

INCH-POUND

MIL-DTL-24765A(NAVY)

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SUPERSEDING

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DETAIL SPECIFICATION

POWER SUPPLY, UNINTERRUPTIBLE, STATIC (NAVAL SHIPBOARD)

This specification is approved for use by the 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 static uninterruptible power supplies (UPS) (see 6.4.3) for Naval shipboard use with outputs equal to or greater than 1kW and AC or DC output voltages.

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-E-917	-	Electric Power Equipment, Basic Requirements
MIL-PRF-16552	-	Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type)
MIL-DTL-24643	-	Cables, Electric, Low Smoke Halogen-Free, for Shipboard Use, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

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)

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.daps.dla.mil>.

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- MIL-STD-461 - Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
- 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-810 - Environmental Engineering Considerations and Laboratory Tests
- MIL-STD-1310 - Shipboard Bonding, Grounding; and Other Techniques for Electromagnetic Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety
- MIL-STD-1399-300 - Electric Power, Alternating Current
- MIL-STD-2003-2 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Equipment)

DEPARTMENT OF DEFENSE HANDBOOKS

- MIL-HDBK-454 - General Guidelines for Electronic Equipment
- MIL-HDBK-470 - Designing and Developing Maintainable Products and Systems, Volume I
- MIL-HDBK-781 - Handbook for Reliability Test Methods, Plans, and Environments for Engineering, Development, Qualification, and Production.

(Copies of these documents are available online at <https://assist.daps.dla.mil/online> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

- S9310-AQ-SAF-010 - Batteries, Navy Lithium; Safety Program Responsibilities and Procedures

(Copies of this document are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at <https://nll.ahf.nmci.navy.mil>.)

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

ASTM INTERNATIONAL

- ASTM F1166 - Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

(Copies of this document are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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.

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3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Performance.

3.2.1 Input voltage and frequency. The rated input voltage and frequency shall be in accordance with MIL-STD-1399, Section 300, Type I power and the following:

- a. For UPS rated 5kVA and above - 440 V, 60 Hz, three-phase.
- b. For UPS rated 1kVA and above but below 5kVA - 440 V, 60 Hz, three-phase or 115 V, 60 Hz, single-phase.”

3.2.1.1 Input power perturbations. When the UPS is supplying any load from no-load to rated-load, the UPS shall withstand, without damage or blowing fuses, the following conditions of input power:

- a. A loss of input power for any time duration.
- b. Departures, excursions, transients, and emergency conditions of input voltage or frequency or combinations of these conditions in accordance with MIL-STD-1399, Section 300.

Upon return of the input voltage and frequency to the specified range (see 3.2.1), the UPS shall operate and supply the load with the same output as that prior to the input power changes.

3.2.1.2 Input voltage spikes. The UPS shall tolerate voltage spikes in accordance with MIL-STD-1399, Section 300, without damage or interruption of UPS operation. Joule content of the spike shall not be greater than would be encountered by interrupting the magnetizing current of an input transformer sized to supply the total kilovolt-ampere (kVA) requirements of the UPS.

3.2.1.3 Input current harmonics. When the input power to the UPS is as specified in 3.2.1 and with the UPS supplying any load from no-load to rated load, the harmonic distortion of the input current waveform for single and multi-phase UPS shall be in accordance with MIL-STD-1399, Section 300 for user equipment.

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 shall comply with the input current balance for user equipment in accordance with MIL-STD-1399, Section 300.

3.2.1.5 Starting time. The UPS 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 (start up).

3.2.1.5.1 Starting without input power present. The UPS may be started without the input power present if the battery is fully charged. For these conditions, the output voltage of the UPS 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 Input power system grounding. The UPS shall meet all requirements specified herein when connected to an ungrounded or high-resistance grounded ship's input power system in accordance with MIL-STD-1399, Section 300.

