NOTE: "MIL-STD-2038 is hereby canceled. However, the technical information and the lessons learned from this standard have been preserved in MIL-HDBK-2038. MIL-HDBK-2038 is to be used for guidance only and should not be cited as a requirement, but information in the handbook may be useful in determining or evaluating requirements."

MIL-HDBK-2038
4 OCTOBER 2000

DEPARTMENT OF DEFENSE
MILITARY HANDBOOK

REQUIREMENTS FOR EMPLOYING STANDARD POWER SUPPLIES

AMSC N/A FSC 6130

FOREWORD

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.

2. 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.

CONTENTS

CONTENTS

1. SCOPE

1.1 Purpose. The purpose of this standard is to provide the acquisition activity with specific instructions for implementation of Standard Power Supplies (SPS). This standard also provides instructions for the preparation of an SPS design approval request (see appendix A), procedures for documenting and qualifying SPS (see appendix B), and instructions for preparing specifications and test requirements for power supplies (see appendix C).

1.2 Scope. This standard establishes the requirements for the implementation of SPS in the design and construction of military electronic systems.

1.3 Coordinated program. The Standard Hardware Acquisition and Reliability Program (SHARP) coordinates the efforts of the SPS, the Standard Electronic Modules (SEM), the Standard Enclosure Systems (SES), and the Standard Battery Systems (SBS). These four elements under SHARP form a complete electronic systems hardware methodology for military electronic systems.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards 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

MILITARY

MIL-P-24764	- Power Supplies, Shipboard, Electronic, General Specification for.
MIL-P-29590	- Power Supplies, Airborne, Electronic, General Specification for.
MIL-M-28787	- Modules, Standard Electronic, General Specification for.

STANDARDS

MILITARY

MIL-STD-965	- Parts Control Program.
MIL-STD-1389	- Design Requirements for Standard Electronic Modules.

(Unless otherwise indicated, copies of military specifications and standards are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents. The following other Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NAVMAT P-4855-1A	- Navy Power Supply Reliability, Design and Manufacturing Guidelines.

(Copies of NAVMAT P-4855-1A are available from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 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. DEFINITIONS

3.1 Terms and definitions. The definitions of terms used in this standard are as follows:

(a) SEM Standard Electronic Modules (includes all modules in the SEM).

(b) SEM Design Review Activity (SEM-DRA). The activity which is responsible for the review and approval of SEM designs. (The SEM-DRA function is performed by the Naval Avionics Center, Code 814, Indianapolis, IN 46219-2189.)

(c) Shipboard Power Supply Products (SPSP). This includes power supplies specifically for shipboard applications but may be used in other appropriate shore based and airborne applications. SPSP power supplies are designed in accordance with MIL-P-24764.

(d) Airborne Power Supply Products (APSP). This includes power supplies specifically for airborne applications but may be used in other appropriate shore based and shipboard applications. APSP power supplies are designed in accordance with MIL-P-29590.

(e) Standard Power Supplies (SPS). This includes all shipboard, airborne, and other standard power supplies in the SPSP and APSP.

(f) Equipment Contractor (EC). This term applies to both system developers and developers of electronic power supplies. This term also applies to commands or agencies that are engaged in developing systems or power supplies.

(g) SPSP Quality Assurance Activity (SPSP-QAA). The activity which is responsible for performing SPSP qualification testing and the review and approval of SPSP designs. (The SPSP-QAA function is performed by the Naval Weapons Support Center, Code 6023, Crane, IN 47522-5060.)

(h) APSP Quality Assurance Activity (APSP-QAA). The activity which is responsible for performing APSP qualification testing and the review and approval of APSP designs. (The APSP-QAA function is performed by the Naval Avionics Center, Code 812, Indianapolis, IN 46219-2189.)

(i) Government Program Manager (PM). The Government program manager who is initiating the particular system application.

(j) Design Approval Request (DAR). A data item necessary to identify and justify a new design for a power supply. DARs for SPS are described in appendix A.

(k) Command or agency concerned. The organizational element of the Government which contracts for articles, suppliers, or services, or a contractor or subcontractor when the organizational element of the Government has given specific written authorization to such a contractor or subcontractor to serve as agent for the Command or Agency concerned.

(l) Correlation. Correlation is the methodology for proving that a military power supply type with a specific part or identification number (PIN) can be tested on a specific power supply production tester. All testers for a specific power supply PIN should yield results which are comparable within calculated tolerances. The tolerances are based upon the limits of each electrical parameter in the associated detail specification.

(m) Preparing activity. The military activity or the Federal civil agency (for Federal documents only) responsible for preparation and maintenance of standardization documents or the conduct of study projects.

4. GENERAL REQUIREMENTS

4.1 General. When this standard is invoked, all power supply functions shall be implemented with SPS, designed in accordance with SPSP for shipboard applications and APSP for airborne applications.

4.2 Priority of implementation. Power supplies shall be implemented in accordance with the priority sequence in 4.2.1 through 4.2.3.

4.2.1 Existing SPS standards. The EC shall initially attempt to implement system power supply requirements with existing SPS.

4.2.2 In-process SPS standards. The EC shall coordinate with the SPSP-QAA and APSP-QAA to determine whether there are any new power supplies being developed within SPS for which documentation has not been released. In the event that there is an applicable design whose completion schedule will not impose unmanageable scheduling incompatibility, the power supply shall be used in lieu of proposing the development of an alternate design.

4.2.3 New SPS designs. New SPS designs shall be proposed only under one of the exceptions specified in 4.2.3.1 or 4.2.3.2 (see 6.3).

4.2.3.1 Circuit functional requirements. New SPS designs shall be proposed when a system partitioning analysis shows that a system function cannot be implemented and system operating parameters cannot be achieved by utilizing existing SPS.

4.2.3.2 Cost effectiveness requirements. A new design shall be proposed in lieu of an applicable existing SPS where substantial cost savings (of at least 25 percent) will result. It shall be demonstrated through a detailed cost analysis that on a life cycle cost basis, the use of a new SPS design is more cost effective than an existing design. This cost analysis shall directly compare the cost of implementing the required system function with existing SPS versus the new SPS design.

4.3 Design requirements for new SPS. New SPS designs shall be developed in accordance with the following requirements:

4.3.1 Maximum flexibility. The design of SPS shall be such that each power supply can be utilized in the broadest range of system applications that is reliably feasible and cost effective.

4.3.2 Proprietary parts or processes and non-standard parts. SPS designs shall not utilize proprietary parts, processes, or techniques that will result in restricting or eliminating additional power supply manufacturers. Proprietary parts are considered to be non-standard parts. Non-standard parts documentation is required in accordance with MIL-STD-965 (see 6.3). Performance parameters of proprietary parts shall be disclosed to the extent necessary to allow computer circuit modeling of the power supply.

4.3.3 Repairability. SPS shall be designed to the maximum extent possible to be repairable. Power supply components (including proprietary parts) shall be selected and specified such that they may be readily acquired by repair activities other than or in addition to the original power supply manufacturer. The EC shall determine the maintenance requirements (see 6.3) for test, fault isolation, and repair of the power supplies.

