INCH-POUND
MIL-P-24765(SH)
19 November 1991

MILITARY SPECIFICATION

POWER SUPPLY, UNINTERRUPTIBLE, STATIC (NAVAL SHIPBOARD)

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

1. SCOPE

1.1 Scope. This specification covers the detail requirements for a 60-hertz (Hz) static uninterruptible power supply (UPS) for non-nuclear Naval shipboard use. Only one classification of power supply is covered by this specification.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade) and Cut Shapes.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 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 6130

MILITARY

MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-F-15160 - Fuses: Instrument, Power, and Telephone.
MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).
MIL-M-16034/9 - Voltmeters, A.C. and D.C., Portable, 0.25-Percent Accuracy Class.
MIL-F-16552 - Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type).
MIL-E-17555 - Electronic and Electrical Equipment Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
MIL-S-19500 - Semiconductor Devices, General Specification for.
MIL-C-24643 - Cable and Cord, Electrical, Low Smoke, for Shipboard Use, General Specification for.
MIL-C-24643/18 - Cable, Electrical, 1000 Volts, Type LSMSCU (Including Variations LSMSCA and LSMSCS).
MIL-M-38510 - Microcircuits, General Specification for.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-470 - Maintainability Program for Systems and Equipment.
MIL-STD-471 - Maintainability Verification/Demonstration/ Evaluation.

MILITARY (Continued)

MIL-STD-740-1 - Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-740-2 - Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-781 - Reliability Testing for Engineering Development, Qualification, and Production.
MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
MIL-STD-883 - Test Methods and Procedures for Microelectronics.
MIL-STD-1310 - Shipboard Bonding, Grounding; and Other Techniques for Electromagnetic Compatibility and Safety.
MIL-STD-1399 Section 300 - Interface Standard for Shipboard Systems Section 300 Electric Power, Alternating Current. (Metric)
DOD-STD-2003-2 - Electrical Plant Installation Standard Methods for Surface Ships and Submarines (Equipment).

HANDBOOK

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.
MIL-HDBK-781 - Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production.

(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 19111-5094.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

F 1166 - Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities.

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

200 - Reference Designations for Electrical and Electronics Parts and Equipments. (DOD adopted)

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

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

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.4.

3.2 Performance.

3.2.1 Input power. The rated input voltage shall be one of the following: 115-volt, 60-Hz, single-phase, ungrounded, transient characteristics and ranges in accordance with MIL-STD-1399, section 300; or 440-volt, 60-Hz, three-phase, ungrounded (three-wire), type I power complying with the steady-state and transient characteristics and ranges in accordance with MIL-STD-1399, section 300.

3.2.1.1 Self-protection from input voltage variation and transient. When the equipment is supplying any load from no-load to rated-load, the equipment shall withstand, without damage or blowing fuses, the following conditions of input power:

(a) A loss of input power for any time duration.
(b) For emergency conditions of input voltage or frequency or both outside the transient limits in accordance with MIL-STD-1399, section 300, as follows:

(1) Any voltage excursion within the range of minus 7 to minus 100 and plus 7 to plus 135 percent of rated voltage. The tolerable voltage reduction to be 15 minutes, and the tolerable voltage excess including voltage transients to be for any period up to 2 minutes.
(2) A frequency excursion within the range of minus 3 to minus 100 and plus 3 to plus 112 percent of rated frequency. The tolerable frequency reduction to be 15 minutes, and the tolerable frequency excess to be for any period including transients up to 2 minutes.
(3) A combination of both (1) and (2).
(4) The input voltage phase rotation is in reverse order (AC-CB-BA).

Upon return of the input voltage and frequency to the specified range (see 3.2.1), the equipment shall operate and supply the load with the same output voltage and frequency as that prior to the input power changes. The performance of the equipment shall meet all the requirements of this specification without any adjustment or replacement of parts.

3.2.1.2 Self-protection from input voltage spikes. The UPS shall tolerate voltage transients (line-to-line, or line-to-ground, or both) up to 2500 volts having a basic impulse level (BIL) wave shape as shown on figure 1 and in accordance with MIL-STD-1399, section 300, without damage or interruption of UPS operation. Joule content of the transient shall be not greater than would be encountered by interrupting the magnetizing current of an input transformer sized to supply the total kilovoltampere (kVA) requirements of the unit. The equipment output shall continue without interruption or malfunction and output waveform shall not deviate from the waveform specified in 3.2.2.8.

3.2.1.3 Input current harmonics. When the input power to the UPS is as specified in 3.2.1 and with the equipment supplying any load from no-load to rated load, the total harmonic distortion of the input current waveform in any line or phase shall not exceed 6 percent of the root-mean-square (rms) value of the fundamental of the input current. And any single harmonic current from the 2nd harmonic to the 32nd harmonic shall not be greater than 3 percent of the rms value of the fundamental of the input current. Any single harmonic above the 32nd harmonic until the 333rd harmonic shall be not greater than 100/n percent of the rms value of the fundamental of the input current, where n is the number of the harmonic.

3.2.1.4 Input current balance. When a three-phase UPS (see 3.2.1) is supplying any load from 15 to 100 percent rated-load, it must comply with the following requirements:

(a) If the 3-phase input voltages are balanced within 4.4 volts rms, the input current in any line shall not differ from the arithmetic average of the three input line currents by more than 5 percent of this average.

(b) If the 3-phase input voltages are unbalanced by 13.2 volts rms (3 percent as specified in MIL-STD-1399, section 300, type I power), the input current in any line shall not differ from the average of the three input line currents by more than 10 percent of this average.

3.2.1.5 Starting current and starting time. The equipment shall accept any load from no-load to rated-load and operate in compliance with all requirements specified herein not greater than 5 seconds after energization.

3.2.1.5.1 Starting without input power present. The equipment may be started without the input power present if the battery is fully charged. For these conditions, the output voltage of the equipment shall be linearly ramped up to the rated output voltage level in 5 ± 1 seconds to avoid load surges of not greater than 200 percent of rated load.

3.2.1.6 Grounding. The UPS shall operate to meet all requirements specified herein when connected to an ungrounded ship's input power system having a 3 to 20 microfared capacitance from any line-to-ground (ship's hull potential) or with any single output line intermittently or permanently grounded.

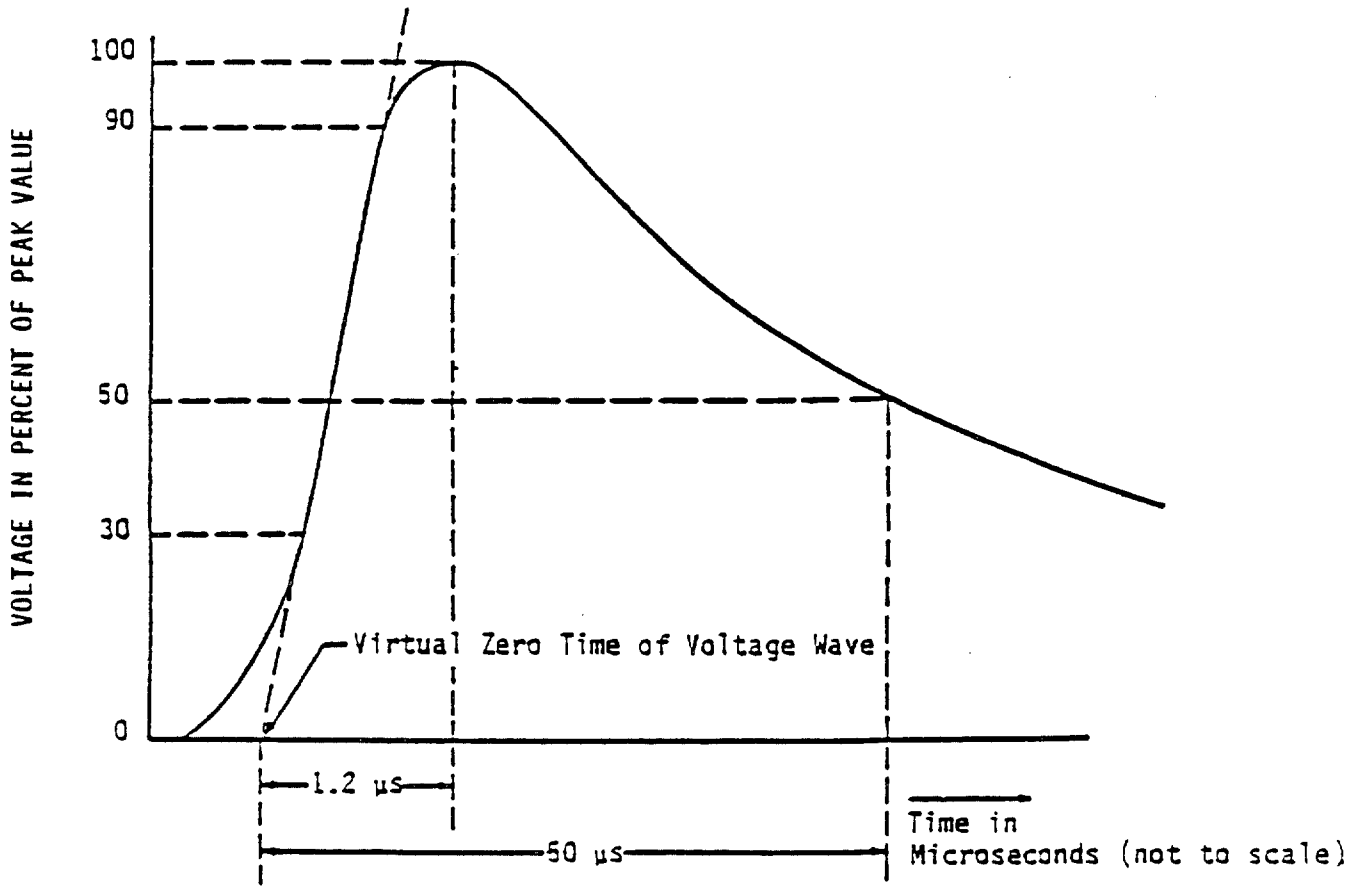

FIGURE 1. Spike voltage (short time transient) wave shape.

3.2.2 Output voltage. Rated output voltage of the UPS shall be one of the following: 115-volt, 60-Hz, single-phase, ungrounded; or 440-volt, 60-Hz, three-phase, ungrounded. Both the input and the output phase rotation of a three-phase system shall be AB-BC-CA, clockwise phasor rotation.

3.2.2.1 Voltage regulation. The average of the line-to-line rms values of the output voltage shall be maintained at the UPS output terminals within plus or minus 1 percent of the rated output voltage under the following variable conditions and any combination thereof at all output voltage settings within the adjustment range specified in 3.2.2.3:

(a) A load variation from no-load to 125 percent load.
(b) Load power factor (p.f.) varying between 0.7 lagging and 0.9 leading with rated output.
(c) Any input voltage and frequency variation within the range specified in 3.2.1 with the storage battery connected and disconnected.
(d) Any input voltage and frequency variation, even outside the range specified in 3.2.1, but with the storage battery connected and charged.
(e) Variation of the UPS temperature from a cold start over the ambient temperature range of 0 to 50 degrees Celsius (°C).
(f) Under the unbalanced load condition specified in 3.2.2.11.
(g) Under the nonlinear load conditions specified in 3.2.2.2.
(h) With batteries supplying 100 percent of rated UPS power for a period of up to 15 minutes.
(i) When batteries are recharged as specified in 3.2.13.