3.2.2 Output. The UPS output shall be as specified (see 6.2) and shall be selected from the following:

- a. AC. The rated AC output voltage and frequency of the UPS shall be 115-volt, 60-Hz, single-phase; 440-volt, 60-Hz, three-phase; or as specified (see 6.2).
- b. DC. The rated DC output voltage of the UPS shall be as specified (see 6.2).

3.2.2.1 Voltage regulation (AC output). The average of the line-to-line rms values of the output voltage shall be maintained at the UPS output terminals within ± 3 percent of the rated output voltage under the following variable conditions and any combination thereof:

- 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.

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- c. Any input power perturbations within the range specified in 3.2.1.1.
- d. Variation of the UPS temperature from a cold start to maximum operating temperature over the ambient temperature range of 0 to 50 degrees Celsius (°C).
- e. Under the unbalanced load condition specified in 3.2.2.11.
- f. Under the nonlinear load conditions specified in 3.2.2.2.
- g. With batteries supplying 100 percent of rated UPS power for specified time (see 3.2.3.2).
- h. When batteries are charging as specified in 3.2.9.

3.2.2.2 Steady-state nonlinear load (AC output). When a typical nonlinear load (see 6.4.2) up to 50 percent of the rated load is applied, the UPS shall meet the following:

- a. The output voltage waveform shall remain within the limits specified in 3.2.2.8.
- b. The voltage amplitude modulation shall be as specified in 3.2.2.7.

The maximum harmonic content in the UPS output current shall be in accordance with the following formula:

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

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

3.2.2.4 Transient output voltage and recovery (AC output). The sudden change of 0.8 lagging power factor loads on the UPS from no-load to ½-load, from ½-load to rated-load and from rated-load to ½-load, and from ¾-load to ¼-load shall cause an output voltage deviation of not greater than ±5.0 percent of rated voltage. The voltage at the UPS output terminals shall recover and stay within the steady-state regulation band (see 3.2.2.1) within 5 milliseconds. Voltage transients developed within the UPS 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 (AC output). Output frequency shall be maintained within ±1 percent of rated frequency under the following conditions and any combination thereof:

- a. Any input power perturbations within the range specified in 3.2.1.1.
- b. Variation of the UPS temperature from cold start to maximum operating temperature over the ambient temperature ranging from 0 to 50 °C.
- c. Any input voltage and frequency variation outside the range specified in 3.2.1. The storage battery shall be charged and the UPS shall supply output power for the specified time (see 3.2.3.2).
- d. A load variation from no-load to 125 percent load.
- e. Load power factor (p f.) varying between 0.7 lagging and 0.9 leading with rated output.
- 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 specified time (see 3.2.3.2).
- i. When batteries are charging as specified in 3.2.9.

3.2.2.6 Isolation. The UPS shall provide electrical isolation of the input from the output.

3.2.2.7 Amplitude and frequency modulation (AC output). 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 condition of operation specified herein.

3.2.2.8 Output voltage waveform (AC output). Under any load conditions between no-load and rated-load, 0.8 lagging p.f., and input power as specified in 3.2.1 or during the loss of input power, the total harmonic distortion of the output voltage shall not exceed 5 percent. The rms value of any single harmonic shall not exceed 3 percent of the rms value of the rated output voltage. 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.

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3.2.2.9 Output phase displacement (AC output). For three-phase UPS, the output voltage displacement angle between adjacent voltage phases shall be not greater than 120 ± 1 degrees under any load conditions between no-load and rated-load, 0.8 lagging p f., and input power as specified in 3.2.1.

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

3.2.2.11 Output voltage balance under unbalanced load conditions (AC output). For the three-phase UPS, the voltage variation between phases shall be not greater than ± 2 percent of rated voltage with the load conditions shown in [table I](#).

