct an operational checkout in accordance with the approved test plan.

Step 7. Record results for compliance.

Step 8. If the test item operates satisfactorily, proceed. If not, restart the test.

Step 9. With the test item in the chamber, adjust the test section temperature to 23 “C and the relative humidity to less than 30%. Maintain less than 30% relative humidity throughout the test.

Step 10. Adjust the air velocity to the required value, determined from the approved test plan.

Step 11. Adjust the dust feed control for a dust concentration of 10.6 ±7 g/m^3.

Step 12. Maintain the conditions of steps 9-11 for at least 6 hours.

Step 13. Stop the dust feed, reduce the test section air velocity to that required to maintain the climatic conditions, and adjust the temperature to that determined from the test plan.

Step 14. Maintain step 13 conditions until stabilization.

Step 15. Adjust the air velocity to that used in step 10 and restart the dust feed to maintain the dust concentration of step 11.

Step 16. If required, operate the test item in accordance with the approved test plan. Continue the exposure for at least 6 hours.

Step 17. Turn off all chamber controls and allow the test item to return to standard ambient conditions.

Step 18. Remove accumulated dust from the test item by brushing, wiping, or shaking, taking care to avoid introduction of additional dust into the test item. Do not remove dust by either air blast or vacuum cleaning.

Step 19. Operate the test item in accordance with the approved test plan.

Step 20. Document the results.

Step 21. Inspect the test item giving special attention to bearings, grease seals, lubricants, etc.

4.5.6.5 EMC test. The equipment shall be subjected to the EMC compatibility tests and limits specified in 3.9 and as specified in the purchase description. The measuring equipment set up, procedures, and operation of the test sample (equipment) shall be in accordance with CISPR 11 Class A, IEC 1000-4-2, IEC 1000-4-3, IEC 1000-4-4, and IEC 1000-4-6. When specified for the electrostatic discharge immunity requirement, MIL-STD-1686C procedures and tests shall be used. Test conditions shall be in accordance with 4.5.1.1.

4.5.6.6 Magnetic environment test. When specified, the magnetic environment test specified in steps 1 through 7 shall be performed. The equipment performance and accuracy shall be as specified in the purchase description. The magnetic environment test shall be conducted with a Helmholtz coil set that is 1 m in diameter, each coil not over 0.13 m in breadth, spaced 0.5 m apart, and capable of carrying sufficient current to produce a field intensity of 20 Oersteds. Larger coil diameters and separation may be used when the dimensional ratios areas specified herein.

Step 1. Prior to placing equipment in the area of the field, energize the coil set with a dc current to produce a 20 ±1 Oersted field in air. Observe the magnitude of current required and de-energize the coil set.

Step 2. Place the equipment in the center of the coil set.

Step 3. Operate the equipment. The performance of the equipment shall be as specified in the purchase description.

Step 4. Energize the coil set so that the equipment is subjected to a magnetic field that is increased from 0 Oersteds to 20 ±1 Oersteds at a rate of change between 20 and 200 Oersteds per second (using the current observed in Step 1). Maintain the field at 20 ±1 Oersteds for 5 minutes or longer, if necessary, to verify correct operation in the satisfactory operation check. Observe any effect on the equipment other than correct operation. If an effect is observed, reduce the magnitude of the field at a rate of change between 20 Oersteds and 200 Oersteds per second until the effect is no longer apparent and observe the magnitude of the field at that point. Reduction of the field to less than 5 Oersteds, to permit specified operation of the equipment, shall constitute a failure of this test. De-energize the coil set.

Step 5. Reverse the connections of the coil to the power source and repeat Steps 4 and 5.

Step 6. Perform Steps 3 through 5 for the three major axes of the equipment.

Step 7. Perform the satisfactory operation test.

4.5.6.7 Group D verification test. The Group D verification test shall be performed after the required tests of 4.5.6.1 through 4.5.6.6 have been completed. This test shall consist of the Group A and Group B tests specified by the class and purchase description. Groups A and B test failure criteria shall apply.