3.2.2.2 Steady-state nonlinear load. When a typical nonlinear load up to 50 percent of the rated load is applied to the equipment, the output voltage waveform shall remain within the limits specified in 3.2.2.8, the output voltage regulation shall be as specified in 3.2.2.1, and the voltage amplitude modulation shall be as specified in 3.2.2.7. A typical nonlinear load is defined as the load imposed on the UPS by single- or three-phase full wave rectifying system. The maximum harmonic content in the UPS output current shall be in accordance with the following formula:

$$I_N = \frac{100}{N} \text{ percent of fundamental current}$$

I_N is the Nth harmonic current and N is the harmonic number. N shall not be an even integer or multiple of three.

3.2.2.3 Voltage adjustment. Means shall be provided to adjust the output voltage at the regulated point over a range of plus or minus 5 percent of the rated voltage, with adjustment resolution not greater than 0.1 percent of output nominal voltage.

3.2.2.4 Transient output voltage and recovery. The sudden change of 0.8 lagging power factor loads on the equipment from no-load to 1/2-load, from 1/2-load to rated-load and from rated-load to 1/2-load and from 3/4-load to 1/4-load

shall cause an output voltage deviation of not greater than plus or minus 5.0 percent of rated voltage. The voltage at the equipment output terminals shall recover and stay within the steady-state regulation band (see 3.2.2.1), within 5 milliseconds. Circuits shall be constructed so that voltage transients developed within the equipment shall not reflect back into the input power system so that transient limits for alternating current (ac) are not greater than the input type I power in accordance with MIL-STD-1399, section 300.

3.2.2.5 Frequency regulation. Output frequency shall be maintained within plus or minus 1 percent of rated frequency under the following conditions and any combination thereof:

(a) Any input voltage and frequency variation within the range specified in 3.2.1 with the storage battery connected or disconnected.
(b) Variation of the UPS temperature from cold start (at ambient temperature ranging from 0 to 50°C) to maximum operating temperature (at ambient temperature ranging from 0 to 50°C).
(c) Any input voltage and frequency variation, even outside the range specified in 3.2.1, but with the storage battery connected, charged, and supplying the UPS output power for a period of up to 15 minutes.

3.2.2.6 Synchronization. With the output load of the equipment supplied by the normal supply (see 3.2.10), the equipment voltage phase angle shall be synchronized to within plus or minus 5 electrical degrees of the input ac line voltage phase angle. When the input ac deviates beyond the type I power frequency regulation band, the equipment shall revert to its internal reference frequency and shall continue to maintain the output frequency within the steady-state regulation limits specified in 3.2.2.5. Synchronization shall be restored after the input power returns to within the limits of 3.2.2.5, and without a restorative transient.

3.2.2.7 Amplitude and frequency modulation. Amplitude and frequency modulation of the output voltage (as defined in MIL-STD-1399, section 300) shall not exceed 1 percent and 0.5 percent, respectively, under any of the conditions or combinations of conditions as specified in 3.2.2.1 and 3.2.2.5.

3.2.2.8 Output voltage waveform. Under any load conditions between no-load and rated-load, 0.8 lagging p.f., at nominal rated input voltage and frequency, the rms value of all of the harmonics in the output voltage shall not exceed 5 percent of the rated output voltage. The rms value of any single harmonic shall not exceed 3 percent of the rms value of the rated output voltage. The deviation factor (as defined in MIL-STD-1399, section 300) of the output voltage waveform shall not exceed 5 percent. Peak-to-peak amplitude of voltage spikes (between the phases) of any frequencies shall be not greater than 3 percent of the rms value of the rated output voltage.

3.2.2.9 Output phase displacement. For three-phase UPS, the output voltage displacement angle between adjacent voltage phases shall be not greater than 120 $\pm$ 1 degrees at no-load and rated-load, 0.8 p.f., at nominal rated input voltage and frequency.

3.2.2.10 Output voltage balance under balanced load conditions. For the three-phase UPS, the difference between phase voltages at the voltage regulated point of the equipment shall be not greater than 1.0 percent of the rated voltage at no-load and at any balanced three-phase load up to rated current with any p.f. between 0.7 lagging and 0.9 leading.

3.2.2.11 Output voltage balance under unbalanced load conditions. For the three-phase UPS, the voltage variation between phases at the voltage regulated point shall be not greater than 2 percent of rated voltage under the unbalanced load conditions shown in table I. The UPS shall operate with a single-phase, 0.7 p.f. load carrying a current 15 percent of rated current. The voltage of the loaded phase at the voltage regulated point shall be regulated within plus or minus 2 percent of rated output voltage.

TABLE I. Unbalanced loads.

Load conditions	Line A (percent of rated current)	Line B (percent of rated current)	Line C (percent of rated current)	Power factor
1	90	75	75	0.7 lagging to unity
2	75	90	75	0.7 lagging to unity
3	75	75	90	0.7 lagging to unity

3.2.2.12 Input voltage change effect. For the UPS supplying no-load, rated-load, 0.7 p.f. lagging and 0.9 p.f. leading, and with any output voltage and frequency within the rated regulation range, the occurrence of any input voltage transient of plus or minus 20 percent with recovery time of 2 seconds as specified for type I power in accordance with MIL-STD-1399, section 300, shall not cause an output voltage variation of plus or minus 5 percent of the initial value. The output voltage shall recover and remain within 1 percent of the initial value within 0.03 seconds from the termination of the input voltage change.

3.2.3 Ratings. The ratings of the UPS shall be 1, 2, 3, 5, 10, 15, and 30 kilowatts (kW) and 0.8 lagging p.f., as specified (see 6.2). The kVA rating and p.f. rating for each kW rating shall be within the range (shaded area) as shown on figure 2.

3.2.3.1 Duty. The UPS shall operate continuously at the specified power rating within the p.f. range as shown on figure 2.

3.2.4 Efficiency. With the UPS operating with rated input voltage, frequency, and batteries on float charge, the overall efficiency for rated output at p.f. of 0.8 lagging shall be not less than 80 percent.

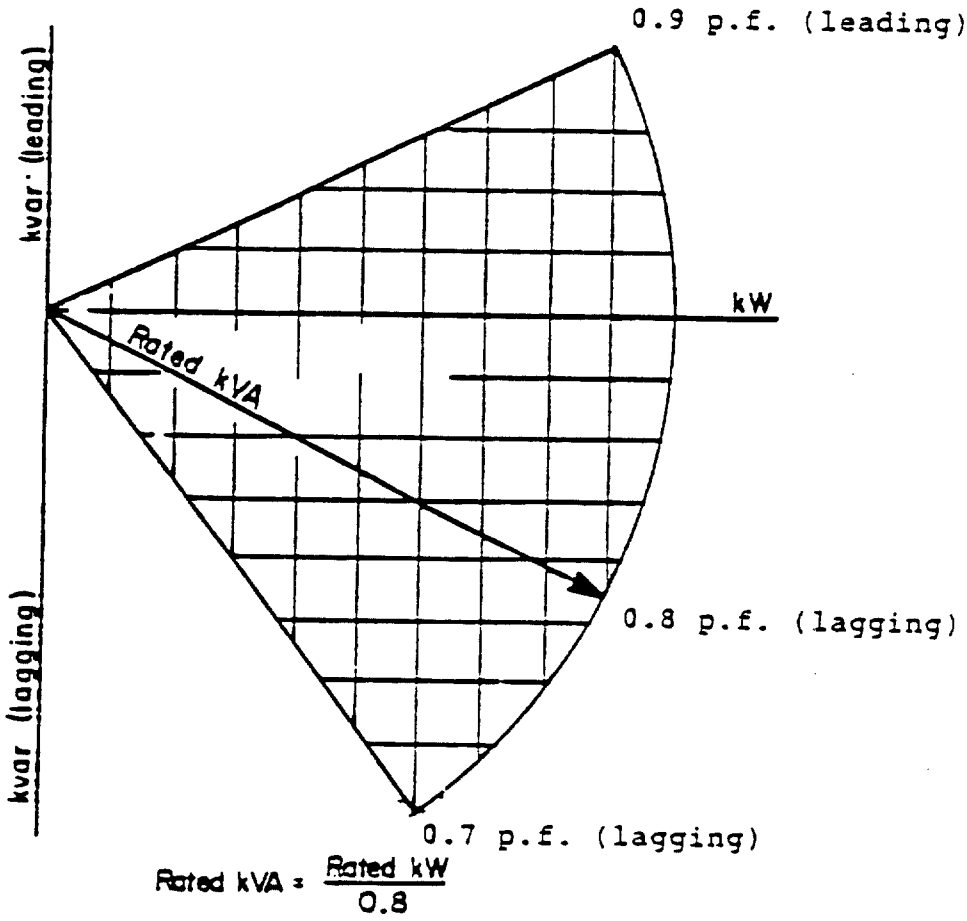

FIGURE 2. Continuous rating.

3.2.5 No-load losses. With the UPS operating with rated input line voltage and frequency, and batteries on float charge, the no-load losses shall be not greater than 16 percent of rated output power.

3.2.6 Overload. The UPS shall provide overload currents, at rated output voltage, of 125 percent for 10 minutes and 200 percent for 30 seconds. For loads exceeding the above specified magnitude or time limits, the load shall be automatically transferred to the UPS input ac lines. This shall be indicated locally and provision shall be made for remote indication. A suitable design shall be implemented to avoid sporadic transfers.

3.2.7 Fault current. Output current between 200 percent and 230 percent of rated current is considered fault current. Without reducing the output voltage, the UPS shall provide and sustain any fault current up to 230 percent of rated current for 5 seconds when a fault develops at any external circuits supplied by the UPS. After the UPS has supplied the fault current for a minimum of 5 seconds, the UPS shall automatically transfer its load to the input ac line. When the fault is cleared, the load shall automatically be transferred to the UPS without disturbance to the load. None of these transfers shall produce voltage transients in the load larger than the limits established in accordance with MIL-STD-1399, section 300.

3.2.7.1 Short circuit protection. Output current above 230 percent of rated current is considered short circuit current. The equipment shall protect itself without damage to any parts from any short circuit on its output. Protection shall be provided by reducing the equipment output voltage and limiting the output current to a value not less than 230 percent of rated current. The current limiting shall not be applied to any output current less than 230 percent of rated current. On failure of the current limiting circuit, the UPS shall be protected by fuses. After the UPS has supplied short circuit current for 5 seconds, the UPS shall automatically transfer its load to the input ac lines. When the short circuit is cleared, the load shall automatically be transferred to the UPS without introducing voltage transients in the load greater than the limits specified in accordance with MIL-STD-1399, section 300.