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
4	15	15	0	0.7 lagging to unity

3.2.2.12 Voltage regulation (DC output). The value of the output voltage shall be maintained within ± 3 percent of the rated output voltage under the following variable conditions and any combination thereof:

- A load variation from no-load to 125 percent load.
- Any input power perturbations within the range specified in 3.2.1.1.
- Variation of the UPS temperature from a cold start to maximum operating temperature over the ambient temperature range of 0 to 50 °C.
- With batteries supplying 100 percent of rated UPS power for the specified time (see 3.2.3.2).
- When batteries are recharged as specified in 3.2.9.

3.2.3 Ratings. The output ratings of the UPS shall be from 1 up to and equal to 100 kilowatts, as specified (see 6.2).

3.2.3.1 Duty. The UPS shall have a continuous duty rating under any operating condition specified herein.

3.2.3.2 Operating time. The UPS shall have an operating time on battery of 10, 15, 20, 30, 45, or 60 minutes, as specified (see 6.2).

3.2.4 Efficiency. With the UPS operating under the conditions specified in 4.6.23, the overall efficiency shall be not less than 90 percent.

3.2.5 Over current protection. The UPS shall provide over current protection as follows:

- 125 percent of rated current at rated output voltage for 10 minutes (see 3.2.1).
- 200 percent of rated current at rated output voltage for 30 seconds (see 3.2.1).
- 200 to 230 percent of rated current at rated output voltage for 5 seconds (see 3.2.1).
- Output over 230 percent of rated current is considered short circuit. For short circuit, the UPS shall limit the current to a minimum of 230 percent at reduced output voltage for 5 seconds.

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For UPS with the same input and output parameters (AC, DC, voltage, phases, etc.), when the load exceeds the limits specified above for a, b, or c; it shall automatically transfer to the UPS by-pass. For UPS with the different input and output parameters, when the load exceeds the limits specified above for a, b, or c; the UPS shall automatically shut down. For all UPS that exceed the load limit specified in d, above; the UPS shall automatically shut down. For instances where the UPS is in automatic by-pass, when the load current drops to a level equal to or less than full-rated, the load shall automatically be transferred to the UPS without disturbance to the load. For instances where the UPS shut down, manual restart shall be required. None of these operations shall cause fuses or circuit breakers to activate or produce voltage transients in the load exceeding 6 percent. These events shall be indicated locally and provision shall be made for remote indication.

3.2.6 Display and control. For UPS rated 5kW and greater, the UPS shall track and display its performance. It shall also provide operational instructions and alarm functions. The operator shall be able to control the UPS from the local, front mounted panel or, when specified (see 6.2), from a remote location via a computer. If the UPS rating is less than 5kW, the panel requirement may be in other forms such as push-buttons and switches and shall not require remote operation capability.

3.2.7 Modes of operation. The UPS shall operate automatically with two modes of operation as follows:

- a. Automatic. The power to the load is provided by the UPS.
- b. By-pass. For AC output, the UPS is disconnected from input power and by-passed with the load directly supplied from the incoming AC line or alternate source. For DC output, the UPS is disconnected from input power and the load. The DC load may be supplied power from an alternate source if available.

3.2.8 Transfer time. 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 6 percent.

3.2.9 Battery charging. Battery charging shall be automatically regulated to provide output voltage and current as necessary to keep the battery bank fully charged. Battery temperature shall be taken into consideration to avoid damage during charging. There shall not be any reverse current flow from the battery bank when the UPS is disconnected from the input power.

3.2.10 Battery bank. The batteries shall be maintenance-free and shall be provided by UPS manufacturer. If lithium batteries are selected for use, NAVSEA S9310-AQ-SAF-010 shall be complied with for battery safety. Batteries shall be selected to provide a minimum of 10-year life.

3.2.10.1 Battery configuration. For small UPS (less than 5kW), batteries may be housed in a common enclosure with the UPS. For all other UPS, batteries shall be supplied on racks in accordance with MIL-STD-2003-2.