4.5.6.8 Solar radiation test. When specified, Class 1 and Class 2 equipment shall be subjected to the solar radiation test specified in Steps 1 through 14.

Step 1. Place the test item in the test chamber and stabilize it at 23°C with ambient humidity.

Step 2. Conduct a visual examination of the test item with special attention to stress areas, such as comers of molded cases.

Step 3. Document the results.

Step 4. Prepare the test item in its operational configuration, with temperature sensors necessary to determine test item response.

Step 5. Conduct an operational checkout in accordance with the approved test plan.

Step 6. Record results for compliance.

Step 7. If the test item operates satisfactorily, place it in its test configuration (if other than operational.) If not, resolve the problem and restart the test. Position the test item in accordance with the following items a through c and proceed to the first test as specified in the test plan.

(a) Place the items as near the center of the test chamber as practical and so that the surface of the item is not closer than 0.3 m to any wall or 0.76 m to the radiation source when the source is adjusted to the closest position it will assume during the test.

(b) Orient, within realistic limits, to expose its most vulnerable parts to the solar radiation, unless a prescribed orientation sequence is to be followed.

(c) Separate each item from other items that are being tested simultaneously, to ensure that there is no mutual shading or blocking of airflow.

Step 8. Raise the chamber temperature to 33°C.

Step 9. Expose the test item to continuous 24-hour cycles of controlled simulated solar radiation and dry-bulb temperature as indicated in Table 15. Three cycles shall be performed. Increase and decrease the solar radiation intensity to correspond with Table 15. The test items may or may not be operated

throughout the test, at the option of the equipment specification. When an evaluation of the heating effects is important, operation at least at peak temperature should be specified.

Step 10. Continue cycling until the peak response temperature achieved during a cycle is within +3 °C to the peak response temperature achieved during the previous 24-hour cycle, or during 7 cycles, whichever comes first.

TABLE 15. Temperature/solar radiation diurnal cycle.

Time	Temperature (°C)	Solar Radiation (W/m^2)
0000	33	0
0300	32	0
0600	30	55
0900	37	730
1200	42	1120
1500	43	915
1600	43	730
1800	42	270
2100	36	0
2400	33	0

Step 11. Conduct an operational checkout of the test item.

Step 12. Adjust the chamber air temperature to standard ambient conditions and maintain until temperature stabilization of the test item has been achieved.

Step 13. Conduct a complete visual examination of the test item.

Step 14. Document the results.

4.5.7 Group E tests. The Group E tests shall be performed as specified herein, by the class and purchase description or approved equipment test procedure (see 6.5.2.2).

4.5.7.1 Maintainability tests. Maintainability tests shall be as specified in 4.5.7.1.1 and 4.5.7.1.2.

4.5.7.1.1 Maintainability demonstration. The equipment shall be evaluated for conformance to the requirements specified in 3.14.1 through 3.14.4.

4.5.7.1.2 Washability test. When specified, the equipment shall be subjected to the washability test specified in Steps 1 through 7. When maintainability compliance is to be demonstrated in accordance with 4.5.7.1.1 and the washability test is invoked, the washability test shall be performed prior to the maintainability demonstration.

Step 1. Remove the equipment case or covers to expose internal parts and circuits as for servicing.

Step 2. Using a hand-atomizer or paint-sprayer, spray a thin coat of light machine oil containing a coloring agent such as food coloring over the exposed interior and exterior parts. The coating shall be sufficient to cause easily recognizable discoloration.

Step 3. Subject the equipment to 50°C for 24 hours with suitable precautions against accumulation of flammable vapor.

Step 4. Subject the equipment to water-wash according to the equipment manufacturer's washing procedure and with detergents or cleaners specified for the equipment by the manufacturer, until the added contaminants of Step 2 have been removed. Rinse and dry the equipment according to the contractor's furnished procedure.

Step 5. Perform relubrication as specified in the manufacturer's procedure.

