

INCH- POUND

MIL-M-24784(SH)  
6 September 1994  
(See 6.6)

## MILITARY SPECIFICATION

MANUALS, TECHNICAL:  
GENERAL ACQUISITION AND DEVELOPMENT REQUIREMENTS

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

## 1. SCOPE

1.1 Scope. This specification sets forth the general acquisition and development requirements of technical manuals and related data in support of weapons systems and equipment.

1.2 Purpose. The purpose of this specification is to provide the requirements for the acquisition and tailoring of the types of technical manuals listed in 1.3. This specification along with selected associated detail specifications forms an acquisition package containing all related technical information necessary to establish requirements for properly and uniformly producing acceptable technical manuals.

1.3 Classification. This specification covers the kinds and types (see 3.2.1 through 3.2.21) of manuals classified as follows:

<u>Kind</u>	<u>Title</u>
C	Change Package.
R	Revision.

<u>Type</u>	<u>Title</u>
1	Combat System Technical Operations Manual (CSTOM).
2	Commercial Off-The-Shelf (COTS) Equipment Manual.
3	Operations Station Book (OSB) for Design.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, SEA 03R42, Naval Sea Systems Command, 2531 Jefferson Davis Hwy, Arlington, VA 22242-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N6946

AREA TMSS

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

<u>Type</u>	<u>Title</u>
4	Operations Station Book (OSB) for Construction and Major Modification.
5	Technical Repair Standard (TRS) for Hull, Mechanical and Electrical (HM&E) Equipment.
6	Technical Repair Standard (TRS) for Electronic Equipment.
7	Technical Repair Standard (TRS) for Ordnance Equipment.
8	Training Aid Booklet (TAB).
9	Ship Information Book (SIB).
10	Hull, Mechanical and Electrical (HM&E) Equipment Manual.
11	Hull, Mechanical and Electrical (HM&E) Single Component Manual.
12	Electronic and Interior Communication (IC) Equipment Manual.
13	Service Test Electronic and Interior Communication (IC) Equipment Manual.
14	Experimental Electronic and Interior Communication (IC) Equipment Manual.
15	Hull, Mechanical and Electrical (HM&E) Systems Manual and Electronic and Interior Communication (IC) Systems Manual.
16	Surface Missile Subsystem or Equipment Manual.
17	Surface Missile System Manual
18	Digital Systems Manual.
19	Digital Equipment Manual.

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

#### SPECIFICATIONS

##### MILITARY

- MIL-Q-9858 - Quality Program Requirements.
- MIL-I-45208 - Inspection System Requirements.

(See Supplement 1 for list of associated specifications.)

#### STANDARDS

##### MILITARY

- MIL-STD-1388-1 - Logistics Support Analysis.
- MIL-STD-1388-2 - DOD Requirements for a Logistics Support Analysis Record.
- MIL-STD-2073-1 - DOD Materiel Procedures for Development and Application of Packaging Requirements.

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

2.1.2 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 are those cited in the solicitation.

DOCUMENTS

DEPARTMENT OF DEFENSE

- DOD 5230.24 - Distribution Statements on Technical Documents.
- DOD 5230.25 - Withholding of Unclassified Technical Data from Public Disclosure.

(Application for copies of DOD documents should be addressed to the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

PUBLICATIONS

DEPARTMENT OF DEFENSE

- DOD 5010.12-L - Acquisition Management Systems and Data Requirements Control List (AMSDL).
- DOD 5200.1-R - Information Security Program Regulation.
- DOD 5220.22-M - Industrial Security Manual for Safeguarding Classified Information.
- DFAR Sup - Defense Federal Acquisition Regulations Supplement.

DEPARTMENT OF THE NAVY

- NAVPERS 18068 - Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards.

(Application for copies of DOD 5010.12-L and Department of the Navy publications should be addressed to the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

(Application for copies of DOD 5200.1-R should be addressed to the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.)

(Application for copies of DOD 5220.22-M and DFAR Supplement should be addressed to the Government Printing Office, Attention: Superintendent of Documents, Washington, D.C. 20402.)

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

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 3951 - Standard Practice for Commercial Packaging. (DOD adopted)

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

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

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for associated detail specifications), the text of this specification shall take precedence. When a generic requirement is in conflict with a unique requirement from the governing associated detail specification, the unique requirement shall take precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General.

3.1.1 Advertising. Technical manuals shall contain no advertising unless the contract specifies that the equipment (see 6.5.15) manufacturer shall be identified on the cover.

3.1.2 Copyrights and proprietary information credit line. Technical manuals shall not contain copyrighted material except as specified in the Federal Acquisition Regulations and Defense Federal Acquisition Regulation Supplement. When copyrighted material is to be included in a technical publication, the developer shall obtain prior written permission from the copyright owner or authorized agent for its use. The signed, written permission shall be delivered together with the final reproducible copy. The written permission shall contain a statement declaring whether or not a copyright credit line is required. When it is necessary to include copyright and proprietary material, it shall be clearly identified and the following warning statement shall be included on the title page:

"This document contains copyright or proprietary materials. Infringement of copyright or proprietary material may violate existing Federal laws and statutes and result in criminal penalties, imprisonment, or removal from office."