4.4 Design requirements for other power supplies. Power supplies which are not appropriate for inclusion in SPSP or APSP as an SPS supply due to application requirements, form factors, and so forth shall be designed in accordance with the guidelines of NAVMAT P-4855-1A. Compliance with NAVMAT P-4855-1A shall be supported by analyses (see 6.3). Justification and rationale for exclusion from SPSP and APSP shall include the DAR information (see 6.3).

4.5 Standards. All power supplies included in the SPS are considered to be standard. This includes all allowable form factors for SPSP and APSP.

5. DETAILED REQUIREMENTS

5.1 SPS form factors. There are three basic form factors that shall be applied in the design and development of SPS. These form factors include module formats, SPSP family S2 and APSP family A2, compatible with SEM configurations (see 5.2) specified in MIL-STD-1389; shipboard SPSP family S1 case styles (see 5.3) specified in MIL-P-24764; and airborne APSP family A1 styles (see 5.4) specified in MIL-P-29590. Any SPS power supply designed in one of the basic form factors may be used in shipboard, airborne, or other appropriate applications, but shall be designed and specified to meet the requirements of those applications.

5.2 SEM compatible configuration requirements. SPS module power supply configurations shall be compatible with SEM module formats and shall meet the requirements of 5.2.1 through 5.2.4.

5.2.1 SEM compatible module requirements for SPSP applications. SEM compatible power supply module design requirements for SPSP applications shall be in accordance with MIL-P-24764 family S2. The modules shall be designed utilizing any of the allowable module formats specified in MIL-STD-1389.

5.2.2 SEM compatible module requirements for APSP applications. SEM compatible power supply module design requirements for APSP applications shall be in accordance with MIL-P-29590 family A2.

5.2.3 SEM compatible module quality assurance requirements. A SEM compatible power supply module shall conform to the quality assurance requirements specified in MIL-M-28787 and as modified in MIL-P-24764 or MIL-P-29590.

5.2.4 SEM compatible module documentation requirements. A SEM compatible power supply module shall be documented in accordance with appendix C unless otherwise specified by the APSP-QAA or SPSP-QAA (see 6.3). Power supply requirements shall be functionally specified and shall not be written such that manufacturing competition is restricted.

5.3 SPSP requirements. An SPSP supply is part of a family of electronic switching mode power supplies for use in naval ship and shore systems including combat and other mission critical applications.

5.3.1 SPSP design requirements. SPSP power supplies shall be designed in accordance with the requirements of MIL-P-24764.

5.3.2 SPSP quality assurance requirements. SPSP power supplies shall conform to the quality assurance requirements specified in MIL-P-24764.

5.3.3 SPSP documentation requirements. SPSP power supplies shall be documented in accordance with appendix C unless otherwise specified by the SPSP-QAA (see 6.3). Power supply requirements shall be functionally specified and shall not be written such that manufacturing competition is restricted.

5.4 APSP requirements. An APSP power supply is part of a family of electronic switching mode power supplies for use in airborne systems including combat and other mission critical applications.

5.4.1 APSP design requirements. APSP power supplies shall be designed in accordance with the requirements of MIL-P-29590.

5.4.2 APSP quality assurance requirements. APSP power supplies shall conform to the quality assurance requirements specified in MIL-P-29590.

5.4.3 APSP documentation requirements. APSP power supplies shall be documented in accordance with appendix C unless otherwise specified by the APSP-QAA (see 6.3). Power supply requirements shall be functionally specified and shall not be written such that manufacturing competition is restricted.

5.5 Documentation and qualification procedure. The procedure for documenting and qualifying new SPS supplies shall be in accordance with appendix B (see 6.3). The procedure for new SEM compatible power supply documentation and qualification (whether SPSP or APSP) to be followed shall be that which best addresses the initial application requirements.

6. NOTES

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

6.1 Intended use. This standard contains requirements for implementation and specification of standard power supplies for military electronic systems.

6.2 Issue of DoDISS. When this standard is used in acquisition, the issue of the DoDISS to be applicable to the solicitation must be cited in the solicitation (see 2.1.1).

6.3 Data requirements. The following Data Item Descriptions (DID's) must be listed, as applicable, on the Contract Data Requirements List (DD Form 1423) when this standard is applied on a contract, in order 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
4.2.3,4.4, Appendix A	DI-GDRQ-80650	Design Data and Calculations	----
4.3.2	DI-MISC-80071	Parts Approval Requests	----
4.3.3	DI-T-25837	Document, Maintenance Requirement	10.4.3f Applies Without Exceptions
5.2.4,5.3.3, 5.4.3,5.5	DI-SDMP-80001	Military Specification	----
5.2.4,5.3.3, 5.4.3,5.5, Appendix B	DI-MISC-80678	Certification/Data Report	10.3.1 Applies

The above DID's were those cleared as of the date of this standard. 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 Waivers, deviations, or exceptions. A contractor or subcontractor serving as agent for the Command or Agency concerned does not have the authority to grant waivers, deviations, or exceptions to this document. Any waiver, deviation, or exception to this document must have written government approval.

6.5 Subject term (keyword) listing.

Modules, Standard Electronic
Standard Electronic Modules
SEM
Standard Hardware Acquisition and Reliability Program
Power Supplies
Shipboard Power Supply Products
Airborne Power Supply Products
SPS
SPSP
APSP
SHARP

APPENDIX A

DESIGN DATA AND CALCULATIONS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the information that shall be included in the design data and calculations when required by the contract or order. This appendix is applicable only when data item description DI-GDRQ-80650 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESIGN DATA and CALCULATIONS

30.1 Design approval request (DAR). When required by the contract or order, the design data and calculations shall contain the DAR information requested on figure 1 in its entirety. The DAR shall be submitted to SPSP-QAA or APSP-QAA as appropriate for review and approval.

30.2 NAVMAT P-4855-1A compliance. When required by the contract or order, the design data and calculations to support NAVMAT P-4855-1A compliance shall contain the following information:

(a) Circuit schematics
(b) Component selection
(c) Component stress analysis and derating
(d) Thermal analysis
(e) Stability analysis
(f) Reliability prediction
(g) Structural analysis (vibration, shock, dimensions)
(h) EMI analysis (emissions, susceptibility)

30.3 Exclusion justification. When required by the contract or order, the design data and calculations for exclusion justification shall contain the information requested on figure 1 in its entirety. The exclusion justification shall include technical requirements rationale as well as life cycle cost calculations comparing SPS implementation versus non-SPS implementation. The exclusion justification shall be submitted to SPSP-QAA or APSP-QAA as appropriate and the Command or Agency concerned for review and approval.

APPENDIX A

STANDARD POWER SUPPLY

DESIGN APPROVAL REQUEST

DAR NUMBER_____FOR
DATE RECEIVED_____DRA
PROGRAM_____USE
KEY CODE_____ONLY
DETAIL SPECIFICATION NO.
_____
INPUT_____
OUTPUT VOLTAGE/CURRENT
_____

INITIATOR INFORMATION:

ACTIVITY NAME_____
ADDRESS_____
_____
NAME OF COGNIZANT INDIVIDUAL_____
PHONE NUMBER_____
INITIAL SYSTEM APPLICATION_____

In order to uniquely identify this system, the system information on the final pages of this DAR must be completed when the first DAR for this system is submitted.