3.2.11 Leakage current. The rms leakage current caused by the electromagnetic interference (EMI) filter capacitor from each input power line to the ship's ground shall not cause a fundamental 60-Hz current greater than 30 milliamperes per line. This requirement applies to the output when the UPS supplies a 60-Hz output.

3.3 Design and construction.

3.3.1 General. Design and construction shall be in accordance with the requirements of MIL-E-917, except as otherwise specified herein.

3.3.2 Electrical construction. The UPS shall use solid-state circuitry and devices to the maximum extent possible.

3.3.3 Mechanical design. UPS rated 5kVA and greater shall provide front access for maintenance.

3.3.3.1 Size and weight. The weight and volume of the UPS shall be minimized to the maximum extent possible.

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3.3.3.2 Cabinet arrangement. The equipment, excluding the battery rack enclosure, shall consist of one or more cabinets (see 6.4.1) with height not greater than 72 inches. When specified (see 6.2), width and depth shall be selected to enable the cabinets 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. For UPS rated 5 kVA and greater, a separate cabinet shall be provided for the by-pass switch that allows total electrical isolation of the UPS for maintenance purposes by removing all electrical energy sources from the UPS cabinet. An alternative to this by-pass switch is a circuit breaker or other similar device located in a switchboard.

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

3.3.3.4 Ground connection. All exposed metal parts of the UPS cabinets and components shall be at ground (ship's hull) potential at all times. 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.

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. Cables shall be in accordance with MIL-DTL-24643.

3.3.5 Remote control panel. Signals for the remote control and monitoring of the UPS shall be provided for a remote control panel, when specified (see 3.2.7 and 6.2), which shall be a computer terminal. The remote control panel shall be connected to the UPS by cable in accordance with MIL-DTL-24643.

3.3.6 Identification plate. The UPS shall be equipped with an identification plate.

3.3.6.1 Operation instruction plate. The UPS shall be equipped with an operation instruction plate.

3.3.7 Human engineering. Human engineering shall be in accordance with ASTM F1166.

3.3.8 Safety. The UPS safety requirements shall be in accordance with MIL-E-917. MIL-HDBK-454 may be used for guidance.

3.4 Component requirements.

3.4.1 Selection of parts. The number of different parts to be designed into the UPS shall be kept to a minimum consistent with its intended use.

3.4.2 Electrical components and semiconductors. Derating of electrical components and semiconductors shall be in accordance with MIL-E-917.

3.5 Environmental requirements.

3.5.1 Shock. The UPS shall meet the Grade A shock acceptance requirements of MIL-S-901 when tested as specified in 4.6.28.

3.5.2 Vibration. The UPS 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), sway braces may be used.

3.5.3 Noise. The UPS shall meet the noise requirements of 3.5.3.1 and 3.5.3.2 when mounted in accordance with manufacturer's recommendations.

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 EMI requirements in accordance with MIL-STD-461.

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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. Where possible, air filters in accordance with MIL-PRF-16552 shall be used with forced-air cooling.

3.5.7 Accessibility. Front access shall be provided, to the maximum extent possible, for operation and maintenance.

3.5.8 Ship motion. The UPS shall operate satisfactorily when inclined 15 degrees permanently in any direction or up to and including 45 degrees temporarily (less than or equal to one hour) in any direction.

3.5.9 Lifting provision. Each cabinet shall have provisions to permit hoisting and handling.

3.5.10 Humidity conditions. The UPS shall operate with relative humidity ranging up to 95±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 | - | 6 inches |
| e. Front | - | 30 inches |

3.6 Reliability.

3.6.1 Reliability measure. The reliability measure shall be mean-time-between-failures (MTBF) and shall be not less than 30,000 hours including battery bank. MIL-HDBK-781 may be used for guidance.

3.6.2 Definition of failure. The definition of failure for the purpose of determining the achievement of reliability characteristics shall be input or output performance not in accordance with requirements specified herein.