3.1.3 Security classification. The overall security classification assigned to a technical manual shall agree with the highest classification assigned to any portion within. Security classification markings, and the handling and production of classified material shall be in accordance with DOD 5220.22-M and DOD 5200.1-R.



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3.1.4 Distribution. Each technical manual and modification thereto shall be marked, in accordance with DOD 5230.24, to denote its availability for distribution, release, and disclosure without additional approvals and authorizations. This marking shall be in addition to a security classification (see 3.1.3) marking. Additionally, a determination shall be made in accordance with DOD 5230.25 whether the technical manual contains export-controlled technical data.

3.1.5 Source data. The primary source data for technical manuals shall be engineering drawings and, if a contract requirement, the Logistics Support Analysis and Logistics Support Analysis Record (LSAR) in accordance with MIL-STD-1388-1 and MIL-STD-1388-2.

3.1.6 Maintenance coverage. Unless otherwise specified (see 6.2), organizational, intermediate, and depot maintenance levels shall be covered in a combined single manual.

3.1.7 Development requirements. Sound engineering principles and techniques, available engineering analyses, service experience, performance data on the item (see 6.5.23) and on similar items, and all other reliability and maintainability data available shall be used in the development of specific instructions. The requirements for the development of each technical manual shall be in accordance with this specification and applicable associated detail specification (see 3.2).

3.2 Associated detail specifications. The associated detail specification to be used for acquisition shall be determined by the following paragraphs and the ordering data specified in 6.2. (See also the military equipment specification invoked in the contract or order for any special technical content requirements for a specific equipment.) The following requirements are applicable when specified (see 6.2).

3.2.1 Change package. Changes (see 6.5.5) to existing manuals shall be corrected replacement pages to the basic manual in accordance with MIL-M-24784/1. The change package (see 6.5.6) shall conform to the format of the basic manual, and shall incorporate all approved information (for example, engineering change proposals, ship alterations, ordnance alterations, machinery alterations, field changes, and so forth). The changes shall also incorporate all advance change notices and outstanding technical deficiencies.

3.2.2 Revision. Revisions (see 6.5.36) shall be either a complete revision (see 6.5.36.1) or update revision (see 6.5.36.3), and shall be in accordance with MIL-M-24784/2 and applicable associated detail specification (see 3.2.3 through 3.2.21). There are two forms of revisions: superseding and nonsuperseding (see 6.5.36.2). Revisions shall incorporate current information from previously issued changes to the existing manual. When a revision is acquired to cover a separate equipment model or a different system application, and the basic issue is not to be superseded, the revision shall be identified as a nonsuperseding update revision. The nonsuperseding update revision shall be classified as "original," have a unique Government identification number on the cover and all pages, and shall not include a supersession notice.

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3.2.3 Combat System Technical Operations Manual (CSTOM). Combat system information concerning design, detailed intersystem interface data, testing, maintenance, and capabilities in fleet user-oriented language and format shall be developed in accordance with MIL-M-24784/3. The CSTOM shall document functional integration of all combat subsystems in performance of the major combat system operational functions (see 6.5.18) of detection and entry, tracking and identification, threat evaluation and threat-to-weapon pairing, and engagement and engagement assessment.

3.2.4 Commercial Off-The-Shelf (COTS) equipment manual. Manuals available off-the-shelf from commercial sources (see 6.5.9) which include operation, maintenance, and other instructions to support equipment in the commercial market shall be acquired in accordance with MIL-M-24784/4.

3.2.5 Operations Station Book (OSB) for design. The design OSB shall be developed in accordance with MIL-M-24784/5. The OSB shall be developed during the later stages of concept design or early in the preliminary design but prior to detail design. The OSB shall be used for guidance and development of a construction and major modification OSB, computer programming, manning and training, ship design modifications, and design approval documentation.

3.2.6 Operations Station Book (OSB) for construction and major modification. The OSB for construction and major modification shall be developed in accordance with MIL-M-24784/6. The OSB shall provide information required by the operator to understand and carry out the required functions of the shipboard operational systems.

3.2.7 Technical Repair Standard (TRS) for HM&E equipment. A TRS shall be developed for HM&E equipment in accordance with MIL-M-24784/7. The TRS shall be used in performing class B overhauls (see 6.5.8 and 6.5.28) to HM&E equipment. The TRS shall provide intermediate and depot level support and repair (see 6.5.33) procedures.

3.2.8 Technical Repair Standard (TRS) for electronic equipment. A TRS shall be developed for electronic equipment in accordance with MIL-M-24784/8. The TRS shall be used in performing class B overhauls to electronic equipment. The TRS shall provide intermediate and depot level support and repair (see 6.5.33) procedures.