Will this power supply be designed in accordance with MIL-P-24764 or MIL-P-29590?_____

If not, give exceptions.
_____

POWER SUPPLY INFORMATION: Identification number (reference DAR, assembly and so forth)?_____
(for correspondence purposes)

INPUT_____ OUTPUT_____
TYPE: SPSP_____ APSP_____
DRAWING ASSY NO._____ CODE IDENT._____
CASE SIZE/SEM COMPATIBLE FORMAT_____
OUTPUT POWER DENSITY_____
_____
COMPONENT INFORMATION: (Control circuits, switching devices, non-standard parts)_____
FUNCTION, TECHNOLOGY, PACKAGE TYPE, VENDOR AND PART NUMBER, ALTERNATE VENDORS, AND PART NUMBERS
_____
_____
(Use additional sheets if necessary)

FIGURE 1. Design approval request data.

WILL PROPRIETARY DESIGN, PARTS OR PROCESSES BE USED?___YES___NO

IF YES, IDENTIFY_____

_____

_____

POWER SUPPLY QUANTITY PER SYSTEM APPLICATION_____

NUMBER OF SYSTEMS CONTRACTED_____

ESTIMATED SPS PRODUCTION UNIT COST_____

WHICH EXISTING SPS HAVE BEEN CONSIDERED FOR THE IMPLEMENTATION OF THIS FUNCTION? SPECIFICALLY LIST WHY EACH CANNOT BE USED.

_____

_____

_____

ESTIMATED COMPLETION DATE:

DESIGN_____

PROTOTYPE_____

POWER SUPPLY SPECIFICATION_____

PRODUCTION READINESS_____

_____

_____

SPECIAL PERFORMANCE REQUIREMENTS DESCRIPTION
(TYPICALLY THE DESCRIPTION SHALL INCLUDE, AS APPLICABLE, SPECIAL OR UNIQUE INPUT/OUTPUT REQUIREMENTS AND RELATIONSHIPS SUCH AS LOW NOISE OUTPUTS, SPECIALIZED OUTPUT PROTECTION SCHEMES, ETC.)

FIGURE 1. Design approval request data - Continued.

APPENDIX A

ELECTRICAL INTERFACE DIAGRAM

(AN ELECTRICAL INTERFACE DIAGRAM SHALL BE INCLUDED, DENOTING PIN ASSIGNMENTS (IF KNOWN), ALL INPUT AND OUTPUT FUNCTIONS, AND RELATIONSHIPS OF RETURN SIGNALS (i.e., COMMON RETURNS)).

FIGURE 1. Design approval request data - Continued.

APPENDIX A

SYSTEMS INFORMATION SECTION

Name and nomenclature of this system/equipment. (Please define acronyms)_____

_____

_____

List other names which also identify this system/equipment._____

_____

_____

Please give a brief description of this system/equipment._____

_____

_____

Is this equipment a part of another equipment, or made up of several different sub-equipment units (cabinets, and so forth) or is it an update of an existing equipment? If so, please explain the relationship._____

_____

What is the cognizant Government activity?

Activity name_____
Activity address_____

Who is the cognizant Government code?

Code_____
Address_____
Telephone_____

Government contract number_____

What is the schedule for this system/equipment?_____

Prototype request for bids (RFB) date?_____

Prototype delivery date?_____

Production RFB date?_____

First production delivery date?_____

FIGURE 1. Design approval request data - Continued.

APPENDIX A

Who is the prime equipment contractor?
Company name_____
Division_____
Address_____
_____
Cognizant individual_____
Telephone_____

Name of subcontractor(s) for major subassemblies (involving new power supply designs)?
Company_____
Division_____
Address_____
_____
Cognizant individual_____
Telephone_____

How many equipment units will be produced?
During prototype phase_____
During production phase_____

Where will this equipment be installed? Describe each different installation. (Indicate whether airborne, surface, submarine or shore based)_____
_____
_____

How many systems will be installed at each different type of installation?_____
_____

What power supply types and how many of each will be used in each system?_____
_____

Will each installation of this system contain the same complement of power supplies or will each installation be entirely different? (Please explain)?_____
_____

If you need assistance please contact:

Naval Avionics Center
Code 812
Indianapolis, IN 46219-2189
Telephone (317) 353-7812
Autovon 369-7812

Naval Weapons Support Center
Code 6023
Crane, IN 47522-5060
Telephone (812) 854-3827
Autovon 482-3827

FIGURE 1. Design approval request data - Continued.

APPENDIX B

CERTIFICATION/DATA REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the information that shall be included in the certification/data report when required by the contract or order. This appendix is applicable only when data item description DI-MISC-80678 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. CERTIFICATION/DATA REPORT

30.1 SPSP documentation and qualification procedure. When required by the contract or order, the certification/data report procedure for SPSP documentation and qualification shall contain the elements, data, processes and approvals shown on figure 2. The functions of the elements shown on figure 2 are as follows:

BLOCK 1. The EC shall complete and forward the DAR (in accordance with appendix A) concurrently to the APSP-QAA, SPSP-QAA, and the PM or Command or Agency concerned for each new design proposed. Submission of the DAR shall be made within 60 calendar days after award of contract and at least 60 calendar days prior to the power supply Preliminary Design Review (PDR). In addition, updated DARs shall be submitted within 14 calendar days after additional requirements are realized.

BLOCKS 2 and 3. Within 25 working days of receipt of each DAR, the SPSP-QAA will coordinate with the PM or Command or Agency concerned and forward the DAR action notification to the EC and the PM. If the DAR is approved, the following will be indicated on the action notification.

(a) Key code (assigned by SEM-DRA).

(b) Detail specification number.

If the DAR is disapproved, the action notification will provide the rationale for the disapproving action. The EC shall notify the APSP-QAA, SPSP-QAA, and the PM or Command or Agency concerned at periodic intervals, not to exceed 90 days, as to the current design status of power supplies with approved DARs. Status notification shall continue until initial qualification samples are submitted to the qualification activity.