Step 6. Inspect the equipment. Loss of finishes or markings, deformation of parts, or other evidences of deterioration shall constitute a failure of this test.

Step 7. Operate the equipment, with particular attention to the ease of operation of controls and switches, and functional stability. Operate as in the satisfactory operation test. Degradation of equipment performance beyond the specified requirement shall constitute a failure of this test.

4.5.7.2 Acoustic noise test. Unless otherwise specified, the equipment shall be tested to ISO 7779 and have a sound pressure level no greater than 70 dBA when measured at the operator and bystander position.

4.5.7.3 Dimensions and weight tests. Compliance with the specified weight and dimensional requirements of the equipment (and any plug-ins or accessories for which the dimension and weight are separately specified in the purchase description) shall be determined by weighing and measuring the equipment.

4.5.7.4 Mechanical stability test. Unless excluded in 3.6.3, the equipment shall be subjected to the mechanical stability test specified in Steps 1 through 5:

Step 1. Position the test item on a raised platform or table with a surface area of sufficient size to accommodate the total bottom surface of the test item in its normal operating position and configuration.

Step 2. Reposition the test item so that one-fourth of the bottom surface extends beyond the edge of the platform or table. The extended side of the test item shall be parallel to the edge of the platform that is located under the test item.

Step 3. Determine that there is no evidence of instability. Evidence of instability shall be considered as a test failure.

Step 4. Repeat Steps 2 and 3 for all additional vertical sides of the test item.

Step 5. Repeat Steps 2 through 4 for each required alternate operating position and configuration of the test item. When the rear of the test item is equipped with feet or bumpers (such as for use on a floor or deck) that prohibit the repositioning of the test item in accordance with Step 2, an auxiliary support may be provided for this step. The auxiliary support (such as a piece of plywood) shall be not larger than the bottom surface in its alternate position, but shall be sufficiently large to accommodate the rear feet or bumpers. During the test, the support and the test item shall be repositioned as specified in Step 2.

4.5.7.5 Equipment emanations test. When specified, the emanations tests for X-radiation, microwave radiation, ozone liberation, and ultrasonic pressure shall be performed in accordance with IEC 1010.

4.5.7.6 Packaging inspection. The inspection of the preservation, packaging, and packing shall be in accordance with the requirements of ASTM D4169, assurance level I. The acceptance criteria is that the equipment is damage-free and that the package is intact. The distribution cycle that the packaged equipment will encounter is DC-18. The manufacturer shall provide documentation to establish that packaging meets the requirements of ASTM D4169, assurance level I. Markings shall be inspected to assure that the required information is present and that the marking is legible, nonfading, and durable. Lettering of all markings shall be examined to assure it complies with the requirement of capital letters of equal height, clearly legible, and proportional to the available space of the container.

4.5.7.7 Additional tests. The test and accept/reject limits for any additional tests shall be as specified in the purchase description.

4.5.8 Group F tests. The reliability of the equipment shall be verified in accordance with 4.5.8.1

4.5.8.1 Reliability tests. The reliability tests shall consist evaluating the mean time between failure (MTBF) based on actual field failure data provided by the manufacturer. Otherwise (i.e. newly

introduced equipment for which there is insufficient data), data shall be provided in analysis form based on closest similar actual product data.

4.5.9 Calibration interval verification. Calibration interval verification shall be as specified in the purchase description.

4.6 Inspection of preparation for delivery. Inspection shall be performed to ensure conformance with the requirements of Section 5.