3.2.9 Technical Repair Standard (TRS) for ordnance equipment. A TRS shall be developed for ordnance equipment in accordance with MIL-M-24784/9. The TRS shall be used in performing class B overhauls to ordnance equipment. It shall provide intermediate and depot level support and repair (see 6.5.33) procedures.

3.2.10 Training Aid Booklet (TAB). A TAB shall be developed in accordance with MIL-M-24784/10. The TAB shall be a schematic or pictorial representation of systems (see 6.5.40) and equipment installed aboard a specific ship. It is primarily used as a training aid by the ship's crew in studying the installed systems of a ship. It is also used as a reference document by engineering and technical personnel.

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3.2.11 Ship Information Book (SIB). A SIB shall be developed in accordance with MIL-M-24784/11. The SIB shall be a system level reference used by operating, maintenance, and overhaul personnel. It shall serve as the primary intra- and intersystem publication for installation and operation of ship systems and equipment. Coverage shall include mechanical, heating, ventilation, air conditioning, piping, electrical, and electronics systems on a ship.

3.2.12 Hull, Mechanical and Electrical (HM&E) equipment manual. A topically structured manual (see 6.5.43) shall be developed for HM&E equipment in accordance with MIL-M-24784/12. The manual shall provide operation, maintenance (all levels), and installation instructions for HM&E equipment.

3.2.13 Hull, Mechanical and Electrical (HM&E) single component manual. A topically structured manual shall be developed for an HM&E single component (see 6.5.10) in accordance with MIL-M-24784/13. The manual is applicable to items performing only one function, such as pumps, valves, motors, and so forth, and which is normally integrated into an operating system or subsystem. These manuals shall provide operation and maintenance (all levels) instructions.

3.2.14 Electronic and Interior Communication (IC) equipment manual. A topically structured manual shall be developed for electronic and (IC) equipment in accordance with MIL-M-24784/14. The manual shall provide operation, maintenance (all levels), and installation instructions for operational electronic and IC equipment.

3.2.15 Service Test Electronic and Interior Communication (IC) equipment manual. A topically structured manual shall be developed for electronics and IC equipment, used for service test, in accordance with MIL-M-24784/15. The manual shall provide operation and maintenance instructions for service test equipment. If the equipment is programmed for production, the manual may also include installation, maintenance instructions, parts lists, and installation, inspection and pre-energizing procedures.

3.2.16 Experimental Electronic and Interior Communication (IC) equipment manual. A topically structured manual shall be developed for experimental electronics and IC equipment in accordance with MIL-M-24784/16. The manual shall provide operation instructions for the experimental electronics and IC equipment. If the equipment is programmed for production, the manual may also include installation, maintenance instructions, part lists, and installation, inspection and pre-energizing procedures.

3.2.17 Hull, Mechanical and Electrical (HM&E) systems manual and Electronic and Interior Communication (IC) systems manual. A topically structured manual shall be developed for HM&E, electronics, and IC systems in accordance with MIL-M-24784/17. The manual shall provide system and subsystem oriented instructions for operation, maintenance, installation, and test data.

3.2.18 Surface missile subsystem or equipment manual. A manual shall be developed for surface missile subsystems of weapon systems as well as separate independent equipment in accordance with MIL-M-24784/18. The manual shall provide operation, maintenance (all levels), and installation instructions for surface missile subsystems and equipment.

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3.2.19 Surface missile system manual. A manual shall be developed for surface missile systems in accordance with MIL-M-24784/19. The manual shall be addressed to the class of ship aboard which the missile weapon system is installed. The system manual shall provide the information necessary for functional understanding of the interrelationships of subsystem or equipment configuration comprising the missile system and the functional interface between that system and associated systems. The manual shall provide operation, testing, and fault isolation of independent areas within a subsystem or equipment.

3.2.20 Digital systems manual. A manual shall be developed for digital systems (complex combat system, command and control system, data processing system, and so forth) in accordance with MIL-M-24784/20. The manual shall provide functional descriptions as well as instructions for operation, maintenance, installation, fault isolation, and test of digital system and subsystem.

3.2.21 Digital equipment manual. A manual shall be developed for digital equipment (data processor, signal processor, and so forth) in accordance with MIL-M-24784/21. The manual shall provide functional descriptions as well as instructions for operation, maintenance, installation, fault isolation, and test of digital equipment.

3.3 Development products requirements. When specified (see 6.2), the following products shall be provided in the development and maintenance of a technical manual:

- (a) Outline and book plan - see 3.5.1 and 6.5.27.
- (b) Manual issues - see 3.5.1 and Appendix A.
  - (1) Review draft copy (RDC) - see 6.5.35.
  - (2) Preliminary technical manual (PTM) - see 6.5.30.
  - (3) Final reproducible copy (FRC) - see 6.5.16.
- (c) Supplement - see 3.5.1 and 6.5.39.
- (d) Change package - see 3.2.1 and 6.5.6.
- (e) Revision - see 3.2.2 and 6.5.36.