APPENDIX B

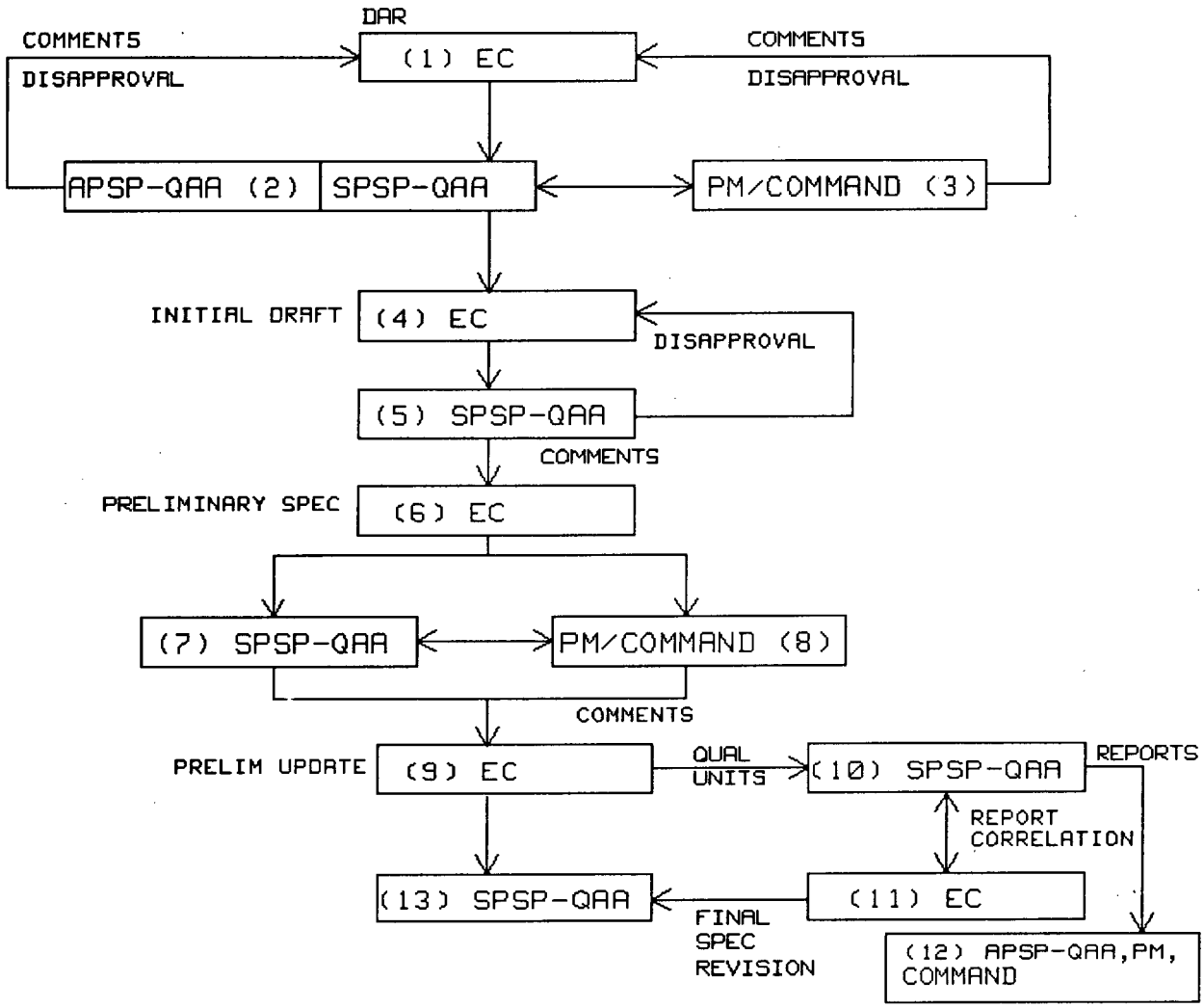

FIGURE 2. SPSP documentation and qualification procedure.

APPENDIX B

BLOCK 4. The EC proposing a new power supply design shall develop the appropriate detail specification in accordance with appendix C. The EC shall submit an initial rough draft detail specification to the SPSP-QAA for review and comment prior to the preparation of the preliminary detail specification. The EC proceeds with the power supply design.

BLOCK 5. The SPSP-QAA reviews the initial draft and comments to the EC.

BLOCK 6. The EC prepares the preliminary detail specification and submits it to the SPSP-QAA and PM or Command or Agency concerned.

BLOCKS 7 and 8. The SPSP-QAA and the PM or Command or Agency review the preliminary detail specification and submit comments to the EC.

BLOCK 9. The EC shall submit the appropriate number of power supply samples and the preliminary specification to the qualification activity for initial qualification in accordance with MIL-P-24764. At the same time, a copy of the preliminary detail specification shall be submitted to the SPSP-QAA for review and revision control. In addition, the EC shall submit to the qualification activity, either prior to or along with the initial qualification samples, the design documentation required by MIL-P-24764. This documentation includes, but is not limited to thermal analysis, failure rate prediction with stress analysis, design drawings, theory of operation, repair troubleshooting procedures, non-standard parts lists, and quality control plan. At least 90 calendar days prior to submission of samples and preliminary detail specification, the EC shall give the qualification activity a notice of intent to submit for initial qualification testing.

BLOCK 10. The SPSP-QAA performs initial qualification on the submitted power supplies and submits the results to the EC, the APSP-QAA, and the PM or Command or Agency concerned. The SPSP-QAA performs correlation testing utilizing the submitted power supplies. Qualification status information is maintained by the SPSP-QAA. The time required to complete qualification procedures for SPS will not exceed 120 days after receipt of the samples at the qualification activity unless the samples fail to meet the specification requirements. The occurrence of failures will cause the length of qualification time to vary depending on the extent of failures and the

required analysis and corrective action. All power supplies submitted for initial qualification will be retained by the qualification activity, unless otherwise agreed to in writing by the PM (or Command or Agency concerned) and the qualification activity.

BLOCK 11. The EC shall make all necessary corrections to the design and documentation or construction, or both, and resubmit samples for qualification or revised detail specification, or both, to the qualification activity. Depending on the extent of the corrections, the original qualification samples may be revised and resubmitted for verification of the corrective action in lieu of requiring submission of new samples. This determination will be made by the qualification activity after the corrective actions have been defined by the EC. The EC shall prepare the final detail specification. The final detail specification shall include recommendations made as a result of design reviews and test data. The EC shall submit copies of the final detail specification to SPSP-QAA for review.

BLOCK 12. The PM or Command or Agency concerned receives test reports for use in decisions concerning a particular system application.

BLOCK 13. The SPSP-QAA maintains revision control of the preliminary specification during qualification activities. The SPSP-QAA reviews and forwards the final detail specification to the preparing activity for approval and distribution.

30.2 APSP documentation and qualification procedure. When required by the contract or order, the certification/data report procedure for APSP documentation and qualification shall contain the elements, data, processes and approvals shown on figure 3. The functions of the elements shown on figure 3 are as follows:

BLOCK 1. The EC shall complete and forward the DAR (in accordance with appendix A) concurrently to the APSP-QAA, SPSP-QAA, and the PM or Command or Agency concerned for each new design proposed. Submission of the DAR shall be made within 60 calendar days after award of contract and at least 60 calendar days prior to the power supply Preliminary Design Review (PDR). In addition, updated DARs shall be submitted within 14 calendar days after additional requirements are realized.