3.2.8 Internal circuit protection. The equipment shall incorporate malfunction protection for each module to prevent failure cascading to other similar modules. Fuses or current limiting means shall be provided for all power circuits and semi-conductors. Each module containing power switching semi-conductors shall be separately fused. Circuits with filter capacitors shall have fuse protection against capacitor failure. All fuses shall be provided with blown fuse indicators.

3.2.9 Display and control. The equipment shall contain a microprocessor dedicated to track and display its performance, and to provide operational instructions and alarm functions. This microprocessor shall receive operational instructions from remote locations and provide digital signals for remote indication of performance parameters. The UPS shall display all performance parameters and graphical representations in an electro-luminescent panel, and shall receive local instructions via an infrared touch-panel fitted around the electro-luminescent display panel. The operator shall have access to at least 20

screen formats. They shall display by text, graphics, and analog mimicking the mode of operation, modules and battery status, value of electrical parameters, temperature of components, parts list, and location of modules and assemblies. The operator shall be able to control and adjust the UPS from the local, front mounted, touch-panel or to control the UPS from a remote location via a computer. Local alarm of UPS malfunctions shall consist of highlighting the faulty item in the screen display by means of reverse flashing video, horn sound, or both. If the UPS rating is not greater than 2 kW, the panel requirement shall be push-buttons and switches mounted in the control panel of the UPS rather than a touch panel.

3.2.10 Modes of operation. The operator shall select the UPS mode of operation as follows:

(a) Normal mode. In this mode the power flow shall be exclusively through the inverter. The load is connected and locked to the inverter, which in turn receives the power from the ac line or the battery bank.

(b) Automatic mode. In this mode the power to the load shall be provided by either the inverter or directly by the ac line (by-passing the inverter). However, if the inverter output is not within the voltage and frequency regulation requirements of 3.2.2.1 and 3.2.2.5, the load will be automatically connected (in less than 5 milliseconds) to the incoming ac line. Furthermore, if the load is too large, faulty, or short-circuited as specified in 3.2.6 and 3.2.7, the load will be connected to the ac line.

(c) By-pass mode. In this mode the UPS is by-passed and the load is directly supplied from the incoming ac line.

3.2.11 Automatic transfer - ac line to battery. If the UPS is in normal or automatic mode and the ac line fails, is interrupted, or does not meet the requirements of type I power in accordance with MIL-STD-1399, section 300, then the battery bank shall automatically become the power source. The power source transfer shall be automatic, shall be accomplished within 1 millisecond, and shall not produce voltage transients in the output of the UPS greater than the limits established for type I power.

3.2.12 Automatic retransfer - battery to ac line. After the ac line is restored to type I power following a transfer to battery power, the UPS shall automatically, and within 10 seconds, transfer to ac line. This retransfer operation shall not produce output voltage transients larger than the limits established for type I power in accordance with MIL-STD-1399, section 300.

3.2.13 Rectifier-charger. This module shall provide rated direct current (dc) power to the inverter and simultaneously provide power for recharging a fully discharged battery bank within an 8-hour period.

3.2.14 Battery charging circuit. The battery charging circuit shall automatically regulate the rectifier output voltage and current to such value as necessary to fully recharge the completely discharged battery bank. There shall not be any reverse current flow from the battery bank when the UPS is disconnected from the input power.

3.2.15 Battery electrolyte temperature. When charging the batteries, the temperature of the terminal shall be not greater than 125 degrees Fahrenheit (°F). When this temperature is reached, the rate of charge shall be reduced or the charge discontinued until the battery electrolyte has cooled off.

3.2.16 Low battery voltage shutdown. If the duration of the incoming ac line interruption is greater than 15 minutes so that the battery discharges to the point where the UPS can no longer maintain the output voltage at 95 percent of the set value, then the UPS shall automatically shutdown to prevent over-discharge of the battery. A battle override shall be provided to prevent this type of shutdown.

3.2.17 Battery float charge. When the power source is the ac line, the rectifier-charger shall maintain the battery bank charged by applying a constant 2.35 volts per cell to the battery bank. This voltage shall be adjustable to prevent excessive electrolyte spillage, gassing, and high battery temperature.

3.2.18 Rectifier-charger protection. The rectifier-charger shall be protected by limiting its output current and voltage.

3.2.19 Rectifier-charger duty cycle. The rectifier-charger and the battery shall operate with the following duty cycle:

(a) When power to the UPS is interrupted, the batteries shall supply power to the inverter for 15 minutes at 100 percent of rated-load.
(b) The rectifier-charger shall re-energize automatically and simultaneously charge the batteries and supply power to the inverter within 10 seconds after the input power to the UPS is restored and within the type I power steady-state limits.
(c) The rectifier-charger shall simultaneously charge the batteries and supply the inverter at any load from no-load to 100 percent rated-load.
(d) The rectifier-charger and the battery shall repeat the cycle steps (a) and (b) immediately following cycle step (c).
(e) After (d), the rectifier-charger shall fully charge the batteries within 8 hours while supplying the inverter operating at rated-load. During the above duty cycle, the UPS output shall be maintained and shall meet all requirements specified herein.

3.2.20 Battery bank. The batteries shall be provided by UPS manufacturer and they shall be starved electrolyte, lead-acid storage type.

3.2.20.1 Battery duty cycle. The battery duty cycle shall be as specified in 3.2.19.

3.2.21 Battery configuration. Batteries shall be supplied on enclosed racks. The battery rack and associated enclosure shall be in accordance with DOD-STD-2003-2, figures 2C3 and 2C4. The battery rack and enclosure shall be separated from the other cabinets (see 3.3.3.2) and shall be properly ventilated to prevent accumulation of hydrogen gas. An individual independent battery bank shall be supplied for each UPS so that each dc bus is isolated from all others.

3.2.22 Leakage current. The rms leakage current caused by the electro-magnetic interference (EMI) filter capacitor connectors from each line to the ship's ground shall not cause a fundamental 60-Hz current greater than 30 milli-amperes per line for each input and output line of the UPS.

3.3 Design and construction.

3.3.1 General. Design and construction (see 6.3) shall be in accordance with the requirements of MIL-E-917, except the following paragraphs and all subparagraphs pertaining thereto:

(a) Fundamental equipment characteristic (excluding safety).
(b) Grounding.
(c) Input power variations (ac equipment).
(d) Inclined operation.
(e) Ambient temperature.
(f) Impact shock and vibration.
(g) Equipment mounting.
(h) Radio interference.
(i) Noise reduction for submarine.
(j) Piping system.
(k) Drawings.
(l) Manuals.
(m) Workmanship.

3.3.2 Electrical construction. The equipment shall use building block module concept with solid-state circuitry and devices only. Electro-mechanical devices, including relays and contactors shall not be used. Vacuum tubes or other similar thermionic devices shall not be used. Control and logic circuits shall have a common negative. Control wires shall be separated from the power conductors as required to avoid noise pickup in the control circuits. Optical coupling may be used to effect electrical isolation between control circuits and power semiconductor devices.

3.3.2.1 Dielectric withstanding voltage and insulation resistance. Insulation resistance of the circuits shall be not less than 10 megohms when measured with units at ambient temperature of 75 $\pm$ 3°F. Dielectric strength shall be twice rated plus 1,000 volts for 60 seconds. The equipment (except the control drawer) shall be such that required insulation system tests can be conducted without either incipient or catastrophic damage or without significant (within acceptable product variability tolerance) degradation to any material or part, including the electrical insulation. Furthermore, a defect in the insulation system shall not cause either of the tests, when properly conducted, to result in damage or degradation to any other material or part except that which possibly may be inflicted to the immediately adjacent parts separated by the defective insulation.

3.3.3 Mechanical design. The UPS shall provide front access and maintenance with pull-out modules, with the exception of batteries. Pull-out modules or roll-out racks shall have stops to lock in the pull-out position. Modules or roll-out racks shall be interlocked with the input power and battery circuit breakers to prevent opening of the modules or pull-out racks before interruption of the power to the equipment. Modules shall be designed so that nonidentical modules cannot be interchangeably plugged in the UPS. EMI filters shall be internally mounted in the cabinet.

3.3.3.1 Size and weight. The UPS, excluding battery bank, shall be not greater than the total weight and total volume requirements as specified in table II.

TABLE II. Volume, weight, and number of cabinets.

kW rating	Cabinet		
	Number of cabinets	Maximum total weight (pounds)	Maximum total volume (cubic feet)
1	1	600	10
2	1	900	12
3	1	1150	13
5	1	1350	15
10	1	1570	20
15	1	1800	30
30	1	2700	40

3.3.3.2 Cabinet arrangement. The equipment, excluding the battery rack enclosure, shall consist of one cabinet with a height not greater than 72 inches with appropriate width and depth to enable it to go through a 30- by 30-inch hatch with round corners of 7.5-inch radius, and 26- by 45-inch doors with round corners of 7.5-inch radius. Drawers may be removed to enable passage through the hatches and doors.

3.3.3.3 Cabinet enclosure. The cabinet enclosure shall be dripproof (45-degree) in accordance with MIL-STD-108.

3.3.3.4 Ground connection. Exposed metal parts of the cabinets shall be at ground (ship's hull) potential at all times. Exposed metal portions of electrical parts (such as switches and rheostats) which are not part of the electrical circuits, shall be electrically grounded to the frame of the cabinet. A ground stud shall be provided on each cabinet in accordance with MIL-STD-1310 to accept a class C, type II bond strap. The ground stud shall be clearly marked and shall be protected from breakage during transit or operation.

3.3.4 Input/output (I/O) connections. Threaded terminal studs with lockwashers and locknuts shall be provided to accept the input and output cable terminal lugs.

3.3.5 Remote control panel. Signals for the remote control, monitoring, and interlock of the UPS shall be provided on a remote control panel. The remote control panel will be connected to the unit by a type LSMSCU cable in accordance with MIL-C-24643. The length of the interconnection cable between the UPS and the remote control panel shall be not greater than 500 feet. The controls and indicators on the remote control panel shall be a computer terminal and may include or be as follows:

(a) Indicator main ac line ON.
(b) Indicator alternate ac line ON.
(c) Indicator battery power ON.
(d) Mode of operation selector switch.
(e) Indicator main ac line supplying load.
(f) Indicator alternate power supplying load.
(g) Indicator battery discharging.
(h) Meters: output current, voltage, and frequency.
(i) Meters: battery voltage and current.
(j) Status indicator for each individual breaker.
(k) Any push-button switch required to operate the UPS.

3.3.6 Identification of equipment divisions. Each part, module, drawer, and cabinet of the equipment shall be identified by reference designations in accordance with IEEE 200 and as specified in 3.3.6.1 and 3.3.6.2.

3.3.6.1 Identification of parts leads. For each polarized part, such as electrolytic capacitors and rectifiers, the polarity identification shall be marked on the part mounting surface in order to help ensure proper replacement of the part. For multiple lead parts such as transistors, where proper circuit operation is dependent upon a specific lead hookup, appropriate lead identification shall be marked on the parts mounting surface to help ensure proper replacement of the part.