#### 3.4 Management data requirements.

3.4.1 Technical manual quality assurance (TMQA) program plan. A plan shall be developed in accordance with 4.5 which shall describe the scope and approach of the contractor's TMQA program (see 6.4). It shall detail the organization, planning and data control to be performed on each technical manual. The plan shall also provide evidence of the contractor's intent and methods for complying with the quality facets of this specification.

3.4.1.1 Quality program plan requirements. A written quality program plan shall be provided and maintained in accordance with the data ordering document included in the contract or order (see 6.2 and 6.4). The quality program plan shall be delineated in sufficient depth to ensure that adequate and accurate data and procedures will be presented and that materials or services being developed and furnished are in accordance with the requirements of this specification. The quality program shall, as a minimum, take into account such areas of concern as the following:

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- (a) Definition of authority, function and duties of those responsible for:
  - (1) Development and inspection.
  - (2) Providing and supervising indoctrination services.
- (b) Designation of qualified personnel for:
  - (1) Development and inspection.
  - (2) Instructing and supervising the instructors during indoctrination services.
- (c) Development, issuance, maintenance, and distribution of procedures.
- (d) Coordination with the Program Manager or Project Manager (as appropriate), to ensure that the latest data is used and that revisions are made concurrent with effected changes in requirements.
- (e) Establishment of validation procedures, inspection points, and inspection criteria, and the conducting of these designated inspections to determine adequacy and accuracy during the development stages.
- (f) Formal detailed review to ensure adequacy of information and compliance with this specification for content, production, and distribution.
- (g) During indoctrination services, where specified, conduct actual operational shipboard examinations of the content against the components of the ship's operational system to ensure that the contents depict accurately and adequately the shipboard installation and relationships specified.

3.4.1.2 Control of subcontractors and vendors. Successful implementation of the contractor's procedures designed specifically for control of subcontractors and vendors, the TMQA program plan shall establish procedures for the following:

- (a) The selection of qualified suppliers.
- (b) The transmission of quality requirements for subcontractors and vendors.
- (c) The inspection of subcontractor and vendor records and corrective action procedures.
- (d) The evaluation of subcontractor and vendor material, processes, and products.

3.4.2 Validation plan. A validation plan shall be developed and shall be acceptable to the Government (see 6.4). It shall reflect compatibility with the overall maintenance and support plan, outline the contractor's recommended validation procedure, and indicate the scope of the validation effort. It shall also include manuals for which requirements have yet to be defined, such as equipment component and support equipment manuals. The plan shall include recommendations for simultaneous validation or verification as appropriate.

3.4.2.1 Validation plan (general). The validation plan shall be in accordance with the following:



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- (a) Effective management to promote quality assurance shall be clearly described. Positions responsible for ensuring performance of quality functions shall have well defined responsibility and authority. The status and adequacy of the program shall be reviewed on a regularly scheduled basis.
- (b) Initial planning shall include the development, maintenance, and implementation of methods and procedures to ensure quality of manual reviews, and actions to ensure compatibility of preparation, inspection, and documentation.
- (c) The validation plan shall ensure there is a system for inspection, validation, and correction of the manual. Validation (see 6.5.44) shall provide a measure of the overall quality of the manual. When the Government performs an inspection at a contractor's plant, such inspection shall not be used by the contractor as evidence of effective control of quality. When revisions or corrections are required after any inspection, validation, or review, there shall be reinspection, revalidation, or re-review by the contractor, and if necessary, by the Government of all data effected.

3.4.2.2 Validation plan (specific). The validation plan shall include, but not be limited to the following:

- (a) Designation of authority, functions, and duties of personnel responsible for development, inspection, and validation of the manual.
- (b) Coordination with equipment or system design and production activities to ensure the use of the latest technical data and information, including operation and maintenance procedures, drawings, and illustrations for the development of the manual.
- (c) Establishment of in-process inspection points and development, maintenance, and implementation of inspection standards to control the adequacy during the development stages of the manual.
- (d) Identification of Government-furnished material or information required in the performance of validation.
- (e) Validation by comparing physical and functional descriptions, and test and fault isolation references in the manual against current Government-approved combat subsystem documentation.
- (f) Detailed review of final reproducible copy (FRC) to ensure that this material is identical to the authorized, validated, verified, corrected, and accepted draft or preliminary manuals and complies with legibility and reproducibility requirements.
- (g) Designation of books, logs, and so forth, that will be maintained for quality assurance and validation records that are suitable for Government inspection and in-process review.

3.4.3 Validation certification. A validation certificate (see figure 1) shall attest that the document has been validated as to its accuracy and adequacy by actual performance or simulation (see 6.4).

3.4.4 Evaluation records. Records (see 4.9) shall be provided that document quality problems and disposition recommendations during the development and evaluation of the technical manual (see 6.4).

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3.4.5 Verification plan. A verification plan shall be developed which shall describe the procedures the Government shall use, prior to the final acceptance (see 6.4) of the technical manual, to test and review the manual's accuracy, adequacy, and suitability for use in an operational environment.