APPENDIX B

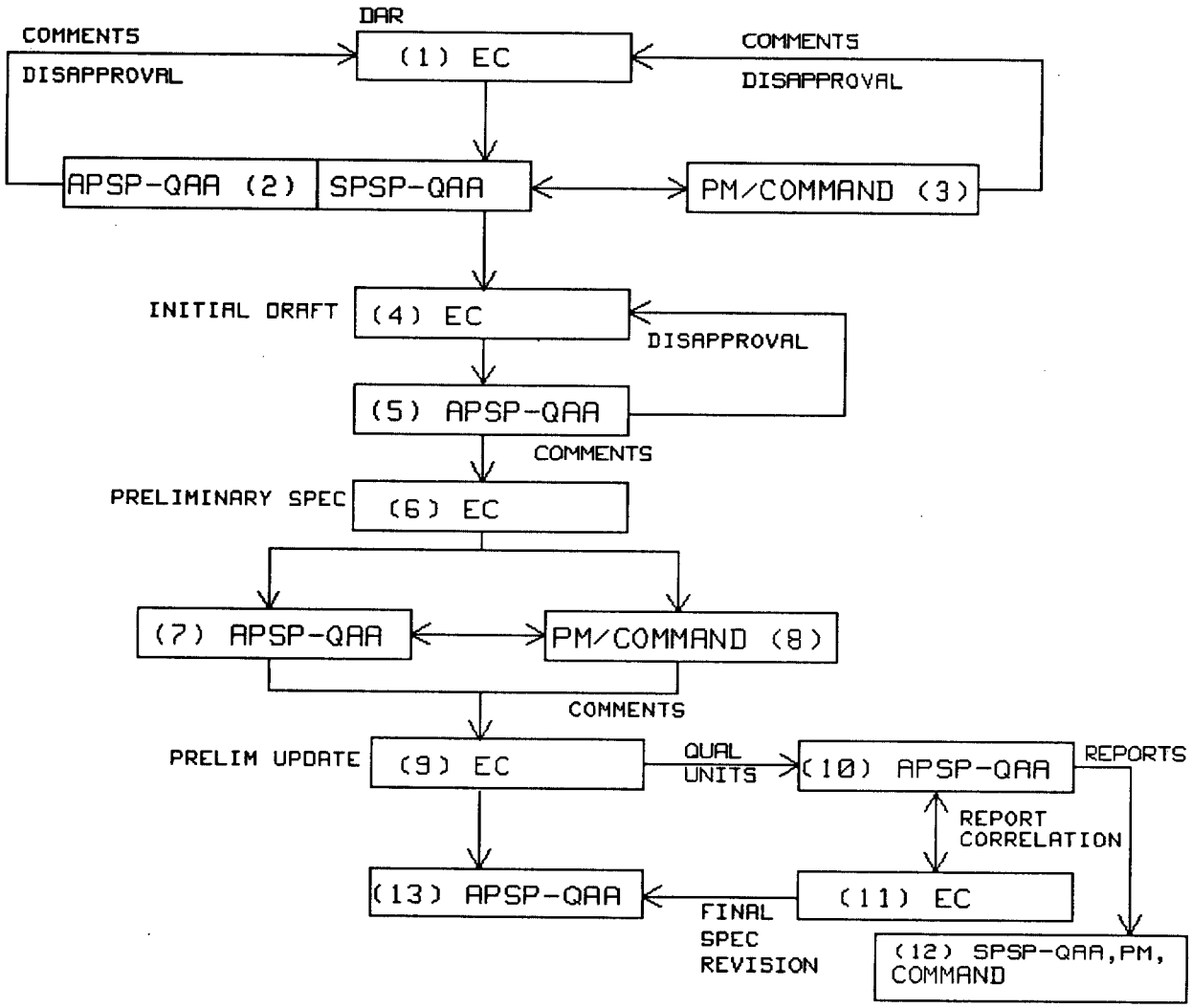

FIGURE 3. APSP documentation and qualification procedure.

APPENDIX B

BLOCKS 2 and 3. Within 25 working days of receipt of each DAR, the APSP-QAA will coordinate with the PM or Command or Agency concerned and forward the DAR action notification to the EC and the PM. If the DAR is approved, the following will be indicated on the action notification:

(a) Key code (assigned by SEM-DRA).

(b) Detail specification number.

If the DAR is disapproved, the action notification will provide the rationale for the disapproving action. The EC shall notify the APSP-QAA, SPSP-QAA, and the PM or Command or Agency concerned at periodic intervals, not to exceed 90 days, as to the current design status of power supplies with approved DARs. Status notification shall continue until initial qualification samples are submitted to the qualification activity.

BLOCK 4. The EC proposing a new power supply design shall develop the appropriate detail specification in accordance with appendix C. The EC shall submit an initial rough draft detail specification to the APSP-QAA for review and comment prior to the preparation of the preliminary detail specification. The EC proceeds with the power supply design.

BLOCK 5. The APSP-QAA reviews the initial draft and comments to the EC.

BLOCK 6. The EC prepares the preliminary detail specification and submits it to the APSP-QAA and PM or Command or Agency concerned.

BLOCKS 7 and 8. The APSP-QAA and the PM or Command or Agency review the preliminary detail specification and submit comments to the EC.

BLOCK 9. The EC shall submit the appropriate number of power supply samples and the preliminary specification to the qualification activity for initial qualification in accordance with MIL-P-29590. At the same time, a copy of the preliminary detail specification shall be submitted to the APSP-QAA for review and revision control. In addition, the EC shall submit to the qualification activity, either prior to or along with the initial qualification samples, the design documentation required by MIL-P-29590. This documentation includes, but is not limited to, thermal analysis, failure rate prediction with stress analysis, design drawings, theory of operation, repair

troubleshooting procedures, non-standard parts lists, and quality control plan. At least 90 calendar days prior to submission of samples and preliminary detail specification, the EC shall give the qualification activity a notice of intent to submit for initial qualification testing.

BLOCK 10. The APSP-QAA performs initial qualification on the submitted power supplies and submits the results to the EC, the SPSP-QAA and the PM or Command or Agency concerned. The APSP-QAA performs correlation testing utilizing the submitted power supplies. Qualification status information is maintained by the APSP-QAA. The time required to complete qualification procedures for SPS will not exceed 120 days after receipt of the samples at the qualification activity unless the samples fail to meet the specification requirements. The occurrence of failures will cause the length of qualification time to vary depending on the extent of failures and the required analysis and corrective action. All power supplies submitted for initial qualification will be retained by the qualification activity, unless otherwise agreed to in writing by the PM (or Command or Agency concerned) and the qualification activity.

BLOCK 11. The EC shall make all necessary corrections to the design and documentation or construction, or both, and resubmit samples for qualification or revised detail specification, or both, to the qualification activity. Depending on the extent of the corrections, the original qualification samples may be revised and resubmitted for verification of the corrective action in lieu of requiring submission of new samples. This determination will be made by the qualification activity after the corrective actions have been defined by the EC. The EC shall prepare the final detail specification. The final detail specification shall include recommendations made as a result of design reviews and test data. The EC shall submit copies of the final detail specification to APSP-QAA for review.

BLOCK 12. The PM or Command or Agency concerned receives test reports for use in decisions concerning a particular system application.

BLOCK 13. The APSP-QAA maintains revision control of the preliminary specification during qualification activities. The APSP-QAA reviews and forwards the final detail specification to the preparing activity for approval and distribution.

APPENDIX C

INSTRUCTIONS FOR PREPARING POWER SUPPLY SPECIFICATIONS

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard and is to be used in the preparation of detail specifications for Standard Power Supplies. This appendix does not attempt to completely specify how a power supply shall be designed or tested, but describes the typical information that shall be included in the detail specification in conjunction with the requirements specified in this standard and the format for presenting the information. MIL-P-24764 and MIL-P-29590 contain specific electrical, mechanical and environmental requirements for SPS. All appropriate detailed requirements for each power supply shall be addressed by its detailed specification.

10.2 Classification. The specifications covered by this appendix shall be of the following types:

Military specifications in accordance with MIL-STD-961.