3.3.6.2 Method of marking. Markings shall be permanent and legible. The markings on plastic or metallic materials shall be made by stamping, engraving, stenciling or rubber stamping with smudgeproof ink covered with a coat of clear lacquer, or silk screening. Decalcomanias or paper labels shall not be used.

3.3.6.3 Identification plate. The UPS shall be equipped with an identification plate. The identification plate shall be in accordance with MIL-P-15024 and MIL-P-15024/5, types A, B, C, or H (metallic only).

3.3.6.4 Operation instruction plate. The UPS shall be equipped with an operation instruction plate. The plate shall be in accordance with MIL-P-15024 and MIL-P-15024/5, types A, B, C, or H (metallic only).

3.3.7 Human engineering. Human engineering shall be in accordance with ASTM F 1166.

3.3.8 Safety. The equipment shall be in accordance with the safety requirements of MIL-E-917 and requirement 1 of MIL-STD-454. When the equipment input isolation circuit breaker and the battery breaker are in the off position, all the equipment circuits shall be deenergized.

3.4 Component requirements.

3.4.1 Selection of parts. The equipment shall use parts, modules, and drawers. Parts, modules, and drawers which perform similar functions shall be standardized and interchangeable to the maximum extent practicable. The number of different parts to be designed into the equipment shall be kept to a minimum consistent with its intended use. Selection of parts shall be in accordance with MIL-E-917.

3.4.2 Contractor furnished parts. Supplementing other requirements for parts identification, contractor furnished parts shall be identified in parts lists and drawings by part, manufacturer's name, and part number in addition to the equipment manufacturer's part number.

3.4.3 Fuses. Fuses used in series with power semiconductors shall be the type for protection of semiconductor devices. Fuses shall be provided for power circuits and semiconductors as backup for the current limiting protection (see 3.2.7.1). Except for semiconductor protection, fuses shall be in accordance with MIL-F-15160. Fuse voltage rating shall be not less than the maximum circuit application voltage.

3.4.4 Solid-state circuitry. The equipment shall utilize solid-state circuitry.

3.4.4.1 Power circuits. Power circuits shall be built as removable modules.

3.4.4.2 Thyristor or transistor firing circuit. Identical thyristor or transistor firing circuit modules shall be used throughout the equipment to the maximum extent possible. Firing circuits shall be designed for maximum noise immunity utilizing decoupling, shielding, low impedance, twisted pair cables, reverse bias, isolation, and proper wiring layout to maximum extent possible.

3.4.4.3 Electrical control circuits. Established reliability components shall be used in the logic circuitry. Microcircuits shall be in accordance with MIL-M-38510, class B, or screened in accordance with MIL-STD-883. Semiconductors shall be in accordance with MIL-S-19500, level JANTX. Resistors and capacitors shall be in accordance with applicable military specifications.

3.4.5 Semiconductor devices. Semiconductor devices shall be chosen and applied in accordance with MIL-E-917 and as specified in 3.4.5.1 through 3.4.5.7. Unless otherwise noted (see 6.2), discrete semiconductor devices shall be silicon and level JANTX in accordance with MIL-S-19500.

3.4.5.1 Standardization promotion. When a justifiable need exists for a device not covered by an existing military specification, but which can be provided by extension of a series or family of military devices, such extension shall be employed in preference to choice of a device from a new series or family. The power semiconductor devices used (diodes, transistors, and thyristors) shall be presently available without further development. The power semiconductor shall have at least two sources of supply.

3.4.5.2 Device selection prohibition. The equipment shall meet all requirements without the need for device selection beyond that covered by the applicable device detail specification sheet of MIL-S-19500. Semiconductor devices of the same type designation shall be interchangeable without any restrictions, including sources of manufacture.

3.4.5.3 Reverse polarity prohibition. Devices of standard polarity shall be used wherever feasible. Devices of reverse polarity may be used only under the conditions applicable to the use of nonstandard parts (see 3.4.1).

3.4.5.4 Stress factors and limits. Circuits shall be constructed and devices shall be applied so that the stress limits as specified in table III will not be exceeded under any condition of operation, standby, and during tests specified for the equipment. The values specified are limits and not design factors or design margins. The contractor shall determine and provide sufficient margin between the applied stresses and the specified limits to ensure that the required life and reliability are achieved. The relative values of the steady-state voltage variation, over-voltage, transient voltage, and surge voltage spikes, for the circuit under consideration, shall be not less than the values specified in 3.2.1, 3.2.1.1, and 3.2.1.2 except where the equipment includes features to limit or suppress over-voltage and surge voltage to lower values. When such exception is used, the contractor shall provide a detailed description of the features and how the circuit functions to limit peak over-voltage and surge voltage impressed on the semiconductor devices to whatever lower values apply. Circuits which employ controlled rectifiers or transistors shall suppress surge voltages to less than three times the supply nominal rms voltage. Semiconductor devices shall be applied as specified in 3.4.5.5. Surge voltage suppressors shall be as specified in 3.4.5.6. Heat dissipaters (heat sinks, cooling fins) shall be as specified in 3.4.5.7.

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
RECTIFIERS				
Working peak reverse voltage	---	0.5	V_{rrm}	Repetitive peak reverse voltage
Nonrepetitive peak reverse voltage	---	0.7	V_{rsm}	Nonrepetitive peak reverse voltage
DC reverse blocking voltage	---	0.4	V_{rrm}	Repetitive peak reverse voltage
Average current	---	0.5	$I_{f(av)}$	Half-cycle forward current average
Peak surge current	---	0.7	I_{tsm}	Peak surge current
Junction temperature	---	0.8	$T_{j(max)}$	Maximum operating junction temperature
SCRs				
Working peak reverse voltage	---	0.5	V_{rrm}	Repetitive peak reverse voltage
Nonrepetitive peak reverse voltage	---	0.7	V_{rsm}	Nonrepetitive peak reverse voltage
DC reverse blocking voltage	---	0.4	V_{rrm}	Repetitive peak reverse voltage
Working peak forward voltage	---	0.5	V_{drm}	Repetitive peak off-state voltage

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors - Continued. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
SCRs - Continued				
Nonrepetitive peak forward voltage	---	0.7	V_{drm}	Nonrepetitive off-state voltage
Peak surge current	---	0.7	I_{tsm}	Surge on-state current
Average current	---	0.5	$I_{t(av)}$	Half-cycle forward current average
Pulsed gate current for	2.0	10.0	I_{gt}	Gate trigger firing current
Peak reverse gate voltage	---	0.5	V_{grm}	Maximum reverse gate voltage
Maximum rate-of-current rise during turn-on	---	0.5	di/dt	Maximum rate-of-rise on-state current
Maximum rate-of-rise forward blocking voltage	---	0.5	dv/dt	Maximum allowable rate-of-rise, forward blocking voltage (static)
Turn-off time	---	0.5	t_q	Circuit commutated turn-off time
Junction temperature	---	0.8	$T_{j(max)}$	Maximum operating junction temperature

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors - Continued. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
GTOs				
DC blocking voltage	---	0.4	V_{drm} V_{rrm}	Repetitive peak voltage
Nominal working peak reverse voltage	---	0.5	V_{rrm}	Repetitive peak reverse voltage
Repetitive peak reverse voltage	---	0.7	V_{rrm}	Repetitive peak reverse voltage
Nonrepetitive peak reverse voltage	---	1.0	V_{rrm}	Repetitive peak reverse voltage
Nonrepetitive peak forward blocking voltage	---	0.8	V_{drm}	Repetitive peak off-state voltage
Maximum rate-of-rise of forward blocking voltage	---	0.5	dv/dt (critical)	Critical rate-of-rise of forward blocking voltage
Rate-of-rise of reapplied forward blocking voltage	---	0.7	dv/dt (reapplied)	Reapplied rate-of-rise of forward blocking voltage
Minimum duration of gate turn-off signal	2.0	---	T_{qq}	Gate controlled turn-off time (Gain=4), T_j=T_j(max)
Average forward current				
(a) Nominal value	---	0.7	$I_{t(av)}$	Average forward current at $T_{j(max)}$ for application waveform,
(b) Maximum value	---	1.0		

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors - Continued. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
GTOs - Continued				
				conduction, angle, duty cycle, and frequency
Surge current	---	0.7	I_{tsm}	Peak surge current, half cycle surge, (1/120 sec) non-repetitive
Maximum rate-of-rise of current during turn-on				
(a) Repetitive maximum	---	0.5	di/dt (rep)	Maximum repetitive rate-of-rise of current during turn-on
(b) Nonrep. maximum	---	0.5	di/dt (critical)	
(c) During surge	---	1.0	"	
Pulsed forward gate current	2.0	10.0		
Junction temperature	---	0.8	T_j	Maximum operating junction temperature
TRANSISTORS - BIPOLAR				
Pulsed base current-switching	2.0	---		Required base current for circuit collector current and device gain
Collector to emitter operating voltage emitter (nominal working)	---	0.5	$V_{ceo(sus)}$	Collector to emitter voltage, base-open

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors - Continued. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
TRANSISTORS - BIPOLAR - Continued				
Collector current				
(a) Nominal value	---	0.6	$I_{C(av)}$	Average collector at rated $T_{j(max)}$ for the application waveform, conduct, angle or period, duty cycle and frequency
(b) Maximum value	---	0.8		
Collector power	---	0.5	P_t	Collector power dissipation derated for temperature
Junction temperature	---	0.8	$T_{C(max)}$	Maximum operating junction temperature
Emitter to base voltage, cut-off mode, nominal working	---	0.5	V_{BEO}	Emitter to base voltage
Peak emitter current	---	0.7	I_E	Maximum emitter current at rated $T_{j(max)}$
TRANSISTORS - FET				
Drain to source voltage, cut-off mode or off-state				
(a) DC	---	0.5	V_{DS}	Maximum rated drain to source voltage
(b) Nominal working	---	0.6	V_{DS}	"
(c) Repetitive peak	---	0.7	V_{DS}	"
(d) Nonrepetitive	---	0.8	V_{DS}	"

TABLE III. Application stress limits and derating factors for rectifiers, SCRs, GTOs, bipolar transistors, and field effect transistors - Continued. 1/

Stress factor	Stress factor limit in relation to rating factor			Rating factor
	Lower	Upper		
TRANSISTORS - FET - Continued				
Drain to gate voltage				
(a) DC	---	0.5	V_{DGR}	Drain to gate voltage with R_{GS}-1, megohm
(b) Nominal working	---	0.6	V_{DGR}	"
(c) Repetitive peak	---	0.7	V_{DGR}	"
(d) Nonrepetitive	---	0.8	V_{DGR}	"
Average drain current, active or on-state mode				Average drain current at rated T[j,max] for the application waveform, conduction angle or period, duty cycle, frequency, and drain to source on-state resistance.
(a) Nominal value	---	0.6	$I_D$on	
(b) Maximum value	---	0.8	$I_D$on	
Gate to source voltage	---	0.7	V_{GS}	Gate to source voltage
Minimum duration of gate controlled turn-off signal	2.0	---	(t[d, off] +t[f])	Turn-off cut-off time or body-drain diode reverse recovery time during turn-off at rated T[j-max] whichever is greater.
			t[rr]	

1/ GTO: Gate turn-off.
FET: Field effect transistors.