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 the 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 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. Equipment covered by this specification is intended for use in testing equipment and systems in the worldwide natural and controlled environments in which Military equipment is operated (on a continuous or intermittent basis for extended periods of time), either stored or transported, or both including utilization in all types of moving Military and commercial vehicles (land, sea, and air). The extent of an equipment's penetration (levels of use) into the Military environment is limited by its classification. Selection of the correct class is essential to ensure procurement of the desired equipment. Where needs supersede requirements, this specification can be referenced in part. Where environmental needs overlap specific classes, the highest appropriate class (lowest environmental resistance) will form the basic requirements, and the additional specific requirements will be selected from the lower classes. The inclusion of batteries may alter the environmental resistance of equipment designed to operate from either internal or external power sources or both.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable purchase description.

c. Appropriate class and configuration (see 1.2).

d. Number of first article samples to be submitted if other than specified in 4.2.

e. Packaging, packing, and marking (see 5.1)

f Issue of DoDISS to be cited in the solicitation, and, if required, the specific issue of documents referenced (see 2.3).

g. First article inspection.

h. Bid sample inspection.

i. Production lot, conformance inspection.

j. The quantity of maintenance and calibration aid sets required shall be as specified by the procuring activity (see 3.14.3), including: circuit board extenders, special adapters, special tools (see 6.5.2.27), and patch cables.

k. Waivers are required for equipment that incorporates restricted materials (see 3.2.3). The restricted materials are prohibited except where such materials are fabricated into completed approved standard parts, or use of the material is approved by the procuring activity.

l. The equipment manufacturer shall have a standard commercial quality assurance program. For example the program could be, but is not required to be certified to ISO 9001 or 9002. Other such recognized commercial quality assurance programs are acceptable.

m. Failure criteria. Failure of any Group A through Group E test shall be counted as a major defect (see 6.5.2. 15). Failure of Group F verification result in elimination from further consideration for procurement.

n. The location of the identification plate on a transit case shall be specified.

o. The requirement for nomenclature assignment and the nomenclature to be assigned (see 3.11 .5).

p. The equipment manufacturer shall have a standard Electrostatic Discharge Control Program that complies with the requirements of MIL-STD-1686C.

6.3 First article. When first article inspection is required, the equipment should be first production units. The first article sample consists of five units. The contracting officer should include specific instructions in procurement documents regarding arrangements for examinations, approval of frost article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product that has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Bid Sample. When a bid sample is required, the equipment should be a production unit normally provided by the manufacturer. The contracting officer should include specific instructions in the procurement documents regarding arrangements for examinations, approval of bid sample test results, and disposition of the bid samples. Invitations for bids should provide that the Government reserves the right to waive the requirement for bid samples to those bidders offering a product that has been previously acquired or tested by the Government, and that bidders offering such products, who wish to

rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.5 Definitions. Definitions of terms used in this specification are given in 6.5.1 through 6.5.2.28.

6.5.1 Input power. Input power is defined as specified in a through g.

a. Voltage waveform deviation factor. Deviation factor of a wave is the ratio of the maximum difference between corresponding ordinates of the wave and of the equivalent sine wave to the maximum ordinate of the equivalent sine wave when the waves are superimposed in such a way as to make this maximum difference as small as possible (see ANSI/IEEE-STD-1 00-1984). Deviation factor computed from the actual crest factor may exceed the specified deviation factor, at peak of the waveform.

b. Harmonics. Harmonics are defined as specified in 1 and 2:

1. Total harmonics. The total harmonic content is the total rms voltage remaining when the fundamental component is removed and is equal to the square root of the sum of the squares of the voltages of the individual harmonic frequencies.

2. Individual. An individual harmonic is the total rms voltage remaining when the fundamental and other harmonic components are removed. Any individual harmonic may be as large as 5 percent of the fundamental; however, total harmonic content will not be greater than 10 percent.

c. Crest factor. Crest factor is the ratio of the crest voltage to the effective voltage and has a value of 1.414 for a true sine wave. The crest factor specified is derived from a total harmonic content (10 percent) wherein the phase and amplitude relationship of the individual harmonic frequencies causes the crest factor to fall between the specified values.

d. Steady-state tolerances. The limits of voltage and frequency within which primary input power is delivered to the equipment, the difference between such limits and the nominal value being expressed as a plus and minus percent of nominal value.

e. Steady-state variation. The effect of periodic and random deviations of instantaneous voltage and frequency of the mean steady-state value, at any constant load, the limit of such effect being expressed as a plus and minus percent of nominal value.

f. Maximum transient amplitude. The maximum excursion of voltage or frequency transient from any initial point within the steady tolerance limits, expressed as a plus and minus percent of nominal voltage or frequency.

g. Transient recovery time. The total elapsed time of the transient disturbance measured from the instant the voltage or frequency (or both) departs from the defined steady-state variation limits to the instant the voltage or frequency (or both) recovers to steady-state condition and stabilizes within the defined steady-state variation band.