20. APPLICABLE DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified:

SPECIFICATIONS

MILITARY

MIL-P-24764/1	- Power Supplies, Shipboard, Electronic, 5 Volt, Key Code AA3A

STANDARDS

MILITARY

MIL-STD-461	- Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-961	- Military Specifications and Associated Documents, Preparation of.

(Unless otherwise indicated, copies of military specifications and standards are available from the Standardization Documents

Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. For specific acquisition functions, these documents should be obtained from the contracting activity or as directed by the contracting activity.)

30. GENERAL REQUIREMENTS

30.1 General requirements. Specifications prepared in accordance with this appendix shall be the documents used for the acquisition and testing of power supplies. Information, in addition to that required by this appendix, may be added to the detail specification as required for the acquisition and testing of a particular power supply.

30.1.1 Types of specifications. Military specifications prepared for SPS in accordance with this appendix shall comply with MIL-STD-961. An example of a functional specification for an SPS power supply is MIL-P-24764/1.

30.1.2 Style, format, and identification. The style, format, and identification of the detail specification shall be as specified in MIL-STD-961 and this appendix.

30.2 Test requirements. This appendix shall be used to assist in determining which tests shall be included in the detail specification and how these tests shall be implemented and performed. All pertinent electrical requirements in MIL-P-24764 or MIL-P-29590 shall be tested.

30.2.1 Types of electrical tests. There are two types of electrical tests performed by the EC. These tests are 100 percent (X) tests and sample (S) tests. The X tests are performed on all power supplies and are generally static tests. The S tests are performed on 1 percent or a minimum of two supplies from each inspection lot and generally include stress and dynamic tests. There are three types of electrical tests performed by the SPSP-QAA. These tests are 100 percent (X) tests, sample (S) tests, and qualification (Q) tests. Qualification (Q) tests are generally tests which check the power supply design such as common mode current and output impedance. The test type of each test condition will be reviewed for acceptance during the SPSP-QAA or APSP-QAA review of the specification. Stress tests are those electrical tests which apply potentially stressful conditions to the power supply. For example, isolation tests are considered to be stress tests because of the high voltage applied between theoretically isolated circuits.

30.2.2 Test limits. Limits for all tests shall come from MIL-P-24764 and MIL-P-29590 or power supply usage criteria where applicable. Limits shall be modified as necessary for special test configurations. When limits are not specified in MIL-P-24764 or MIL-P-29590 and usage criteria is not available, engineering judgement and experimental data shall be used to determine the applicable limits. All tests shall have minimum and maximum limits specified.

30.2.3 Order of testing. An order of testing paragraph shall be included in the detail specification and shall specify that the isolation tests and other stress tests, when required, shall be performed first in any sequence of electrical tests. All other tests in a sequence may be performed in any order unless otherwise specified in this paragraph. During quality conformance inspection testing, the performance of isolation and other stress tests shall be followed by the performance of, at a minimum, all 100 percent (X) tests.

30.2.4 Environmental tests. Those environmental tests which require the power supply to be operated during the exposure or which require special instructions or procedures shall be described in the detail specifications. The detail specifications shall include operating requirements for the environmental tests listed in 30.2.4.1 through 30.2.4.4. Other unique environments such as the dripproof test for shipboard applications will also require appropriate operating instructions in the detail specifications.

30.2.4.1 Operating temperature test conditions. The operating temperature test in MIL-P-24764 and MIL-P-29590 shall be performed with the power supply at nominal input voltage. The power supply outputs shall be loaded as specified in the detail specification. Before starting this test, all initial electrical tests shall be performed in the order specified in the order of testing paragraph (see 30.2.3) using the initial limits at 25 $\pm$ 5°C ambient. When electrical testing is called for at the end of each temperature stabilization period, all applicable X, S, and Q nonstress tests shall be performed in the order specified in the order of testing paragraph (see 30.2.3) using the initial limits for the applicable operating temperature. At all other times during this test, the power supply shall be operated as shown on the operating temperature test circuit which appears in the detail specification.

30.2.4.2 Component temperature test. The component temperature test shall be performed in accordance with MIL-P-24764 or MIL-P-29590. The power supply shall be operated as shown on the operating temperature test circuit.

30.2.4.3 Long term stability test conditions. The long term stability test shall be performed with the power supply input at nominal voltage. The power supply shall be operated at maximum mounting surface temperature. All outputs shall be loaded with maximum rated load unless otherwise specified in the detail specification. Following the test and while still at the maximum temperature, the output voltage shall be measured and compared with pre-test measurements to determine output voltage stability. Following the return of the power supply to 25°C, all applicable nonstress tests shall be performed in the order specified in the order of testing paragraph (see 30.2.3) using the 25 $\pm$ 5°C ambient end-of-life limits.

30.2.4.4 Shock and vibration test conditions. The shock and vibration tests in MIL-P-24764 or MIL-P-29590 shall be performed with the power supply input at nominal voltage. The outputs shall be loaded with a minimum of 10 percent of maximum rated load. Following each test, all X tests shall be performed using the initial limits at 25 $\pm$ 5°C ambient.

30.2.5 Test tables. Test tables are used to convey necessary information. Figures 4 and 5 are examples of test tables used for line regulation tests and ripple tests.

30.2.6 Test figures. Test figures are used to convey needed information or to clarify a test. Their use shall be limited to these areas.

30.2.7 Functional block diagram. A sample power supply functional block diagram is shown on figure 6.

APPENDIX C

TABLE XX. Line regulation test.

Test cond	Parameter	Output load current	Input volts	Output program pins	Initial limits 25 ± 5°C ambient		Unit	Test fig
					Min	Max		

FIGURE 4. Example of a line regulation test condition table.

APPENDIX C

TABLE XXX. Ripple test.

Test cond	Parameter	Measurement		Input voltage	Initial limits 25 ± 5°C ambient		Unit	Test fig
		Device	Freq		Min	Max		

FIGURE 5. Example of a ripple test condition table.