3.4.5.5 Application limitations. The following limitations and guides shall apply in the application of semiconductor devices:

(a) Devices constructed and rated for conduction cooling shall be mounted on metallic heat dissipators. Attention shall be given to the compatibility of materials and to the finish coatings on parts mounted together in an assembly. Connections and joints in both electrical and thermal circuits shall be constructed to ensure that their effectiveness will be maintained for the life of the equipment under adverse shipboard conditions, including shock, vibration, thermal cycling, high humidity, and salt-laden atmosphere. Means for maintaining positive contact pressure on bolted or clamped joints, under all service conditions, taking into account the aging (including creep, cold flow, relaxation, fatigue, shrinkage, and so forth) of materials shall be included.

(b) Direct mounting of devices to their heat dissipater with electrical insulation of the heat dissipaters, as necessary, is preferred to the use of intervening electrical insulating material between the devices and their heat dissipaters. This preferred arrangement shall be used except where it is impracticable to insulate the heat dissipaters, or where other technical considerations make electrical insulation of the semiconductor device from its mounting surface necessary.

(c) Semiconductor devices shall not be operated in parallel to provide current capacity.

(d) Semiconductor devices (diodes, rectifiers, semiconductor controlled rectifiers (SCRs), and transistors) shall not be operated in series. Transistors shall not be used in series to obtain higher voltage capacity.

(e) Voltage reference diodes and voltage regulator diodes shall not be used in parallel to obtain higher current density.

3.4.5.6 Surge voltage suppression. Circuits containing devices which do not have inherent capability of withstanding voltage surges of the level as specified in 3.4.5.4 without exceeding allowable stresses shall be protected by incorporating adequate surge voltage suppression within the circuit. The internal generation of voltage surges shall be minimized with respect to both frequency of occurrence and amplitude. Means shall be provided within the circuit both for suppressing any remaining voltage surges generated within the circuit that would otherwise be excessive and for preventing external propagation at a peak level greater than three times the rms voltage for the ac output circuit and that permitted as specified in 3.2.1, 3.2.1.1, and 3.2.1.2 for the input circuit. Surge voltage suppressors shall be in accordance with MIL-E-917.

3.4.5.7 Heat dissipaters. Heat dissipaters for semiconductor devices shall be constructed of metallic material which is either corrosion-resistant, or which is treated or coated to resist corrosion under shipboard environmental conditions. Surfaces which contact the semiconductor device and surfaces to which electrical contacts are made shall not be painted or anodized but shall be plated or otherwise coated to form surfaces to which the connections or junctions are made and which will retain their mechanical, thermal, and electrical effectiveness for

the life of the equipment. The method of processing and the preparation of the connections and joints shall be as specified on the applicable heat dissipater drawing. Heat dissipaters shall be sized to dissipate the heat generated by the semiconductor device of highest losses that may be expected to conform to the applicable semiconductor device specification, and to do so under the highest ambient temperature conditions without exceeding the limiting temperatures as specified in table III. Maximum power dissipation may be estimated from calculations taking into account the mode of operation of the device in the circuit, the worst stress levels applied, and the limiting device characteristics as covered by the device specification. Maximum power dissipation may also be estimated by using published data for a particular brand of device, scaling up the losses using a factor calculated from parameter limits applicable to the particular brand of device and specification limits, taking into account the influence of the parameters considered on the losses under the mode of operation in the circuit, and allowing for any difference in form factor involved in the way the values are given. Where maximum power dissipation at rated conditions is specified and controlled by the device specification, this value corrected for the stress levels of the application shall be used in the design.

3.5 Environmental requirements.

3.5.1 Shock. The UPS shall withstand the high-impact, type A, grade A, class I shock test of MIL-S-901. Resilient mounts shall not be used for any parts, modules, or drawers in order to meet the shock test requirement.

3.5.2 Vibration. Equipment shall meet the type I vibration requirements in accordance with MIL-STD-167-1 up to and including 15 Hz without sway braces. When a higher frequency up to and including 25 Hz is required for a class of ship (see MIL-STD-167-1), the equipment shall meet these requirements with sway braces.

3.5.3 Noise. The UPS shall be solidly mounted to the ship structure and shall be tested for noise requirements under this condition.

3.5.3.1 Airborne noise. The UPS shall meet the airborne noise requirements in accordance with MIL-STD-740-1, grade B equipment.

3.5.3.2 Structureborne noise. The UPS shall meet the structureborne noise requirements in accordance with MIL-STD-740-2, type III equipment.

3.5.4 Electromagnetic interference emission and susceptibility. The UPS shall meet the following requirements in accordance with MIL-STD-461 for class A4 equipment and subsystems installed on surface ships with solid-state components -- CE01, CE03, CS01, CS02, CS06, RE01, RE02, RS01, RS02, RS03, CS10, and CS11.

3.5.5 Ambient temperature. The UPS shall start and operate satisfactorily and conform to all requirements specified herein throughout an ambient temperature range of 0 to 50°C.

3.5.6 Cooling. The UPS shall be cooled by ambient air of a temperature not greater than 50°C. The cabinets may be forced-air cooled. Air filter in accordance with MIL-F-16552 shall be used with forced-air cooling.

3.5.7 Accessibility. Front access shall be provided to all parts, modules, and drawers of the UPS. Side or back access shall not be required for operation and maintenance.

3.5.8 Ship motion. The UPS shall operate satisfactorily when inclined 15 degrees permanently in any direction and when installed on board ships having the following pitch and roll:

	Magnitude	Period
Pitch	10 degrees	5 seconds
Roll	45 degrees	8 seconds

3.5.9 Lifting provision. Each cabinet shall have removable eyebolts provided on top to permit hoisting and handling. The eyebolts shall be located to balance the weight of the cabinet as prepared for shipping in the upright position. The lifting attachment shall be of sufficient capacity to carry at least five times the total weight of the cabinet. The cabinet shall remain dripproof when the eyebolts are removed.

3.5.10 Humidity conditions. The UPS shall operate with relative humidities ranging up to 95 $\pm$ 5 percent for both intermittent and continuous periods including conditions wherein condensation takes place in and on the UPS cabinets in the form of both water and frost.

3.5.11 Clearance for ventilation and accessibility. Maximum clearance allowed between the UPS cabinet and adjacent equipment or structure shall be as follows:

(a)	Bottom	No clearance allowed
(b)	Sides	No clearance allowed
(c)	Rear	6 inches
(d)	Top	12 inches
(e)	Front	30 inches

3.6 Reliability.

3.6.1 Reliability analysis. The reliability analysis shall employ one or more of the prediction methods in accordance with MIL-HDBK-217 (see 6.3). Failure rates should be selected in accordance with MIL-HDBK-217 (see 6.9). For the reliability analysis, the failure rate of each component should be calculated based on maximum ambient temperature in which the component operates in the equipment. The ambient temperature at each component shall be calculated from the input cooling air temperature which is 50°C. The environmental factor shall be Naval unsheltered in accordance with MIL-HDBK-217.

3.6.2 Reliability measurement. The reliability measure shall be mean-time-between-failures (MTBF) in accordance with MIL-STD-781 and shall be not less than 13,000 hours including battery bank.

3.6.2.1 Definition of failure. The definition of failure for the purpose of determining the achievement of reliability characteristics shall be:

(a) The input and output performance not in accordance with requirements specified herein.
(b) Malfunction requiring transfer and shutdown because of damage or incipient damage.

3.7 Maintainability.

3.7.1 Maintainability demonstration. Maintainability of the equipment should be demonstrated as specified in 4.7.40 (see 6.3).

3.7.2 Maintainability measurement. The mean time to repair shall be not greater than 2 hours. The maximum time to repair shall be not greater than 6 hours as calculated in accordance with MIL-STD-470.

3.7.2.1 Test equipment. The maintenance of the equipment shall require the use of only the following test equipment:

(a) Clamp-on volt ammeter, 0 to 600 amperes and 0 to 600 volts, ac; Nomenclature: CV-633 or AN/USM-33.
(b) Multimeter, 0 to 5000 volts, direct current (dc), 0 to 1000 volts, ac; 0 to 10 amperes, dc to 0 to 30 megohm range; Nomenclature: AN/PSM-4.
(c) Oscilloscope, X-Y, low frequency; Nomenclature: AN/USM-368 (Hewlett Packard Model 130 C or equivalent).
(d) DC millimeter, 0 to 150 milliampere range; Nomenclature: CV-931-4904003.
(e) AC voltmeter, 0 to 600 volts range type MR71W600ADVV in accordance with MIL-M-16034 and MIL-M-16034/9.

3.8 Endurance. Equipment shall pass the endurance test as specified in 4.7.41.

3.9 Workmanship. The UPS, including all parts and accessories, shall be constructed in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of soldering, marking of parts and subassemblies, wiring, welding and brazing, plating, riveting, finishes, machine operation, screw assemblies, and freedom of parts from burrs and sharp edges.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program (see 6.3). The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

(a) First article inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified herein, tests shall be conducted under ambient temperature 25 ± 2°C. The specific ambient temperature at the time of test shall be determined. Transient voltage or current traces taken by oscillograph or pictures of oscilloscope shall have peak-to-peak magnitude of not less than 3 inches and the speed of the traces shall be not greater than 2 cycles per inch.

4.4 First article inspection. One unit of each power rating shall be subjected to the examination and tests as specified in table IV.

TABLE IV. First article inspection.

Examination and test 1/	Requirement	Test method
General examination	3.4.1 and 3.9	4.6
Size and weight	3.3.3.1	4.7.1
Creepage and clearance	3.3.1	4.7.2
Insulation resistance	3.3.2.1	4.7.3
Dielectric withstanding voltage	3.3.2.1	4.7.4
Enclosures	3.2.21 and 3.3.3.3	4.7.5
Self-protection from input voltage variation and transient	3.2.1.1	4.7.6
Self-protection from input voltage spikes	3.2.1.2	4.7.7
Input current harmonics	3.2.1.3	4.7.8
Input current balance	3.2.1.4	4.7.9
Starting current and starting time	3.2.1.5, 3.2.1.5.1	4.7.10
Grounding	3.2.1.6	4.7.11
Output voltage and frequency regulation	3.2.2.1 and 3.2.2.5	4.7.12

TABLE IV. First article inspection - Continued.