3.4.6 Verification planning data cards. Verification planning data cards shall be developed that will tailor each verification effort based on the scope of the manual and complexity of the hardware (see 6.4). The number of verification planning data cards may vary as follows:

- (a) A manual covering a single level of maintenance on a single item will normally require only one planning card.
- (b) A manual covering more than one level of maintenance will normally require planning data cards for each level of maintenance.
- (c) An organizational level maintenance instruction manual will normally require a separate planning card for each prime heading.

3.4.7 Verification sequence control charts. A verification sequence control chart (see 6.4) shall be developed when several manuals are to be verified under a concerted effort, or several parts (see 6.5.29) of a single manual are to be verified, or a preferred verification sequence is required for continuity (see 6.4).

3.4.8 Verification incorporation certification. Upon completion of all verification (see 6.5.45) actions, the contractor shall provide a certificate (see figure 2) attesting that all discrepancies and deficiencies recorded during verification have been corrected or resolved (see 6.4). Final acceptance of the technical manual will be in accordance with terms of the contract.

3.4.9 Schedule and status report. A technical manual schedule and status report shall be supplied at the frequency determined by the contract. The report shall be in a narrative format and indicate the information necessary to provide a comprehensive management level analysis of all development activities (see 6.4).

3.4.10 Cost data. A technical manual cost report shall be developed identifying the final cost of each final manual developed and provided to the Government (see 6.4 and Appendix A).

3.4.11 Engineering judgement record (EJR). An engineering judgement record report shall be developed for each deviation from technical specification requirements or parameters (see 6.4 and Appendix A).

3.5 Development details. The requirements for the development of technical manuals shall be in accordance with the associated detail specification (see 3.2.1 through 3.2.21) and the applicable appendices of this specification. Unless otherwise specified in the contract, the following requirements apply.

3.5.1 Development products and reports. Outline and book plans, RDCs, PTMs, FRCs, supplements, and digital data shall be in accordance with the requirements of Appendix A.

3.5.2 Writing style. The style of writing, level of writing, readability, and referencing shall be in accordance with the requirements of Appendix B.



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3.5.3 Arrangement. Each manual shall be arranged in a standardized format (that is front matter, technical content, appendices, glossaries, indexes and back matter) and be appropriately divided by volume, part, chapter and section in accordance with the requirements of Appendix C.

3.5.4 Safety precautions. Safety and health warnings, cautions, and notes shall be in accordance with the requirements of Appendix D.

3.5.5 Tabular material. Tables shall be in accordance with the requirements of Appendix E.

3.5.6 Graphics. Illustrations, drawings, diagrams, sketches, and graphics shall be in accordance with the requirements of Appendix F.

3.5.7 Numbering. The numbering of paragraphs, procedures, divisions, issues, changes, illustrations, tables, and publications shall be in accordance with the requirements of Appendix G.

#### 4. QUALITY ASSURANCE PROVISIONS

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

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

4.2 Quality conformance inspection. All material furnished in accordance with this specification shall be inspected by the contractor for conformance to the applicable requirements of this document.

4.3 Government inspection. Material furnished in accordance with this specification shall be subject to inspection, verification and approval or disapproval by the Government as specified by the terms of the contract. Inspection and verification will be performed by the Government prior to acceptance. The Government reserves the right to conduct a guidance and quality planning conference and quality program reviews (see 6.5.31) throughout the term of the contract to ensure compliance with the quality assurance program plan, applicable technical manual specifications, the contract, and the production of a quality product (see 6.2).

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4.3.1 Government inspection at subcontractor facilities. Government inspection, verification and acceptance of a preliminary material at a subcontractor facility shall not constitute Government acceptance of the manual. Such Government actions shall not in any way relieve the prime contractor of his responsibilities for inspection and validation of his responsibility to furnish an acceptable manual. When the Government requires inspection or verification at the subcontractor location, the prime contractor shall include in the purchasing document a statement equivalent to the following:

"Government inspection and verification is required prior to shipment from your plant. Upon receipt of this order, promptly notify and provide a copy of this order to the Government representative servicing your plant so that Government inspection and verification may be planned. If the Government representative cannot be identified, the prime contractor shall be notified immediately."

The prime contractor shall report to his Government representative any nonconformance of Government source inspected and verified manuals and shall require the subcontractor to coordinate corrective action with the appropriate Government representative.

4.3.1.1 Purchase orders. The contractor's quality program shall not be deemed acceptable to the Government unless that contractor requires from his subcontractor a quality control program satisfying the requirements of this specification, or equivalent control over the subcontractor. The prime contractor shall ensure that applicable requirements are included or referenced in all purchase orders for subcontracted manuals or portions of manuals.

4.3.1.2 Control of subcontractors and vendors. The contractor shall ensure the quality of technical manuals developed by subcontractors and suppliers.