3.7 Maintainability.

3.7.1 Maintainability measure. The maintainability measure shall be mean time to repair (MTTR) and shall be not greater than 2 hours. MIL-HDBK-470 may be used for guidance.

3.7.2 Test equipment. The maintenance of the UPS shall not require the use of any special tools or equipment.

4. VERIFICATION

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

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection. One UPS of each power rating shall be subjected to the examination and tests as specified in [table II](#).

4.3 Conformance inspection. Each UPS offered for delivery shall be subjected to the conformance inspection as specified in [table III](#).

4.4 Inspection conditions. Unless otherwise specified herein, tests shall be conducted under nominal existing ambient temperature and humidity.

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TABLE II. First article inspection.

Examination and test	Requirement	Test method	UPS – AC output	UPS – DC output
General examination	3.3	4.5	X	X
Size and weight	3.3.3.1	4.6.1	X	X
Creepage and clearance	3.3.1	4.6.2	X	X
Insulation resistance	3.3.1	4.6.3	X	X
Dielectric withstanding voltage	3.3.1	4.6.4	X	X
Enclosures	3.2.10.1 and 3.3.3.3	4.6.5	X	X
Input power perturbations	3.2.1.1	4.6.6	X	X
Input voltage spikes	3.2.1.2	4.6.7	X	X
Input current harmonics	3.2.1.3	4.6.8	X	X
Input current balance	3.2.1.4	4.6.9	X	X
Starting time	3.2.1.5, 3.2.1.5.1	4.6.10	X	X
Grounding	3.2.1.6	4.6.11	X	X
Output voltage and frequency regulation	3.2.2.1 and 3.2.2.5	4.6.12	X	---
Steady-state non-linear load	3.2.2.2	4.6.13	X	---
Transient output voltage and recovery	3.2.2.4	4.6.14	X	---
Amplitude and frequency modulation	3.2.2.7	4.6.15	X	---
Output voltage waveform	3.2.2.8	4.6.16	X	---
Output phase displacement	3.2.2.9	4.6.17	X	---
Output voltage balance under balanced load	3.2.2.10	4.6.18	X	---
Output voltage balance under unbalanced load	3.2.2.11	4.6.19	X	---
Output voltage regulation (DC)	3.2.2.12	4.6.20	---	X
Power rating	3.2.3 and 3.2.3.1	4.6.21	X	X
Operating time on battery	3.2.3.2	4.6.22	X	X
Efficiency	3.2.4	4.6.23	X	X
Over-current protection	3.2.5	4.6.24	X	X
Transfer time	3.2.8	4.6.25	X	X
Low voltage shut down	3.2.3.2	4.6.26	X	X
Leakage current	3.2.11	4.6.27	X	X
Shock	3.5.1	4.6.28	X	X
Vibration	3.5.2	4.6.29	X	X
Airborne noise	3.5.3.1	4.6.30	X	X
Structureborne noise	3.5.3.2	4.6.31	X	X
Electromagnetic interference emission and susceptibility	3.5.4	4.6.32	X	X

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TABLE II. First article inspection - Continued.

Examination and test	Requirement	Test method	UPS – AC output	UPS – DC output
High temperature operation	3.5.5	4.6.33	X	X
Inclined operation	3.5.8	4.6.34	X	X
Humidity	3.5.10	4.6.35	X	X
Reliability	3.6	4.6.37	X	X
Maintainability	3.7	4.6.38	X	X
Remote operation	3.3.5	4.6.36	X	X

TABLE III. Conformance inspection.