6.5.2 Terms. Terms are defined in 6.5.2.1 through 6.5.2.28.

6.5.2.1 Accessory. An accessory is an assembly or a group of parts or a unit that is not always required for the operation of a test set or unit as originally designed but serves to extend the functions or

capabilities of the test set; similarly as headphones for a radio set supplied with a loudspeaker, a vibrator power unit for use with a set having a built-in power supply, or a remote control unit for use with a set having integral controls.

6.5.2.2 Approved equipment test procedure. The test procedure furnished by the Government or furnished by a contractor in accordance with the requirements of the contractor order and approved by the Government in accordance with the contractor order.

6.5.2.3 ATE. For the purpose of this specification, the terms ATE and automatic checkout equipment (ACE) are synonymous.

6.5.2.4 Bench-top equipment. Bench-top equipment is designed to be used on a fixed bench or table or on a mobile cart. Equipment that exceeds 5 kg in weight and has no handles, or exceeds 20 kg with or without a handle, is considered to be bench-top equipment.

6.5.2.5 BIT. For the purpose of this specification, the term BIT identifies the test approach using either BITE or self-test capability or both.

6.5.2.6 BITE. Any device that is part of or permanently mounted in the prime test equipment and used for the express purpose of testing that equipment, either independently or in association with external test equipment.

6.5.2.7 Calibration interval. The maximum length of time between calibration services during which a specified percentage of equipment is expected to remain within acceptable performance levels under normal conditions of handling and use.

6.5.2.8 Certification time. Certification time includes all time required to check the equipment parameters on all range and function settings and all inputs and outputs. Certification time does not include the time to repair and readjust the equipment as a result of a malfunction.

6.5.2.9 Component batteries. Batteries used as components are nickel cadmium, or equivalent, designed for extended use and reliability equal to or exceeding that of other components (such as resistors or capacitors) that are incorporated into the equipment.

6.5.2.10 Configuration. Configuration is used to identify two or more units from a single purchase description that differ in class or other electrical or mechanical characteristics.

6.5.2.11 Destructive corrosion. Destructive corrosion is any type of corrosion that, in any way, inteferes with mechanical or electrical performance of the equipment or associated parts.

6.5.2.12 Dimensions. Dimensions are specified in units of width, height, and depth of the equipment in its normal operating position, and may be specified as maximum or partial, or both. Maximum dimensions include all handles, latches, knobs, and other protuberances, and are the three interior dimensions of a rectangular box into which the equipment (less detachable cords, cables, or accessories) may be fitted. Partial dimensions, when specified, include all protrusions except removable handles, connectors, bumper feet, latches, and cover. Partial depth, when specified, is defined in a and b:

a. Portable bench-top equipment. From the front surface of the front panel (less removable bezels, handles, or cover) to all rear protrusions except controls, bumper feet, connectors, latches, or handles

b. Rack-mounted equipment. From the rack-mounting surface (normally, the rear surface of the front panel) to the rearmost permanent protrusion, including any connectors or controls, but not including cable retractors, slide-out track parts not fixed to the equipment, or cable clearances

6.5.2.13 Enclosure. Enclosure and case are interchangeable terms that may apply to any of the classes.

6.5.2.14 Equipment/Unit. Equipment is an instrument, with the parts, accessories, components, or any combination thereof, required for performing a specified operational fiction. Unless otherwise specified the equipment consists of a single instrument or a mainframe and plug-in configuration. When a mainframe and plug-in configuration is supplied, the combined weight will not exceed the maximum weight allowed by the purchase description. Accessories, such as sensors, leads, bridges, loads, and adapters, will be provided with a storage case. Certain equipment may be complete within itself and may not require the addition of parts, accessories, or components to perform a specified operational fiction. The term ‘units’ is used to denote multiple items of equipment.