Examination and test 1/	Requirement	Test method
Steady-state non-linear load	3.2.2.2	4.7.13
Output voltage adjustment	3.2.2.3	4.7.20
Transient output voltage and recovery	3.2.2.4	4.7.14
Amplitude and frequency modulation	3.2.2.7	4.7.15
Output voltage waveform	3.2.2.8	4.7.16
Output phase displacement	3.2.2.9	4.7.17
Output voltage balance under balanced load	3.2.2.10	4.7.18
Output voltage balance under unbalanced load	3.2.2.11	4.7.19
Input voltage change effect	3.2.2.12	4.7.21
Power rating	3.2.3 and 3.2.3.1	4.7.22
Efficiency and no-load losses	3.2.4 and 3.2.5	4.7.23
Overload, fault, and short circuit	3.2.6, 3.2.7, and 3.2.7.1	4.7.24
Automatic transfer	3.2.11 and 3.2.12	4.7.25
Rectifier-charger and battery duty cycle	3.2.13 through 3.2.20	4.7.26
Leakage current	3.2.22	4.7.27
Shock	3.5.1	4.7.28
Vibration	3.5.2	4.7.29
Airborne noise	3.5.3.1	4.7.30
Structureborne noise	3.5.3.2	4.7.31
Electromagnetic interference emission and susceptibility	3.5.4	4.7.32
Temperature rise and high temperature operation	3.5.5	4.7.33
Low temperature operation	3.5.6	4.7.34
Inclined operation	3.5.8	4.7.35
Humidity	3.5.10	4.7.36
Reliability	3.6	4.7.39
Maintainability	3.7	4.7.40
Remote start-up	3.3.5	4.7.37

1/ These tests may be conducted in any order or concurrently, except that the order of the four last tests shall be: Reliability, dielectric withstanding voltage, stress level conformation, and maintainability.

4.5 Quality conformance inspection. Each UPS offered for delivery shall be subjected to the quality conformance inspection as specified in table V (see 6.3).

TABLE V. Quality conformance inspection.

Examination and test 1/	Requirement	Test method
General examination	3.4.1 and 3.9	4.6
Insulation resistance	3.3.2.1	4.7.3
Self-protection from input voltage variation and transient	3.2.1.1	4.7.6
Input current harmonics	3.2.1.3	4.7.8
Input current balance	3.2.1.4	4.7.9
Output voltage and frequency regulation	3.2.2.1 and 3.2.2.5	4.7.12
Output voltage adjustment	3.2.2.3	4.7.20
Transient output voltage and recovery	3.2.2.4	4.7.14
Amplitude and frequency modulation	3.2.2.7	4.7.15
Output voltage waveform	3.2.2.8	4.7.16
Output voltage balance under balanced load	3.2.2.10	4.7.18
Output voltage balance under unbalanced load	3.2.2.11	4.7.19
Input voltage change effect	3.2.2.12	4.7.21
Overload, fault, and short circuit	3.2.6, 3.2.7, and 3.2.7.1	4.7.24
Auto transfer	3.2.11 and 3.2.12	4.7.25
Rectifier-charger and battery duty cycle	3.2.13 through 3.2.20	4.7.26
Endurance run	3.8	4.7.41
Airborne noise	3.5.3.1	4.7.30
Structureborne noise	3.5.3.2	4.7.31

1/ Any of the tests in table V may be conducted concurrently except that the endurance run shall be conducted after all other tests have been completed to verify that all requirements have been met.

4.6 General examination. Parts on assemblies and completed units shall be examined to verify that the following requirements have been met:

(a) Sufficient space is provided for these connections and sufficient cable support within the drawers and cabinets, and connections made at the appropriate terminals.
(b) Wherever wires run through holes in metal partitions or chassis, grommets are provided for mechanical protection.
(c) Wires are not bent around sharp corners which may injure the insulation.

(d) Wires are connected by either bolted or soldered connections.
(e) Bolted connections are provided with locking devices.
(f) Both ends of all wires are marked with designations as shown on the accepted drawing.
(g) The equipment pull-out drawers have stops to lock in pull-out position.
(h) Non-identical drawers cannot be interchanged in the equipment cabinet.
(i) Identification and instruction plates are furnished as shown on the accepted drawing.

4.7 Test methods.

4.7.1 Size and weight. The UPS including battery rack shall be measured and weighed.

4.7.2 Creepage and clearance. Creepage and clearance distance shall be demonstrated by actual measurement.

4.7.3 Insulation resistance tests. Insulation resistance tests shall be conducted in accordance with method 302 of MIL-STD-202, test condition B, and with the battery circuit breaker open. When making insulation measurements from input or output lines to equipment cabinet, all power semiconductors may be jumpered. Electrically isolated circuits shall be determined by application of the following criteria:

(a) Circuits whose only connection to each other is by electromagnetic coupling through a magnetic core which is shared in common by the circuits shall be considered to be electrically isolated from each other.
(b) Circuits whose only connection to each other is through a capacitor shall not be considered to be electrically isolated from each other. When the purpose is to test circuits internal to the equipment, and only then, such circuits shall be temporarily interconnected with a jumper wire, or test load.

4.7.4 Dielectric withstanding voltage tests. Dielectric withstanding voltage tests shall be conducted in accordance with method 301 of MIL-STD-202, and with the battery circuit breaker open. The rms test voltage shall be twice rated circuit voltage plus 1000 volts. When making dielectric withstand measurements from input and output power leads and equipment cabinet, all power semiconductors may be jumpered. The duration of the test shall be 60 seconds. Any evidence of arcing, flashover, or punctured insulation shall be interpreted as a failure of the test. Corona (visible, audible, or odorous) shall not be considered as a failure.

4.7.5 Enclosures. Acceptability of the enclosures shall be determined by performance of the dripproof test in accordance with MIL-STD-108.

4.7.6 Self-protection from input voltage variation and transient. The test shall be performed as follows:

(a) The equipment shall be operated at minimum, nominal, and maximum input voltages at no-load and rated-load. The input voltage of the UPS shall be raised and then lowered beyond the specified operation range for 3 seconds and 50 milliseconds (ms), respectively. The input voltage, output voltage, and output current shall be determined with an oscillograph.

(b) The equipment shall be operated at minimum, nominal, and maximum input voltages to supply rated-load. The input power shall be interrupted for a period of 30 seconds and then restored to the original condition. The test shall be repeated by interrupting the input power for periods of 100 and 50 ms. The equipment input voltage, output voltage, and output current shall be determined with an oscillograph.

4.7.7 Self-protection from input voltage spikes. The equipment shall be operated at nominal input voltage to supply rated-load and an applicable transient voltage as specified in 3.2.1.2 shall be applied between line-to-line and between line-to-cabinet. The joule content of the transient shall be no more than would be encountered by interrupting the magnetizing current of an input transformer sized to supply the total kVA requirements of the equipment being tested. The transient need not be applied with the line connected.

4.7.8 Input current harmonics. The equipment shall be operated at minimum, nominal, and maximum input voltage and frequency. The input current harmonics of each input line shall be determined at no-load, 50 percent load, and rated load, with harmonics less than 0.1 percent of the fundamental (60 Hz) disregarded. Harmonics may be measured with shunts or current transformers shown to have documented frequency response characteristics to 20,000 Hz.

4.7.9 Input current balance. Rated input voltage shall be applied to the equipment balanced to plus or minus 0.5 percent of nominal voltage. The equipment shall be loaded to 15, 50, and 100 percent of rated load balance to plus or minus 0.5 percent of average. The input current shall be measured with sufficient accuracy to demonstrate input current balance to within plus or minus 1 percent.

4.7.10 Starting current and starting time. The minimum, nominal, and maximum voltages shall be connected to the equipment input and the equipment started under no-load conditions. The input starting current and output voltage shall be measured with an oscillograph, and the test shall be repeated with full-load connected to the UPS. The test shall be repeated with the input voltage absent. The starting time shall be determined. An attempt shall be made to energize the equipment when the input voltage phase rotation is in the reverse order (AC-CB-BA). Any damage to the equipment shall be determined.

4.7.11 Grounding. The test shall be performed with the equipment operated at minimum, nominal, and maximum input voltage at no-load and rated-load. For the test, the input power ground or earth shall be connected to the equipment cabinet.

Each single output terminal shall be connected to the equipment cabinet, and a determination made of any changes in operating output voltage, frequency, or waveform.

4.7.12 Voltage and frequency regulation. For first article test, the equipment shall be connected to an input whose voltage and frequency can be varied as specified in table VI. After the equipment has been stabilized at load, the output steady-state voltage and frequency regulation shall be determined when the test condition (TC) changes as follows:

From TC2 to TC36
TC5 to TC18
TC26 to TC24
TC33 to TC34

and when the load changes from 75 percent of rated-balanced-three-phase load to a three-phase-unbalanced load, as specified in 3.2.2.11, table I, load condition 1. For quality conformance test, the output steady-state voltage and frequency regulation shall be determined when the TC changes from TC2 to TC36 and from TC26 to TC24.

TABLE VI. Conditions of input and output.

Test condition numbers	Input						Output (of rated voltage and frequency)							
	Voltage within the specified range			Frequency within the specified range			Rated load (percent)				Power factor			
	Max	Nom	Min	Max	Nom	Min	0	50	100	125	lag 0.7	lag 0.8	1.0	lead 0.9
1	X	-	-	-	-	X	X	--	-	-	-	-	-	--
2	-	X	-	-	X	-	X	--	-	-	-	-	-	--
3	-	-	X	X	-	X	X	--	-	-	-	-	-	--
4	X	-	-	-	-	X	-	X	-	-	X	-	-	--
5	-	X	-	-	X	-	-	X	-	-	X	-	-	--
6	-	-	X	X	-	-	-	X	-	-	X	-	-	--
7	X	-	-	-	-	X	-	X	-	-	-	X	-	--
8	X	-	-	-	X	-	-	X	-	-	-	X	-	--
9	-	X	-	-	X	-	-	X	-	-	-	X	-	--
10	-	-	X	-	X	-	-	X	-	-	-	X	-	--
11	-	-	X	X	-	-	-	X	-	-	-	X	-	--
12	X	-	-	-	-	X	-	X	-	-	-	-	X	--
13	X	-	-	-	X	-	-	X	-	-	-	-	X	--
14	-	X	-	-	X	-	-	X	-	-	-	-	X	--
15	-	-	X	X	-	-	-	X	-	-	-	-	X	--
16	-	-	X	-	-	X	-	X	-	-	-	-	X	--

TABLE VI. Conditions of input and output - Continued.