Examination and test	Requirement	Test method	UPS – AC output	UPS – DC output
General examination	3.3	4.5	X	X
Insulation resistance	3.3.1	4.6.3	X	X
Input power perturbations	3.2.1.1	4.6.6	X	X
Output voltage and frequency regulation	3.2.2.1 and 3.2.2.5	4.6.12	X	---
Steady state non-linear load	3.2.2.2	4.6.13	X	---
Transient output voltage recovery	3.2.2.4	4.6.14	X	---
Amplitude and frequency modulation	3.2.2.7	4.6.15	X	---
Output voltage waveform	3.2.2.8	4.6.16	X	---
Output voltage regulation (DC)	3.2.2.12	4.6.20	---	X
Operating time on battery	3.2.3.2	4.6.22	X	---
Over-current protection	3.2.5	4.6.24	X	X
Transfer time	3.2.8	4.6.25	X	X

4.5 General examination. UPS shall be examined to verify that the following requirements, at a minimum, have been met:

- a. Sufficient space is provided for input and output cable connections.
- 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.
- d. Wires are connected by either bolted or soldered connections.
- e. Bolted connections are provided with locking devices.
- f. Identification and instruction plates are furnished as shown on the accepted drawing.

4.6 Test methods.

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

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

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4.6.3 Insulation resistance tests. Insulation resistance tests shall be conducted with the battery isolated from the circuit.

4.6.4 Dielectric withstanding voltage tests. Dielectric withstanding voltage tests shall be conducted with the battery isolated from the circuit. 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.

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

4.6.6 Input power perturbations. The test shall be performed as follows:

a. The UPS 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 UPS operation shall be as specified herein.

b. The UPS 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 UPS operation shall be as specified herein.

4.6.7 Input voltage spikes. The UPS 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 UPS operation shall be as specified herein.

4.6.8 Input current harmonics. The UPS shall be operated at nominal input voltage and frequency. The input current harmonics of each input line shall be determined at no-load, 50 percent load, and rated load. The UPS operation shall be as specified herein.

4.6.9 Input current balance. Rated input voltage shall be applied to the UPS balanced to ± 0.5 percent of nominal voltage. The UPS shall be loaded to 15, 50, and 100 percent of rated load balance to ± 0.5 percent of average. The UPS operation shall be as specified herein.

4.6.10 Starting time. The UPS starting time shall be determined with nominal input voltage under no-load and full-load conditions. The test shall be repeated with the input voltage absent. The UPS operation shall be as specified herein.

4.6.11 Grounding. The UPS shall be tested for grounding in accordance with MIL-STD-1399-300.

4.6.12 Voltage and frequency regulation. The UPS shall be connected to an input whose voltage and frequency can be varied as specified in [table IV](#). After the UPS has been stabilized at load, the output steady-state voltage and frequency regulation shall be determined for each of the test conditions (TC) shown in [table IV](#).

TABLE IV. Conditions of input and output.

TC#	Input			Output							
	Voltage & frequency			Rated load (percent)				Power factor			
	Max.	Nom.	Min.	0	50	100	125	lag 0.7	lag 0.8	1.0	lead 0.9
1	X	-	-	X	-	-	-	-	-	-	-
2-3	X	-	-	-	-	X	X	X	-	-	-
4	-	X	-	X	-	-	-	-	-	-	-
5-7	-	X	-	-	X	X	X	X	-	-	-
8-10	-	-	X	-	X	X	X	-	-	X	-
11	-	X	-	-	-	X	-	-	-	-	X

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4.6.13 Steady-state nonlinear load. The UPS shall be operated at nominal input voltage and a balance nonlinear load. The test shall be run with DC loads equal to 25, 50, 70, and 100 percent of the rated UPS capacity. A second series of tests shall be run with loads consisting of equal 0.8 (lagging) p f. and nonlinear loads at 25, 50, 70, and 100 percent of rated UPS capacity. UPS operation shall be as specified herein.

4.6.14 Transient output voltage and recovery. With the UPS 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 ½-load.
- b. From ½-load to rated-load.
- c. From rated-load to ½-load.

The UPS operation shall be as specified herein.

4.6.15 Amplitude and frequency modulation. The UPS output voltage amplitude and frequency modulation shall be determined for test conditions as specified in 4.6.12. The UPS operation shall be as specified herein.