4.4 Guidance and quality planning conference. The guidance and quality planning conference is conducted to ensure the contractor's understanding of applicable specifications, technical manual contract requirements, formal instructions, established policies, and program requirements. Such conferences may be requested by either the contractor or Government.

4.5 Technical Manual Quality Assurance (TMQA) program. The contractor shall establish a TMQA program (see 6.5.42) in accordance with the requirements of this specification which supplements and details the requirements of MIL-Q-9858 and MIL-I-45208 to ensure the development of technically accurate and complete technical manuals. A quality assurance program developed as a result of material generated by the requirements of MIL-Q-9858 and MIL-I-45208 will be reviewed by the requiring activity for acceptance provided it satisfies the requirement of this specification. The contractor's quality assurance program shall encompass the accountability for and development of quality control functions required for the management of the following technical manual program elements:

- (a) Source data collection.
- (b) Intermediate product (see 6.5.22).
- (c) Graphics and illustrations.
- (d) Validation.

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- (e) Internal coordination.
- (f) Records.
- (g) Verification support.
- (h) Final product.

4.5.1 Sampling plans. All technical manual products, regardless of percentage of completion, shall be sampled and evaluated as a method of determining the acceptability of product in development. Sampling plans shall be as specified in the Quality Assurance program plan.

4.5.2 Data base control. The contractor shall ensure that the most current source data is available and utilized for technical manual development (see 6.5.13). The following are examples of the types of items and control documents that are considered appropriate source data:

(a) Description of source data:

- (1) Acquisition and test specification.
- (2) Proposal technical description.
- (3) Photos of mockups or equipment.
- (4) Support of equipment description data.
- (5) Task analysis data.
- (6) Maintenance plan.
- (7) Special user personnel qualifications as defined in NAVPERS 18068.
- (8) Notes and materials from vendors.
- (9) Failure modes and effects analysis data.
- (10) Engineering reports.
- (11) Engineering drawings, protection drawings and sketches.
- (12) Vendor brochures and commercial manuals.
- (13) Engineering change proposals (ECPs).
- (14) Logistics support analysis records (LSARs).
- (15) Maintenance engineering analysis records.
- (16) Hazard analysis.
- (17) Subsystem hazard analysis.
- (18) Support equipment requirements sheets.
- (19) Provisioning data.
- (20) Classification (DD 254).
- (21) Local engineering specifications.
- (22) Manual change releases.
- (23) Technical publication deficiency reports.
- (24) Technical manual deficiency and evaluation reports (TMDERs).
- (25) Validation and verification comments.
- (26) Design change notices (DCN).
- (27) Supply item change records (SICRs).

(b) Data base control documents (see 6.5.12):

- (1) Data recording and cataloging system documents.
- (2) Management forms.
- (3) Data release authority liaison documents.
- (4) Procedure for ECP routing (for technical manual input).
- (5) Release schedule tracking documents.

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- (6) Design and training groups liaison documents.
- (7) Procedures for engineering review of draft material and sign-off.

4.5.3 Quality assurance program functions. All technical manual elements and processes shall be evaluated by contractor and Government quality assurance personnel at various stages of development, by any or all of the following Quality Assurance program functions:

- (a) Guidance and quality planning conferences.
- (b) Adequacy reviews.
- (c) In-process reviews.
- (d) Quality program reviews.
- (e) Quality reviews (see 6.5.32).
- (f) Validation.
- (g) Verification.

4.5.4 Program plan and implementation. Implementation of the TMQA program plan shall be evidenced by development of:

- (a) Work instructions (see 6.5.49) and their use;
- (b) Review procedures and records;
- (c) Corrective and preventive action procedures;
- (d) Support for quality assurance functions;
- (e) Product validation procedures; and
- (f) Compliance with the approved milestone dates.

4.5.5 TMQA program plan organization. The contractor's quality assurance program organization shall have well defined responsibility, authority, and the organizational freedom to identify and evaluate quality assurance problems and to recommend and initiate solutions.

4.5.6 Quality program acceptance. Acceptance of the contractor's quality program by the Government in no way relieves the contractor of the responsibility to furnish the final manual as specified in the contract or order. Acceptance shall not preclude additions, refinements, or changes to the quality program by the contractor where evidence indicates that the program does not or will not meet the requirements of the contract or this specification. When additions, refinements, or changes to the program are determined necessary by the contractor, acceptance shall be obtained from the cognizant Government activity prior to implementation. The Government will furnish written notice of the acceptability of the contractor's TMQA program plan.

4.6 Validation. Validation is a contractor quality assurance responsibility which shall be accomplished for all technical manuals, changes, and revisions thereto. A technical manual shall not be considered validated until the following conditions have been fulfilled:

- (a) Contractor's engineering technical review (see 6.5.14) has been completed.
- (b) Information reflects configuration of the systems and equipment and includes all engineering changes.

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- (c) Adequacy (see 6.5.2) of data is checked to ensure that it supports the approved maintenance and support plan.
- (d) Hardware of the proper configuration is available for the validation effort.