Test condition numbers	Input						Output (of rated voltage and frequency)							
	Voltage within the specified range			Frequency within the specified range			Rated load (percent)				Power factor			
	Max	Nom	Min	Max	Nom	Min	0	50	100	125	lag 0.7	lag 0.8	1.0	lead 0.9
17	X	-	-	-	-	X	-	X	-	-	-	-	-	X
18	-	X	-	-	X	-	-	X	-	-	-	-	-	X
19	-	-	X	X	-	-	-	X	-	-	-	-	-	X
20	X	-	-	-	-	X	-	--	X	-	X	-	-	X
21	-	X	-	-	X	-	-	--	X	-	X	-	-	-
22	-	-	X	X	-	-	-	--	X	-	X	-	-	-
23	X	-	-	-	-	X	-	--	X	-	-	X	-	-
24	X	-	-	-	X	-	-	--	X	-	-	X	-	-
25	-	X	-	-	X	-	-	--	X	-	-	X	-	-
26	-	-	X	-	X	-	-	--	X	-	-	X	-	-
27	-	-	X	X	-	-	-	--	X	-	-	X	-	-
28	X	-	-	-	-	X	-	--	X	-	-	-	X	-
29	X	-	-	-	X	-	-	--	X	-	-	-	X	-
30	-	X	-	-	X	-	-	--	X	-	-	-	X	-
31	-	-	X	X	-	-	-	--	X	-	-	-	X	-
32	-	-	X	-	X	-	-	--	X	-	-	-	X	-
33	-	X	-	X	-	X	-	--	X	-	-	-	X	-
34	-	X	-	X	-	-	-	--	X	-	-	-	X	-
35	-	X	-	-	X	-	-	--	-	X	X	-	-	-
36	-	X	-	-	X	-	-	--	-	X	-	X	-	-
37	-	X	-	-	X	-	-	--	-	X	-	-	X	-

4.7.13 Steady-state nonlinear load. The equipment shall be operated at nominal input voltage and a balance nonlinear load consisting of a multiphase rectifier/filter with a dc load. The test shall be run with dc loads equal to 25, 50, and 70 percent of the rated equipment kW load applied to the rectifier/filter. A second series of tests shall be run with loads consisting of equal 0.8 (lagging) p.f. and nonlinear loads (as described herein) at 25, 50, and 70 percent of rated equipment kW load. The output voltage waveform shall remain within the limits as specified in 3.2.2.8; output voltage regulation shall be as specified in 3.2.2.1; and the voltage amplitude modulation shall be as specified in 3.2.2.7.

4.7.14 Transient output voltage and recovery. With the equipment operating with nominal input, a balanced three-phase load of 0.8 p.f. shall be changed in one step for the following conditions:

(a) From no-load to 1/2-load.
(b) From 1/2-load to rated-load.
(c) From rated-load to 1/2-load.
(d) From 3/4-load to 1/4-load.

Oscilloscope pictures shall be taken of the load application and removal to determine the voltage transient and recovery time. This test shall be conducted at minimum, nominal, and maximum input conditions as specified in 3.2.1. The frequency transient and recovery test shall be performed the same way except that load application and removal shall be from no-load to rated-load and from rated-load to no-load in one step, respectively.

4.7.15 Amplitude and frequency modulation. The equipment output voltage amplitude and frequency modulation shall be determined for test conditions as specified in 4.7.12.

4.7.16 Output voltage waveform. The harmonic content and output voltage spikes shall be determined. For first article, this test shall be performed with the equipment operating under the TCs 2, 25, and 30 as specified in table VI. For quality conformance test, this test shall be performed under the TCs 2 and 25 as specified in table VI. For quality conformance test, this test shall be performed under the TCs 2 and 25 as specified in table VI.

4.7.17 Output phase displacement angle. The equipment output displacement angle shall be measured at the output terminals. For first article and quality conformance tests, this test shall be performed for TCs 2 and 25 as specified in table VI.

4.7.18 Output voltage balance under balanced load. After the equipment has been stabilized at rated-load, the output voltage of each phase at the equipment output terminal shall be determined. For first article test, this test shall be performed for TCs 1, 2, 3, 7, 9, 11, 23, 25, and 27 as specified in table VI. For quality conformance test, this test shall be performed for TCs 2, 14, and 25 as specified in table VI.

4.7.19 Output voltage balance under unbalanced load. For the three-phase UPS, the UPS shall be operated with rated input. A three-phase, 0.7 p.f. load shall be applied across the output phases to have the lines carry current of 75 percent of rated current. A single-phase, 0.7 p.f. load shall be applied across the UPS output phase AB to have line A carry an additional current of 15 percent of rated current. The output voltage of all phases shall be determined at the output terminals. The test shall also be conducted using a single-phase, 0.7 p.f. load across output phase BC and CA. The tests shall be repeated for unity power factor loads.

4.7.20 Voltage adjustment. After the equipment has been stabilized at rated-load, the output voltages at the equipment output terminals shall be adjusted over their full ranges using the voltage adjustment devices. For the first article test, the test shall be conducted for TCs 2, 23, 24, 25, and 26 as specified in table VI. For quality conformance test, the test shall be conducted for TCs 2 and 25 as specified in table VI.

4.7.21 Input voltage change effect. The input to the equipment shall be nominal, rated voltage and frequency, and the input voltage shall instantaneously be increased to the limits and duration as specified in 3.2.2.12, and then returned to the initial value. The input and output voltage transient and recovery time shall be determined by an oscillograph. These tests shall be repeated with the input voltage instantaneously decreased to the limits and duration as specified in 3.2.2.12, and then returned to the initial value. The test shall be performed at no-load and rated-load.

4.7.22 Power rating. The UPS shall be operated at rated input voltage and frequency for 1 hour with each of the following loads:

(a) Rated-load, 0.8 p.f. lagging.
(b) Rated-load, unity power factor.

4.7.23 Efficiency and no-load losses. The battery of the UPS shall be disconnected. Input and output voltages and frequency of the UPS shall be set at rated values. Input and output power shall be measured for no-load and rated-load, 0.8 p.f. lagging. The UPS efficiency and no-load losses shall be determined.

4.7.24 Overload, fault, and short circuit. The equipment shall be operated at rated input voltage and frequency. The UPS shall be overloaded to 180 percent of rated for 1 minute at unity power factor. The UPS shall maintain rated output voltage during this period. The test shall be repeated with the UPS subjected to a load of 220 percent of rated. An oscillograph shall be used to determine the output voltage and the time for the transfer switch to operate. Load shall then be reduced to 180 percent of rated and the time to retransfer determined. The test shall be repeated with the UPS subjected to a load of 240 percent of rated.

4.7.25 Automatic transfer. The UPS shall be operated with rated input voltage, frequency, and rated-load. The automatic transfer switch operation, transfer time, and voltage synchronization shall be determined with an oscillograph for the following malfunctions:

(a) UPS output voltage outside the regulation range as specified in 3.2.2.1.
(b) UPS output frequency outside the regulation range as specified in 3.2.2.5.
(c) Any output overload, fault current or short circuit conditions as specified in 3.2.6, 3.2.7, and 3.2.7.1.

4.7.26 Rectifier-charger and battery duty cycle. The equipment output power, current, voltage, and harmonics shall be determined as indicated below, and voltage regulation shall be calculated when the equipment is operated with the following duty cycle:

(a) Set the UPS input voltage and frequency at rated value and the output at rated-load, 0.8 p.f. The battery shall be fully charged and the specific gravity of the electrolyte shall be determined.

(b) Interrupt the UPS input power for a period of 15 minutes. Take instrumentation readings at the beginning and at the end of this 15-minute period.
(c) Reapply the UPS input power and maintain at step (a) value for 1 hour. Take instrumentation readings at the beginning and at the end of this 1-hour period.
(d) Repeat steps (b) and (c).
(e) Run the UPS for a period of 8 hours with the input power maintained as step (a). Take instrumentation readings every hour.

Upon completion of the above duty cycle, the specific gravity of the battery shall be determined.

4.7.27 Leakage current. Equipment input and output EMI capacitors (if they are connected to the equipment ground stud) shall be disconnected from the ground stud. A low resistance shunt shall be connected between the EMI capacitor, one phase at a time, and the ground. The equipment shall be operated with the rated input voltage. The ground current through the shunt shall be measured for magnitude of the 60-Hz fundamental current.

4.7.28 Shock. The UPS shall withstand the high-impact, type A, grade A, class I shock test of MIL-S-901. Resilient mounts shall not be used for any parts, modules, or drawers in order to meet the shock test requirement.

4.7.28.1 Test features. Test features shall be as follows:

(a) Type A (for principal units) test shall be performed. The equipment shall be energized and operated at rated-load during shock test.
(b) Definition of failure to perform principal functions shall be as follows:

(1) Breakage of any parts, including mounting bolts. Minor chipping of parts such as plastic knobs and cases, and minor distortion of parts will be permitted where such chipping or distortion cannot in any manner impair operation of the UPS as specified.
(2) Appreciable distortion of any parts, including enclosure and framework.
(3) A value of insulation resistance lower than that permitted by this specification (see 3.3.2.1).
(4) Low dielectric strength. After shock tests the dielectric test shall be conducted at a voltage equal to 65 percent of the voltage specified in 4.7.4. Failure to pass this test shall be cause for rejection.
(5) Failure to pass visual examination. The equipment shall be carefully examined after removing removable panels, doors, and drawers to ascertain any mechanical damage. If necessary, partial disassembly shall be performed to aid in determining any possible damage.

(6) Failure to continually carry rated-load during shock test and to perform electrical test following shock. Adjustment or replacement of damaged parts shall not be permitted during shock test.

(c) Mounting. The equipment shall be mounted on the shock machines in a manner simulating shipboard installations in accordance with MIL-S-901 for deck-mounted equipment.

(d) Immediately following the shock test, the UPS shall be tested for output voltage and frequency regulation (see 4.7.12), and transient voltage, frequency deviation, and recovery (see 4.7.14) of rated voltage and frequency.

4.7.29 Vibration. Vibration measurements shall be obtained using procedures in accordance with MIL-STD-167-1.

4.7.29.1 Test features. Test features shall be as follows:

(a) The equipment shall be mounted so as to simulate actual shipboard installation.

(b) The equipment shall be energized and operated at rated-load during vibration tests.

(c) The failure determination as specified for the shock tests in 4.7.28.1(b) shall apply also to the vibration tests.

(d) Immediately following the vibration test, the equipment shall be tested for output voltage and frequency regulation (see 4.7.12), and transient voltage, frequency deviation, and recovery (see 4.7.14) with rated input voltage and frequency.

4.7.30 Airborne noise. Airborne noise measurements shall be obtained in accordance with MIL-STD-740-1 at test level for grade B equipment (see 6.3). The equipment is to be operated at rated voltage, frequency, and rated-load.

4.7.31 Structureborne noise. Structureborne noise measurements shall be obtained in accordance with MIL-STD-740-2 at test level for type III equipment (see 6.3). The equipment is to be operated at rated voltage, frequency, and rated-load.

4.7.32 Electromagnetic interference emission and susceptibility. The equipment shall be tested in accordance with the applicable tests of MIL-STD-462 or the approved EMI test plan (see 6.3). Tests performed will include input and output cables, simulated using system integration configuration and length.

4.7.33 High temperature operation. High temperature tests shall be conducted at an ambient temperature of 50°C. The test methods to be employed and the precautions to be observed shall be as specified in 4.7.33.1 through 4.7.33.5.