4.6.16 Output voltage waveform. The harmonic content and output voltage spikes shall be determined. For first article, this test shall be performed with the UPS operating under the TC# 1, 2, 7, and 11 as specified in [table IV](#). For conformance test, this test shall be performed under the TC# 2 and 7 as specified in [table IV](#). The UPS operation shall be as specified herein.

4.6.17 Output phase displacement angle. The UPS output displacement angle shall be measured at the output terminals. For first article and conformance tests, this test shall be performed for TC# 2 as specified in [table IV](#). The UPS operation shall be as specified herein.

4.6.18 Output voltage balance under balanced load. After the UPS has been stabilized at rated-load, the output voltage of each phase at the UPS output terminal shall be determined. For first article test, this test shall be performed for TC# 2 and 3 as specified in [table IV](#). For conformance test, this test shall be performed for TC# 2 as specified in [table IV](#). The UPS operation shall be as specified herein.

4.6.19 Output voltage balance under unbalanced load. For the three-phase UPS, the UPS shall be operated with rated input. The output voltage unbalance shall be determined under the conditions of [table I](#). UPS operation shall be as specified herein.

4.6.20 Output voltage regulation (DC). The UPS shall be connected to an input whose voltage and frequency can be varied. After the UPS has been stabilized at load, the output steady-state voltage regulation shall be determined for the test conditions (TC# 1-10) specified in [table V](#).

TABLE V. Conditions of input and output.

TC#	Input			Output			
	Voltage & frequency			Rated load (percent)			
	Max.	Nom.	Min.	0	50	100	125
1-3	X	-	-	X	X	X	-
4-6	-	X	-	X	X	X	-
7-9	-	-	X	X	X	X	-
10	-	X	-	-	-	-	X

The UPS operation shall be as specified herein.

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

- a. For AC output:
 - (1) Rated-load, 0.7 p f. lagging
 - (2) Rated load, unity p.f.
- b. For DC output: rated-load.

The UPS operation shall be as specified herein.

4.6.22 Operating time on battery. The operating time on battery shall be determined with the UPS input power off and output supplying rated load (0.8 p f. lagging for AC outputs). The UPS operation shall be as specified herein.

4.6.23 Efficiency. The battery of the UPS shall be fully charged and the input voltage and frequency shall be at nominal rated values. Efficiency of the UPS shall be measured for 50 percent load and rated-load (0.8 p.f. lagging for AC output). The UPS operation shall be as specified herein.

4.6.24 Over-current protection. The UPS shall be operated at rated input voltage and frequency. For UPS with AC output, the load shall be at unity power factor.

a. The UPS shall maintain rated output voltage during this period. The operating time before transfer to UPS by-pass shall be determined for load currents of 125 percent, 200 percent, and 230 percent.

b. The UPS may reduce output voltage and may limit output current to 230 percent during this period. The operating time before transfer to UPS by-pass shall be determined for a load current of 250 percent.

The UPS operation shall be as specified herein.

4.6.25 Transfer time. The UPS shall be operated with rated input voltage, frequency, and rated-load (0.8 p.f. lagging for AC outputs). The transfer time shall be determined when input power is shut off. The UPS operation shall be as specified herein.

4.6.26 Low voltage shut down. The UPS shall be operated with rated input voltage, frequency, and rated-load (0.8 p.f. lagging for AC outputs). The output voltage shall be determined when the battery capacity is depleted and shut down occurs. The UPS operation shall be as specified herein.

4.6.27 Leakage current. The UPS shall have all input and output (when present) EMI capacitors (if they are connected to the ship's ground potential) disconnected. The leakage current for each EMI capacitor shall be determined at 60 Hz. The UPS operation shall be as specified herein.

4.6.28 Shock. The UPS shall be subjected to a Class I, Type A shock test in accordance with MIL-S-901. Shock test mounting shall be as specified (see 6.2). The equipment shall be energized and operated at the rated-load (0.8 p.f. lagging for AC outputs) during the shock test. The UPS operation shall be as specified herein during and after shock without breakage of parts including mounting bolts.