APPENDIX C

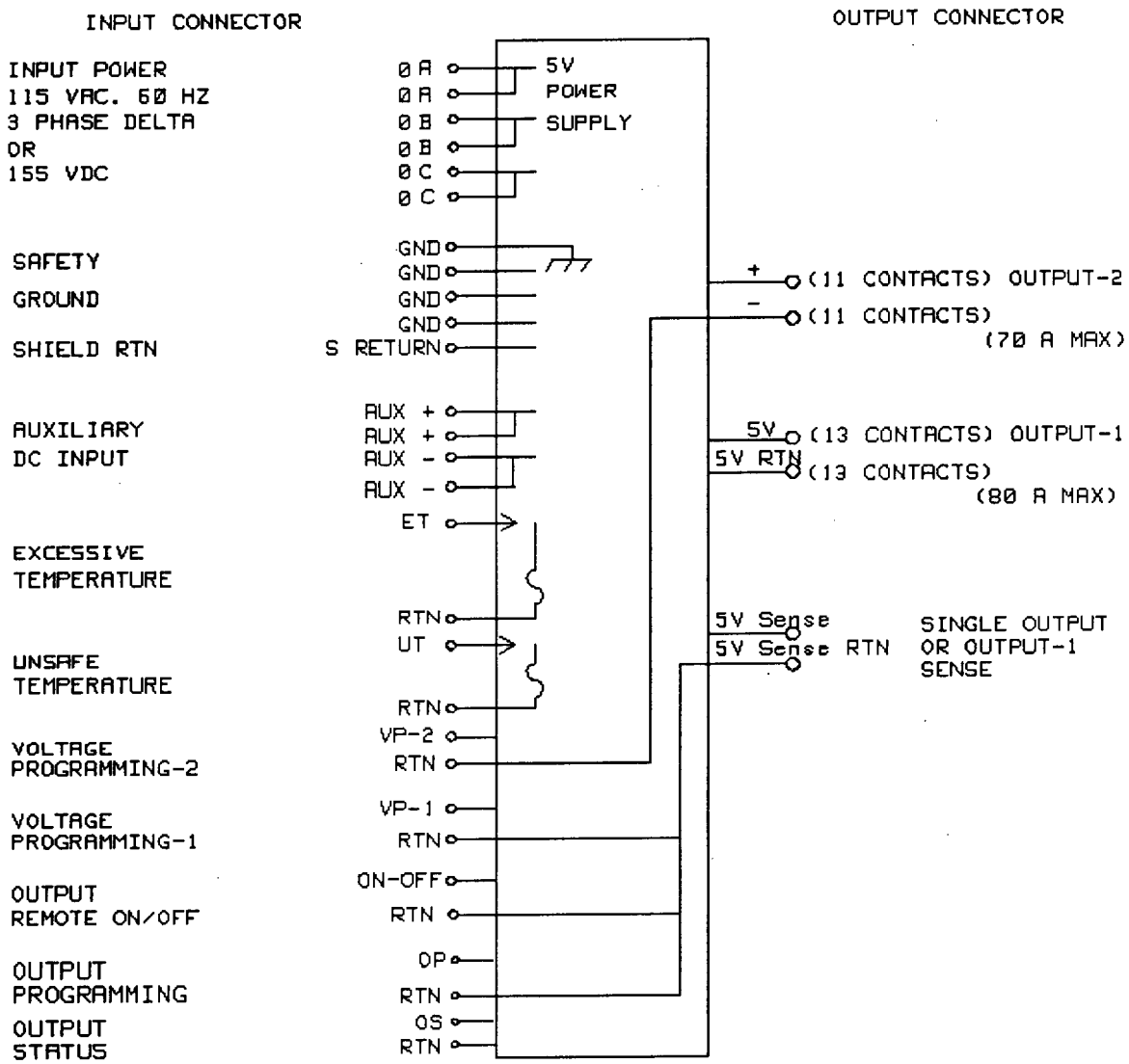

FIGURE 6. Example of an SPSP function diagram.

APPENDIX C

40. DETAILED REQUIREMENTS

40.1 Detailed requirements. Unless otherwise specified, the following tests shall be performed. Other tests not listed may be added if they are necessary to characterize the power supply function. Many of the tests will have multiple conditions, each of which must be tested, and the test type (X, S, or Q) of each condition may vary from other conditions. The EC's recommended test type (X, S, or Q) designation for each test condition shall be based on the test types specified in the following paragraphs. Optional test type selections are allowed in some cases and the EC may recommend the types that are most appropriate for the particular power supply and the particular test conditions.

40.1.1 Unused pin and circuit isolation. If the power supply has unused pins, this test shall be performed to ensure isolation between used and unused pins. It shall also be performed to ensure isolation between circuits which have no common connections (input to output, input to chassis, output to chassis, Built-In-Test (BIT) circuitry, etc). Isolation shall be checked using a megohm bridge with the voltage set according to the detail specification. The minimum initial limit shall be 10 megohms and the minimum end-of-life limit shall be 1 megohm. The maximum limits shall be infinity. This is a stress test but shall be X tested and shall be one of the first tests run.

40.1.2 Pin-to-pin continuity. If the power supply has multiple pins which are internally tied together, this shall be performed to ensure that the connections exist. The continuity shall be checked using an ohmmeter. The maximum resistance shall be 1 Ohm. Perform as an X test. If a tighter limit of 0.1 Ohm is required, it may be specified either as an X test, S test, or as a Q test depending on the application.

40.1.3 Chassis continuity. If the power supply has a chassis ground pin, the continuity shall be checked between this pin and the chassis. The continuity shall be checked using an ohmmeter. The maximum resistance shall be 1 Ohm. This shall be an X test. A tighter limit of 0.1 Ohm is also required and shall be performed as a Q test.

40.1.4 Load regulation. This test is a measure of the output voltage variance under different load conditions. The load shall be changed from no load (or minimum load) to full load while measuring the output voltage. If there are multiple outputs, all shall be measured as above as well as measuring that a load change on one output has a minimal effect on another

output (cross regulation). Power supply turn on with no load shall be verified during load regulation testing. The input voltage shall be set at a nominal value. This shall be an X test.

40.1.5 Line regulation. This test is a measure of the output voltage variance with a change in input voltage. The input test voltage shall be the worst case minimum and maximum allowed and shall vary in frequency over the range allowed. The load shall be set at minimum and at maximum for each input test voltage. These tests shall be performed as X and S tests except for line frequency variation tests which shall be Q tests.

40.1.6 Low input voltage. This test applies a slowly increasing (and decreasing) input voltage to the power supply to verify the immunity of the power supply to damage due to operation at low input voltage conditions. The output load(s) shall be set at maximum. Perform as an X, S or Q test.

40.1.7 Loss of phase protection. This test checks the power supply susceptibility to damage due to the loss of one or more phases of a three phase input. Perform as an X, S or Q test.

40.1.8 Efficiency. This test is intended to measure the efficiency of the power supply. Using wattmeters which are not limited by nonsinusoidal waveforms, measure the input power at nominal input voltage. Determine the output power by measuring output voltage at maximum rated load current. Perform this test as an X test. Also, measure efficiency at light (10 percent) load current. Perform this test as an S test.

40.1.9 Power factor. This test measures the input power factor for alternate current (AC) inputs. Using a wattmeter which is not limited by nonsinusoidal waveforms, measure the input power at nominal input voltage and maximum load current. Power factor is determined from the ratio of real power (wattmeter reading) to apparent power (function of rms line voltages times rms line currents). Perform as an S or Q test.

40.1.10 Input current. Input current parameters to be tested include the following.

40.1.10.1 Input current balance. This measures the balance between the three phases of an AC input. Use nominal input voltage and rated load current. Perform as an X, S or Q test.

40.1.10.2 Inrush current. This measures the peak instantaneous input current during turn-on of the power supply. The limit should be less than 10 times the nominal steady state input current at maximum load. Use direct current (DC) input voltage for the test when applicable to the power supply. Measurement bandwidth should be 100 kHz ± 10 percent. Perform as an S or Q test.

40.1.10.3 Maximum steady state input current. This measures the maximum DC current that occurs over the range of input voltage as the input is varied from zero to the maximum rated voltage and returned to zero volts. Use the maximum rated load. The limit should be no more than twice the steady state DC input current at nominal input voltage and maximum load. Perform as an S or Q test.

40.1.10.4 Input peak current and rate of rise. This measures the maximum peak current (as opposed to steady state current in 40.1.10.3) that occurs with a slowly rising input voltage (1 volt/sec) or with remote turn-on. The rate of current rise is the steepest slope on the rising input current vs. time waveform. Use maximum rated load current. Perform as an S or Q test.