4.7.33.1 Assembly and mounting of equipment. Temperature rise tests shall be made only with the equipment completely assembled and mounted in the manner for which it is designed. Barriers shall be placed adjacent to the enclosure to

simulate shipboard space restrictions. The minimum temperature measurement points shall be as follows:

(a) Power semiconductor-studs.
(b) Capacitors.
(c) Power transformer and reactor coil windings.
(d) Ambient temperature.
(e) Cooling air inlet and outlet.
(f) Battery electrolyte.

4.7.33.2 Method of temperature measurements. The methods of temperature measurement of ambient and parts or subassemblies shall be in accordance with MIL-E-917, method 3, measurement by thermocouple. Thermometers shall not be used.

4.7.33.3 Method of loading. The UPS shall be operated at nominal rated TCs 23, 25, and 27 as specified in table VI. The temperature shall reach the steady final value as specified in 4.7.33.4. Temperature rises shall be in accordance with temperature requirements of MIL-E-917.

4.7.33.4 Duration of test. Consecutive temperature measurements of each measurement point shall be taken not greater than 3 minutes apart. The temperature rise test shall continue until temperature measurements for all points attain a steady final value. Steady final value is that value of temperature which will remain at a 2°C band for 2 hours, while the ambient temperature is maintained at 50°C.

4.7.33.5 High temperature tests. After the equipment has attained a steady final value as specified in 4.7.33.4, the following tests shall be conducted at the ambient temperature 50°C:

(a) Voltage and frequency regulation test as specified in 4.7.12.
(b) Transient voltage, frequency deviation, and recovery test as specified in 4.7.14.
(c) Amplitude and frequency modulation test as specified in 4.7.15.
(d) Output voltage waveform test as specified in 4.7.16.
(e) Short circuit protection test as specified in 4.7.24.
(f) Input voltage step change test as specified in 4.7.21.
(g) Inclination test as specified in 4.7.35.

4.7.34 Low temperature operation. Prior to this test, the UPS shall be sufficiently conditioned to ensure that each part is at a temperature of 0 to 5°C. Rated input shall be connected to the equipment. The equipment shall be started at an ambient temperature of 0°C and shall operate at no-load, initially, and rated-load for a period of 1 hour at each load condition. The same series of tests run for high temperature operation shall be repeated (see 4.7.33.5) before running 1 hour at condition 9.

4.7.35 Inclined operation. The equipment shall be tested for inclined operation at 45 degrees from the horizontal. The equipment shall be run at rated-load for a period of not less than 1 hour at each of the following positions:

(a) 45 degrees forward.
(b) 45 degrees backward.
(c) 45 degrees to left side.
(d) 45 degrees to right side.

During the progress of this test, it shall be ascertained that there is no apparent overheating of any drawers, modules, or parts; dropping out of circuit breakers; or malfunction of operation of the UPS.

4.7.36 Humidity. The equipment shall be tested in accordance with MIL-STD-810, modified so that the maximum chamber temperature is 50°C.

4.7.37 Local and remote start-up and shutdown. The equipment shall be operated at nominal input voltage. The control of the equipment shall be accomplished both locally (see 3.2.9) and from a remote control (see 3.3.5) panel equivalent which is connected to the equipment with a cable having an equivalent resistance of a 500-foot type LSMSCU cable in accordance with MIL-C-24643 and MIL-C-24643/18. The operation of all controls, alarms, and indications shall be demonstrated.

4.7.38 Stress level conformation. The electrical stresses of the parts in the equipment shall be tested to conform to the derated stress limits as specified in 3.4.5.4. Stress level shall be tested on representative parts as approved.

4.7.39 Reliability test. After completion of all other tests, a 2000-hour reliability test shall be conducted in accordance with MIL-STD-781 and MIL-HDBK-781, except as otherwise specified herein. The test shall be performed with the unit at 50°C only.

4.7.40 Maintainability demonstration. The equipment shall be subjected to maintainability demonstration tests in accordance with MIL-STD-471, method I, test B for mean corrective maintenance time (Mct) (15 samples). Maintenance tasks of the maintainability demonstration tests shall be performed by military or civil service personnel of the level and training available during operational use. After completion of each maintenance action, the equipment shall be operated for 15 minutes at rated-load. The time measured for each corrective maintenance task shall consist of the sum of the following steps: Fault location, fault correction, adjustment, if any, and check-out, including the consulting of technical manuals and other allowed aids during this time.

4.7.41 Endurance run. A continuous 200-hour endurance run shall be conducted on the equipment. The test shall be as follows:

(a) Ambient temperature cycling. Operate equipment at 50 ± 5°C for 15 hours. Then reduce temperature to ambient of 25 ± 5°C for 5 hours. Repeat the cycle 10 times continuously.
(b) Output load cycling. When the equipment is operating at 50 ± 5°C, the rated-load shall be applied continuously for 13 hours followed by 2 hours at no-load. When the equipment is operating at 25 ± 5°C, the rated-load shall be applied continuously for 3 hours

followed by 2 hours at no-load. The contractor may, for the purpose of energy management, schedule the rated-load operating hours and power down so as to avoid the normal peak utility load operating times.

(c) Output voltage and frequency. Rated.

(d) Input voltage and frequency. Rated.

(e) Readings. The input current, input voltage, input frequency, output current, output voltage, output frequency, output power, test chamber ambient temperature, outside chamber ambient temperature, and operating time shall be taken automatically every 15 minutes. Results shall be verified every 50 hours by test personnel.

(f) Failure. If a failure should occur during the first 130 hours of operation, the cause of failure shall be determined, corrected, and the test continued. The equipment shall operate the final 70 hours without failure. If any failure occurs, the final 70 hours shall be repeated without failure. The definition of failure shall be as specified in 3.6.2.1. A failure is not considered to have occurred if malfunction can be attributed to external causes such as operator error or ambient temperature over 50°C.

4.8 Inspection of packaging. Sample packages and the inspection of the packaging (preservation, packing and marking) for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging or preparation for delivery requirements of referenced documents listed in section 2, see 6.8.)

5.1 General.

5.1.1 Navy fire-retardant requirements.

(a) Treated lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping containers and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material in accordance with MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.

Level C - Type I - non-weather resistant.
Category 1 - general use.

(b) Fiberboard. Fiberboard used in the construction of interior (unit and intermediate) and exterior fiberboard boxes including interior packaging forms shall conform to the class-domestic/fire-retardant or class-weather resistant/fire-retardant materials requirements as specified (see 6.2), of PPP-F-320 and amendments thereto.

5.2 Packaging requirements. The packaging (preservation, packing, and marking) requirements of valves shall be in accordance with MIL-E-17555 or the level (A, B, C, or commercial) of preservation; level of packing (A, B, C, or commercial), marking, including bar coding and other packaging acquisitioning options therein as specified (see 6.2).

5.3 Special requirements for critical close tolerance equipment. Special preservation, packing, and marking, in addition to any preservation and packing requirements specified by the product specification and packing requirements code, equipment which are identified to MIL-STD-740-1 and MIL-STD-740-2 shall be protected against damage resulting from environmental conditions, multiple handling and the hazards of transportation (rough handling, shock, vibration, and so forth). Shipping containers or method of packing utilizing shock or vibration mitigation systems shall only use mounts which have captive features. Unit packs and shipping shall be marked as specified (see 6.2).

5.3.1 Special marking. Special marking unit packs and shipping containers and unpacked shipments shall be marked with the following:

"CRITICAL, CLOSE TOLERANCE OPERATING EQUIPMENT
HANDLE WITH CARE
DO NOT DROP OR SUBJECT TO SHOCK OR JARS"

Markings shall be stenciled, red color, and applied on two sides and both ends of the container for shipment. Letters shall be a minimum 1-1/2 inch high, except for small containers with insufficient space, in which case letters shall be of such size as to be legible. In addition, arrows and the word "UP", center of balance, sling or lifting point markings as indicated in MIL-E-17555 shall apply.

6. NOTES

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

6.1 Intended use. The UPS covered by this specification is intended to provide uninterruptible Navy shipboard 60-Hz electrical power for vital loads.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(c) Whether first article inspection is required (see 3.1).
(d) Rating (see 3.2.3).

(e) When semiconductor devices are other than silicon (see 3.4.5).
(f) When fire-retardant materials are not required (see 5.1.1).
(g) Level of preservation, level of packing, and other packaging acquisitioning options required (see 5.2).
(h) Special marking requirements (see 5.3).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.3.1	DI-DRPR-81000	Product drawings and associated lists	-----
3.6.1	DI-R-7085	Failure mode, effects, and criticality analysis report	-----
3.6.1		Reliability analysis	-----
3.7.1	DI-R-2129	Plan, maintainability demonstration	-----
4.1.1	DI-QCIC-80906	Calibration system description	-----
4.5	DI-NDTI-80809	Test/inspection reports	-----
4.7.30	DI-HFAC-80272	Equipment airborne sound measurements test report	-----
4.7.31	DI-HFAC-80274	Equipment structureborne vibration acceleration measurements test report	-----
4.7.32	DI-EMCS-80200	Electromagnetic interference test report	-----

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first 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 which 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. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.6 Definitions.

6.6.1 UPS. The UPS is a power supply that is noninterruptible (see MIL-STD-1399, section 300). The UPS is also referred to as a no-break power supply.

6.6.2 Unit. Unit is defined as a single, individual solid state UPS.

6.6.3 Cabinet. Cabinet is defined as a number of drawers physically joined together to perform a specific function.

6.6.4 Drawer. Drawer is defined as two or more parts or removable modules in one drawer. A drawer is a portion of a cabinet.

6.6.5 Module. Module is defined as two or more parts to form an entity as part of a drawer. Module can be replaceable as a whole, but having a part or parts which are individually replaceable.

6.6.6 Part. Part is defined as one piece, or two or more pieces, joined together which are not normally subjected to disassembly, without destruction of intended use. Parts are the lowest level of breakdown.

6.7 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.7.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.8 Sub-contracted material and parts. The packaging or preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.9 Reliability analysis. When component failure rates are not available in accordance with MIL-HDBK-217, failure rates from other sources should be fully documented and substantiated.

6.10 Conditions for use of level B preservation. When level B preservation is specified (see 5.2), this level of protection should be reserved for the acquisition of power supplies for resupply worldwide under known favorable handling, transportation, and storage conditions.

6.11 Subject term (key word) listing.

Battery back-up
Black-out protection
Brown-out protection
Clean power
Computer power supply
Harmonics
No-break power supply
Semiconductor device

Review activities:
Navy - EC, YD

Preparing activity:
Navy - SH
(Project 6130-N321)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document 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 the 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	2. DOCUMENT DATE (YYMMDD)
	MIL-P-24765(SH)	1991 November 19

3. DOCUMENT TITLE
POWER SUPPLY, UNINTERRUPTIBLE, STATIC (NAVAL SHIPBOARD)

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) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
Technical Point of Contact(TPOC): Mr. Orlando Acosta (NAVSEA 56Z33) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS	(1) Commercial TPOC: (703) 602-6063	(2) AUTOVON 332-6063
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	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 AUTOVON 289-2340	