4.6.29 Vibration. The UPS shall be subjected to the vibration test in accordance with MIL-STD-167-1. The equipment shall be energized and operated at rated-load (0.8 p.f. lagging for AC outputs). The UPS operation shall be as specified herein during and after vibration without breakage of parts including mounting bolts.

4.6.30 Airborne noise. Airborne noise measurements shall be obtained with the UPS operated at rated input voltage and frequency and rated-load (0.8 p f. lagging for AC outputs). The UPS operation shall be as specified herein.

4.6.31 Structureborne noise. Structureborne noise measurements shall be obtained with the UPS operated at rated input voltage and frequency and rated-load (0.8 p.f. lagging for AC outputs). The UPS operation shall be as specified herein.

4.6.32 Electromagnetic interference emission and susceptibility. The UPS shall be tested in accordance with the applicable tests of MIL-STD-461. UPS operation shall be as specified herein.

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4.6.33 High temperature operation. High temperature tests shall be conducted at an ambient temperature of 50 °C. The test shall be conducted as specified in 4.6.33.1 through 4.6.33.4.

4.6.33.1 Assembly and mounting of equipment. The UPS shall be completely assembled and mounted in a manner which simulates shipboard mounting and space restrictions.

4.6.33.2 Operation. The UPS shall be operated at nominal rated input voltage and frequency.

4.6.33.3 Loading. The UPS shall be loaded to 100 percent of rated capacity (0.8 p.f. lagging for AC outputs).

4.6.33.4 Duration of test. The UPS shall be operated continuously for 120 hours. The UPS shall operate as specified herein without any failure.

4.6.34 Inclined operation. The UPS shall be tested for inclined operation at 45 degrees from the horizontal. The UPS shall be run at rated-load (0.8 p.f. lagging for AC outputs) 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.

The UPS shall operate as specified herein.

4.6.35 Humidity. The UPS shall be tested in accordance with MIL-STD-810 and shall operate as specified herein.

4.6.36 Remote operation. If remote operation is specified (see 6.2), the UPS shall be operated at nominal input power and load. Remote operation shall be demonstrated.

4.6.37 Reliability. Reliability shall be certified. MIL-HDBK-781 may be used as a guide.

4.6.38 Maintainability. Maintainability shall be certified. MIL-HDBK-470 may be used as a guide.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. The UPS covered by this specification is intended to provide uninterruptible Navy shipboard electrical power for vital loads. Both AC and DC output power is available.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. When first article is required (3.1).
- c. Output (AC or DC) (see 3.2.2).
- d. If AC output, voltage required (see 3.2.2.a).
- e. If DC output, voltage required (see 3.2.2.b).

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- f. Power rating (see 3.2.3).
- g. Operating time on battery (see 3.2.3.2).
- h. When remote operation is required (see 3.2.7)
- i. If special enclosure width and depth required (see 3.3.3.2).
- j. Packaging requirements (see 5.1).
- k. Shock test mounting location, plane, and orientation (see 4.6.28).

6.3 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 4.2. 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.

6.4 Definitions.

6.4.1 Cabinet. Cabinet is defined as an enclosure that can be a complete stand alone UPS or be one cabinet of a multi-cabinet UPS physically joined to the other cabinets.

6.4.2 Typical nonlinear load. A typical nonlinear load is defined as the load imposed on the UPS by single-phase or three-phase full wave rectifying system.

6.4.3 UPS. The UPS is a power supply that is non-interruptible (see MIL-STD-1399, Section 300). The UPS is also referred to as a no-break power supply.

6.5 Subject term (key word) listing.

Battery back-up

Black-out protection

Brown-out protection

Clean power

Computer power supply

Harmonics

No-break power supply

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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Custodian:

Navy – SH

Preparing Activity:

Navy – SH

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