4.6.1 Support equipment. Available Government approved support equipment shall be utilized in the performance of validation. Simulation or substitution of support equipment shall be approved by the Government. It is the responsibility of the contractor to request Government furnished equipment in order to support the validation effort.

4.6.2 Validation performance. Theory and principles of operation, system and component description, source, maintenance and recoverability (SM&R) codes (when applicable), schematic, and wiring data shall be validated against engineering source data in accordance with the validation plan. Operating and maintenance procedures including checkout, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system and equipment by actual demonstration. Malfunctions shall not be introduced into the system or equipment for the purpose of validation unless specifically required for certification of procedural tasks or system tests. Destructive malfunctions shall not be introduced into the system or equipment for any purpose.

4.6.3 Validation of readability. Narrative text shall be validated for conformance to readability standards specified in Appendix B, paragraph 40. If the Overall Grade Level (OGL) (including tolerance) is exceeded, the manual shall be rewritten as required to meet the specified Reading Grade Level (RGL). If a sample Grade Level (GL) is exceeded, the entire text surrounding each sample must be rewritten as required. Automated equipment may be used to compute RGL provided the computation meets the requirements of this document.

4.6.4 Disposition of validated data. Corrections and significant comments resulting from validation shall be incorporated prior to the certification and acceptance of the technical manual.

4.7 Verification. When specified (see 6.2), verification shall be accomplished under the jurisdiction of the Government and may include contractor support. Verification is a responsibility of the approval authority or authorized representative. The purpose of verification shall be to ensure that the contractor's products and services are in conformity with the requirements of this specification.

4.7.1 Scheduling. Verification may be simultaneously performed with validation in cases where time and equipment facilities availability do not permit separate verification. Verification may include contractor assistance in addition to qualified personnel of the prescribed skill level from the operating command or activity.

4.7.2 Combined validation and verification. When necessary, verification shall be performed concurrently with validation. The Government retains jurisdiction over a combined validation and verification in coordination with the contractor.

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4.7.3 Verification support requirements. Contractor support of verification shall consist of the following:

- (a) Serve as verification recorder, if required. Record and maintain records of changes associated with performance of verification.
- (b) Provide assistance in performing verification tasks, if required.
  - (1) Provide or assist in the development of verification schedule and plan.
  - (2) Provide summary of verification actions.
  - (3) Update or make appropriate changes in procedures.

4.8 TMQA program reviews. During the TMQA program review, the contractor shall demonstrate to the Government the operation of the TMQA program. This shall include review of data generated during contractor quality reviews and quality-related reports and records. TMQA program reviews chaired by a Government representative will be conducted at the contractor's facility. All quality review results will be documented by the Government.

4.8.1 Quality reviews. The contractor shall support quality program reviews as requested by the Government and provide access to quality assurance records. The contractor's quality assurance organization shall conduct quality reviews to ascertain compliance to the requirements cited in Section 3 of this specification. Quality reviews shall be conducted to evaluate the availability and adequacy of materials, processes, procedures, and intermediate products which constitute technical manual development. Sampling plans (see 4.5.3) shall be as specified in the TMQA program plan. During technical manual development and production, the inspector shall perform reviews of the technical manual and of all constituent elements and processes. The reviews shall be used to ensure compliance with this specification and provide for corrective action.

4.8.2 Adequacy review. When specified (see 6.2), adequacy reviews will be authorized and convened by the Government to monitor the preparation of illustrated parts breakdown (IPB) and documentation in support of the planned maintenance system (PMS) and may be conducted on maintenance manuals to determine adequacy prior to verification. Adequacy reviews will be conducted on IPBs to ensure that the coverage is in accordance with the approved SM&R codes; PMS documentation will be reviewed to ensure it is ready for fleet evaluation.

4.8.3 In-process reviews (IPRs). IPRs (see 6.5.21) will be authorized and convened by the Government. The contractor shall support IPRs and provide access to technical manual materials, intermediate, and final products. As a minimum, IPRs will include evaluation of source data, technical manual plans and outlines, presentation methods, modes of development, specification compliance, completed text and artwork, and readability.

4.8.3.1 IPR and adequacy review location. IPRs and adequacy reviews will be held at the contractor's facility but can be held at a designated Government facility. IPR and adequacy reviews intended for locations other than the contractor's facility must be approved by the Government (see 6.2). The contractor may request IPR and adequacy reviews at any time during the term of the contract when assistance or clarification is desired. The Government will request additional IPR and adequacy reviews when it appears the program is not proceeding according to schedule.



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4.8.3.2 Disposition of IPR and adequacy review findings. The Government and the contractor shall resolve IPR and adequacy review findings that involve problem areas or findings that require further evaluation before final disposition. Any discrepancy or deficiency found as the result of the IPR and adequacy review shall be corrected prior to certification and acceptance of the technical manual.