40.1.11 Input voltage threshold and hysteresis. These tests measure the input voltage where the power conversion circuitry is activated and once activated, where it turns off as the input voltage is decreased. The turn-off threshold should be not greater than the low line voltage (transient or steady state) for the specified input. Separation between the turn-on and turn-off voltages (hysteresis) should be at least 10 percent of the nominal input voltage. Perform as an X or S test.

40.1.12 Input-to-chassis capacitance. The capacitance to chassis is measured with all similar inputs tied together and at a test voltage low enough such that the power supply rectifiers are not forward biased. Capacitance to chassis measurements shall be performed separately on the AC and auxiliary inputs. Perform as S tests.

40.1.13 Power turn on/turn off response and holdup time. These tests are a measure of the characteristics of the power supply during application or removal of input power. The time from power application until the output voltage rises to within regulation limits shall be measured. Output hold up time from when power is turned off until the output falls out of specified limits shall also be measured. If there are multiple outputs, it may be required to verify that the outputs come up (are energized) or go down (are de-energized) in a specified

sequence. Output voltage transients during turn-on and turn-off shall be measured. Measure the turn-on characteristics using worst case resistive and capacitive loads. Perform as S and Q tests.

40.1.14 BIT and protection circuitry. BIT circuitry (status, LEDs, power interrupt, temperature, etc.) and protection circuitry (spike voltage, lead reversal open lead, output reverse bias, parallel outputs, programming pin signal rejection, incorrect programming susceptibility, etc.) tests measure the detection and activation thresholds, recovery transients and time, signal settling times and signal impedances. BIT circuitry tests are X tests while protection circuitry tests are S or Q.

40.1.15 Overvoltage threshold. The power supply shall be checked for shutdown under output overvoltage conditions. With nominal input voltage and frequency applied to the power supply, apply an overvoltage to the power supply output and check to see that the power supply will shut down. Other test methods may be used when appropriate. Perform as an X test.

40.1.16 Current limiting and output short circuit current. These tests measure the output current limiting feature. For current limiting, increase the output loading while monitoring the output voltage for a specified drop (or over-current BIT for a change in state). Measure the output current at the limiting point. For output short circuit current, measure the output current with the output terminals shorted together. The input voltage shall be nominal. Current limiting shall be an X test and output short circuit current shall be an X or S test.

40.1.17 Dynamic load regulation. This test measures the ability of a power supply to maintain regulation with rapid changes in output loading. The output loading shall be switched from no load (or a typical load) to full load and the resultant voltage spike and time to regain static output regulation shall be measured. The test shall be repeated with a load switching from full load to no load (or a typical load). The load transition time and maximum repetition rate shall be specified. The input voltage shall be nominal. This shall be an X, S or Q test as appropriate.

40.1.18 Dynamic line regulation. This test measures the ability of the power supply to respond to rapid changes in line voltage in order to maintain output regulation. The input voltage is stepped between nominal and a positive limit and stepped from nominal to a negative limit. The output transients are measured. Perform as a Q test.

40.1.19 Remote sense leads. Tests on the remote sense leads shall include sense lead reversal, distribution loss compensation and open sense lead transients and steady state voltages. Sense lead impedance shall be specified when applicable. Perform as S or Q tests.

40.1.20 Output ripple voltage. This test is a measure of the peak to peak random and periodic deviation present at the power supply output. Output ripple voltage may be measured over several different frequency ranges. Total ripple would be a wideband [5 megahertz (MHz) - 100 MHz] measurement. Line ripple would be measured with a 10 kilohertz (kHz) bandwidth. Converter frequency ripple would be measured over a passband of 10 kHz to 1 MHz. The upper test frequency shall be increased if the converter operating frequency approaches or exceeds 1 MHz. Ripple shall be measured at full load. The total ripple test shall be performed as an X test. Line and converter ripple tests shall be performed as S tests.

40.1.21 Output impedance. This test measures the impedance looking into the output of the power supply. The frequency range of measurement should be at least 10 Hz to 25 kHz and performed at 75-100 percent of rated load. Perform as a Q test.

40.1.22 Common mode output current. This test measures the common mode currents which flow in the output leads and are returned to a chassis ground. The broadband limits should be less than 200 mA (peak to peak). Perform as a Q test.

40.1.23 Emergency condition input voltage protection. This test applies input voltages that exceed the maximum rated power supply inputs for specified lengths of time and which may be expected to occur during emergency conditions. This test verifies immunity of the power supplies to damage due to these emergency condition voltages. The output loads shall be set at maximum. Perform as an S or Q test.

40.1.24 Pre-bias turn on test. This test applies both a positive and a negative voltage (one at a time) to the output of an unenergized power supply and verifies that it will turn on under these pre-bias conditions. Perform as a Q test.

50. OTHER REQUIREMENTS

50.1 Other requirements. Additional requirements and information shall be included in the detail specification so as

to completely specify the power supply operation and allow its incorporation into systems that may include other power supplies and other power filtering.

50.1.1 Power supply function. Functional descriptions should be provided to describe the purpose and use of the various features of the power supply. These functional descriptions typically include output programming, overvoltage programming, remote on/off control, remote sense capability, and diode-ORing capability.

50.1.2 Paralleling of outputs. A paragraph shall appear in each detail specification which states whether or not paralleling of outputs is permissible. If paralleling of outputs is permissible, the paragraph shall specify which outputs can be paralleled and under what conditions they may be paralleled. If paralleling of outputs is permissible, there must be a test to verify the fact that certain outputs may be paralleled. The ratio of current sharing between paralleled outputs shall be specified.

50.1.3 Conducted and radiated emissions and susceptibility. All modifications to the requirements of MIL-P-24764, MIL-P-29590, and MIL-STD-461 shall be specified along with appropriate figures depicting the limits and frequency of each modified requirement.

50.1.4 Input filter and stability. Sufficient information shall be provided in the detail specification such that electromagnetic interference filtering (if not included in the power supply) can be designed and used with the power supplies. This information shall include power supply input impedance such that the Nyquist criteria can be applied and stable systems can be designed and implemented.

50.1.5 Spike voltage. The allowable spike voltage amplitude to be applied to the power supply inputs shall be specified.

50.1.6 Exceptions. Requirements in MIL-P-24764 or MIL-P-29590 which do not apply to the power supply shall be listed.

50.1.7 Visual indicator location and marking. The permissible area for the visual indicator and the marking information shall be shown on figure 1 of the detail specification.

CONCLUDING MATERIAL

Custodians:

Army - ER
Navy - SH
Air Force - 99

Review activity:

Army - AV
DLA - GS

Preparing activity:

Navy - SH

Agent:

NW

(Project 6130-0284)

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-STD-2038	

3. DOCUMENT TITLE
Requirements for Employing Standard Power Supplies

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. Randy Collins (Code 6023) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS	(1) Commercial TPOC: 812-854-3826	(2) AUTOVON 88-482-3826
c. ADDRESS (Include Zip Code) Commanding Officer Naval Weapons Support Center ATTN: Randy Collins, Bldg. 2917, Code 6023 Crane, Indiana 47522-5060	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	