6.5.2.15 Failure. Equipment failure as used herein is any departure from the required performance or operation outside of the required accuracies (not correctable by normal use of the operating controls), or deviation from the criteria of 4.5 after the testis initiated.

6.5.2.16 Intermittent and short-time operation. Intermittent and short-time operation are the alternating periods of operation for the specified time followed by 15 minutes of non-operation.

6.5.2.17 Lot. The size of a lot is that quantity of units from each individual production run that is specifically set aside for delivery to the Government (i.e., if a given production run consists of 1000 units of which ISO are set aside for delivery to the Government, the lot size would be ISO). Portions of separate production runs will not be combined into a single lot but will be treated as individual lots.

6.5.2.18 Nonrepairable subassembly. A component, module, or subassembly is nonrepairable if the physical nature of the item is such that the item cannot be economically or feasibly repaired due to the excessive cost of material and labor required to effect such repair. This excessive cost is normally

considered as 65 percent, or greater, of the acquisition cost of the item. Examples of nonrepairable subassemblies are: a) an integrated circuit, b) a printed circuit card wherein the components and card are sealed in a hard thermosetting plastic compound, and c) a module wherein all printed circuit cards or components are sealed in a hard thermosetting plastic compound or the module is hermetically sealed.

6.5.2.19 Performance requirements of the test equipment. Wherever referenced in this specification, the performance requirement of the test equipment means the satisfactory performance of all electrical and mechanical characteristics under the conditioning, destructive, and accelerated tests specified by class and in the purchase description for simulating anticipated field service demands as closely as possible.

6.5.2.19.1 Performance tests, Level A and Level B. Level A and Level B performance tests are characterized by the degree of testing performed for a specific parameter. Level A testing is intended to be a reduced amount of testing per unit, that is performed on each unit of a lot. Level B testing is more extensive within each parameter, but is limited to certain samples of the lot.

6.5.2.20 Portable equipment. Portable equipment is designed to be easily carried between locations of use. Equipment of 5 kg, or less in weight that can be safely moved without handles, or 20 kg or less and provided with a handle, is considered to be portable. Portable equipment may be designed for portable as well as bench-top use.

6.5.2.21 Procuring activity. The Military or Federal agency contracting for equipment.

6.5.2.22 Purchase description. Purchase description as used herein may include an acquisition document referred to as a Salient Characteristic or Purchase Document that details equipment performance characteristics.

6.5.2.23 Ruggedized. Physical and operational characteristics that allow equipment to withstand rough handling and extreme or hostile environments.

6.5.2.24 Satisfactory operation check. A satisfactory operation check employs a maximum number of active circuits of the equipment with a minimum requirement for external input or evaluation equipment to ensure that all functions of the equipment are operational.

6.5.2.25 Satisfactory operation test. A satisfactory operation test employs the necessary external input and evaluation equipment to determine if the equipment conforms to the requirements of the purchase description.

6.5.2.26 Self-test. A self-test is a test or series of tests, performed by a device upon itself, that shows whether or not the device is operating within designed limits. This includes test programs on computers and ATE that check out their performance status and readiness.

6.5.2.27 Special tools. Special tools are tools not listed in the National Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service).

6.5.2.28 Standby. Equipment is considered to be in a standby condition when any part of its circuitry is energized regardless of the power switch setting.

6.6 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, they shall conform to the content requirements as identified in paragraphs 6.6.1 through 6.6.4. Acquisition Management Systems and Data Requirements Control List (AMSDL), must be listed on a separate Contract Data Requirements List (DD Form 1423), that is included as an exhibit to the contract. The technical manuals must be acquired under a separate contract line item in the contract.

6.6.1 Style and format, technical manuals. All text shall be legible. A cover page shall include, equipment name and model number. A table of contents shall be provided.

6.6.2 Content, technical manuals. The contents of the technical manuals shall include sections addressing safety, general information, use and installation maintenance and service, storage, and symbols. The content of the sections shall conform to the description provided in paragraphs 6.6.2.1 through 6.6.2.4.6.

6.6.2.1 Safety, technical manual section. The manual shall contain warnings, cautions and notes to prevent injury to personnel and damage to equipment. The warnings shall contain safety precautions where hazards such as high voltage, ESD, and RF radiation may be present during installation, operation, or maintenance.

6.6.2.2 General, technical manual section. The manual shall contain the following: purpose and functions, capabilities, performance characteristics, description (model number, dimensions, and weight), power information, environmental, list of items furnished, list of items required for operation and maintenance but not supplied, tools and test equipment, warranty information, and shipping and handling precautions.

6.6.2.3 Use and installation, technical manual section. This section shall provide any instructions that may be required for unpacking, assembly, and procedures to pursue in the case of the equipment found damaged during shipping. This section shall also minimally contain information on the following: operating instructions (illustrations and explanations of the uses and functions of all controls and indicators), initial adjustments and control settings, start up procedures, system reset procedures, ventilation clearances required, illustrations of equipment connections to external units under test, external memory storage device instructions and precautions, and reprogramming of reprogrammable memory if required shall: include program setup, check-out and illustrations.

6.6.2.4 Maintenance and servicing, technical manual section. The level of maintenance philosophy shall be stated in the purchase description for the unit. There shall be three levels of maintenance and servicing: (1) unit operational verification, (2) to the module level, and (3) to the component level. All levels of maintenance shall require information on performance verification. Information required for performance verification shall include: instructions to verify equipment is performing accurate measurements, list of test equipment required to perform the verification tests, step-by-step instructions for test connections, signal levels expected, calibration information, and self-test routines.

6.6.2.4.1 Additional servicing for module and component level mainenance. Module level (level 2) and component level (level 3) shall require information on troubleshooting, disassembly, reassembly, and test. The manual shall include step-by-step instructions for troubleshooting and fault isolation, signal levels expected, list of required test equipment and connection diagrams, and block and schematic diagrams. Parts lists shall be shown on illustrations or a separate listing that includes an index or reference to other illustrations. Parts lists shall include part number and generic description. Sequential instructions for disassembly, repair, replacement, and reassembly shall be provided. As required the instructions will define localizing a defective circuit card or component. Test data sheets will be included.

6.6.2.4.2 Battery information. If batteries are used in the equipment, instructions shall be included that describe the procedure for battery replacement – part number and description. If lithium batteries (as authorized by the procuring activity) are used, a warning label shall be affixed to the outside of the unit, and proper disposal procedures shall be contained in the manual.

6.6.2.4.3 Cleaning maintenance. Cleaning information covering intervals, types of solvents, and materials used shall be listed in the maintenance and servicing section of the technical manual.

6.6.2.4.4 Warranty returns. The maintenance and servicing section of the technical manual shall contain instructions on equipment return procedures for equipment failures occurring during the period the manufacturers warranty is in effect.

6.6.2.4.5 Part replacement information. Common commercial parts such as hardware items shall be identified by part number and description to facilitate substitutions of parts from other sources.

6.6.2.4.6 Equipment repackaging instructions. Manuals shall contain instructions for repackaging of unit or assembly including electrostatic sensitive devices information.

6.6.3 Storage. The technical manual shall include information on storage. Information required shall include environmental conditions, battery removal if required, and any specific requirements.

6.6.4 Symbols. All symbols used in the technical manual shall be standard or common to the trade. Where nonstandard symbols are used, explanations shall be provided.

6.7 Changes from previous issue. Asterisks or margin lines are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

6.8 Subject term (key word) listing.

Acoustic noise
Automatic test equipment (ATE)
Batteries
Bounce, loose cargo
Built-in test (BIT)
Calibration interval
Commercial-off-the-shelf (COTS) equipment
Enclosures
Environmental requirements and tests
Explosive atmosphere requirements and tests
First article
Flammable materials
Frequency-transient test
Interchangeability
Maintainability
Mercury, lithium, or radioactive material, Navy use of
Reliability
Shock
Transient-state power
Vibration

Preparing Activity
Navy - SH
(Project No. 6625-0770)

Custodians:
Army: CR
Navy: SH
Air Force: 11

Review activities:
Army: AV, MI, EA, AL, AR, TE, CE, SC, MD
Navy: MC, AS, OS, MCRDAC, YDl
Air Force: 10, 13, 15, 17, 18, 19,99

APPENDIX

10. SCOPE

10.1 Scope. This appendix is provided for the specification writer to use as a guideline for the preparation of a purchase description invoking MIL-PRF-28800. It provides a list of the requirements that are automatically invoked, or when needed, those that maybe specifically invoked by the purchase description. The information contained herein is intended for guidance only.

20. APPLICALBE DOCUMENTS. This section is not applicable to this appendix.

30. REQUIREMENTS

30.1 General. General specification requirements that are automatically invoked by referencing MIL-PRF-28800 in the purchase description areas specified in 30.2. Requirements that maybe invoked at the option of the specification writer are as specified in 30.3 and 30.4. When the requirements of 30.4 are invoked, supplemental information is required in the purchase description to complete each requirement.

30.2 Automatic requirements. The requirements listed below are automatically invoked when the purchase description requires conformance with the requirements of MIL-PRF-28800. Any one of these requirements may be specifically disinvoked or overridden by the purchase description (see 2.3).

Requirements . . . . . .3.

Equipment Components 3.2
Finishes 3.2.1
Interchangeability 3.2.2
Restricted materials 3.2.3
Material restricted for Navy use 3.2.3.1
Other restricted materials and gases 3.2.3.2
Organic materials 3.2.3.2.1
Flammable materials 3.2.3.2.2
Explosive materials 3.2.3.2.3
Carcinogens 3.2.3.2.4
Helium 3.2.3.2.5
Combination of materials 3.2.3.3

Design and construction 3.3
Operator adjustments and controls 3.3.1
Operator adjustments 3.3.1.1
Operator controls 3.3.1.2
Connectors, electric 3.3.2
Wiring, internal 3.3.3
Internal cooling 3.3.4
Cooling devices 3.3.4.1
Front panel display indicators 3.3.5

Electrical power sources and connections 3.5
Electrical power source 3.5l
Nominal and alternate power source 3.5.1.2
Steady-state conditions 3.5.1.2.1
Transient-state conditions 3.5.1.2.2
Interruption of power source 3.5.1.2.3
Alternate single-phase source 3.5.1.2.4
Electrical power correction 3.5.2
Multiphase equipment 3.5.2.1

APPENDIX

APPENDIX

30.3 Optional requirements. The requirements listed below may be invoked in the purchase description at the option of the specification writer.

30.4 Supplemental requirements. Supplemental information is required in the purchase description to complete each requirement.

INDEX

INDEX

INDEX

INDEX

INDEX

TABLES

FIGURES

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the comment number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of this form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of 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.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-28800F	2. DOCUMENT DATE (YYMMDD) 960624

3. DOCUMENT TITLE

TEST EQUIPMENT FOR USE WITH ELECTRICAL AND ELECTRONIC EQUIPMENT, GENERAL SPECIFICATION FOR

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (LAST, FIRST, MIDDLE INITIAL)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) DSN (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Technical Point of Contact (TPOC) Mr. Ralph Compton, 0413C Address all correspondance as follows:	b. TELEPHONE (Include Area Code) (1) Commercial: DSN: TPOC: 703-607-2457
c. ADDRESS (Include Zip Code) COMMANDER, Naval Sea Systems Command ATTN: SEA 03R42 2531 Jefferson Davis Highway Arlington, VA 22242-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403 Falls Church, VA 22041-3466 Telephone 703-756-2340 DSN 289-2340