4.9 Technical manual evaluation records. The contractor shall maintain objective records of all quality reviews. Objective evidence shall be demonstrated by the ease of retrieval of specific information from records and their accuracy (see 6.5.1), currency, and completeness at the time of the Government representative's request. Records shall be maintained during IPR's, validation and verification efforts. The records (see 6.2) shall document quality problems and disposition recommendations. The records shall adequately identify the items in the manual(s) to which the comments and recommendations apply.

4.9.1 IPR and adequacy review records. The Government will act as recorder and record decisions, results, and findings during the IPR and adequacy review evaluation utilizing the Technical Manual Evaluation Record. The Government will provide a copy of all recorded IPR and adequacy reviews to the contractor.

4.9.2 Validation Records. Records of all validations performed shall be maintained. These records shall indicate the affected manuals, weapon system, component part number, or serial number. The records shall be maintained by the contractor and be available for Government review.

4.9.3 Verification disposition records. The contractor shall analyze each comment and correct manual discrepancies recorded during verification. The Government will review and indicate acceptance of verification dispositions.

4.10 Rejection criteria. Failure to meet all contractual requirements, including those specified in this and other referenced specifications, shall be cause for rejection of the deliverable items. The following requirements shall also apply to rejection criteria:

- (a) Failure to conform with the Government accepted technical manual outline and book plan.
- (b) Failure of all information to exactly represent the system or equipment being described and to be consistent with descriptive terms.
- (c) Omission of any applicable data elements required by this and other referenced specifications.
- (d) Failure to provide adequate evidence of validation.
- (e) Failure to include changes or corrections contractually required as conditions of acceptance.
- (f) Failure to conform with the terms of the contract.

4.10.1 Classification of defects (CD). The CD table associated with the contractor sampling plans shall be made available during the guidance and quality planning conference (see 4.4). The CD shall be patterned after the CD listed below for product evaluation. The contractor and the Government may jointly classify additional defects applicable to the specific products being acquired.



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## (a) Major defects (incorrect, incomplete, missing):

- (1) Maintenance procedures;
- (2) Values and tolerances;
- (3) Illustrations, schematics, wiring diagrams;
- (4) Part numbers;
- (5) References and indices;
- (6) Safety - notes, cautions, warnings;
- (7) Technical content (source dates and hardware comparison);
- (8) Classified matter (incorrect identification and handling);
- (9) Charts and tables; and
- (10) An excess of any one or combination of the following:

unfamiliar words, inconsistent vocabulary, long sentences, long paragraphs, noninformative headings, organization not based on immediate needs of the user, and complex or unclear illustrations.

## (b) Minor defects (incorrect, incomplete, missing):

- (1) Typographical errors;
- (2) Collated pages;
- (3) Source, maintenance, and recoverability (SM&R) codes;
- (4) Style comparison; and
- (5) Guide errors.

4.10.2 Corrective action. The contractor shall initiate a process of corrective action for all recorded and detected deficiencies. The contractor shall implement preventive action programs to counter any apparent deficiency trends. The detection of deficiencies which are recognized and are not cited in the CD shall be added to the CD in the TMQA program plan. Objective evidence of the effectiveness of the corrective action program for each deficiency shall be maintained.

4.11 Inspection of packaging. The inspection of packaging (preservation, packing, and marking) for shipment, stowage and storage shall be in accordance with requirements of Section 5 and the documents specified therein.

## 5. PACKAGING

5.1 Packaging requirements. Unless otherwise specified (see 6.2), the packaging and preservation requirements for delivery of outline and book plans, RDCs, PTMs, FRC, technical manuals, replenishment materials (see 6.5.34), changes and revisions shall be in accordance with this specification.

5.1.1 Classified material. Classified material shall be packaged and marked in accordance with the requirements of DOD 5220.22-M (see 6.2).

5.1.2 Single and multivolume manuals. Single copies and multivolume technical manuals (see 6.5.25) shall be packaged to preclude damage in transit. Multivolume technical manuals shall be furnished as complete sets (see 6.5.38) except for bulk manuals shipped for stock. Stock copies of identical volumes (see 6.5.46) shall be packed and shipped in common containers.

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5.1.3 Manuals of 16 pages or less. Manuals consisting of 16 pages (8 sheets) or fewer shall be enclosed in a clear, durable, vinyl envelope not exceeding 15-1/2 by 13 inches in size. The title page and publication number of the manual shall be printed on or be visible through the envelope. The bulk quantity of manuals shall be individually enclosed in the vinyl envelopes.

5.1.4 Replenishment material. Replenishment materials shall be packaged in accordance with 5.2.2.2. Container(s) shall be identified (see 5.4.1) and marked "FOR STORAGE". The container with a transmittal letter shall be forwarded to the Government activity specified in the contract.

5.2 Preservation. Unless otherwise specified (see 6.2), preservation shall be level C as follows:

5.2.1 Manuals.

5.2.1.1 Accompanying equipment. Copies of manuals shall accompany equipment shipments. Manuals shall be packed in a transparent, waterproof plastic bag, minimum 4 mil thick which shall be heat sealed. Technical manuals shall not be placed within any flexible, sealed barrier enclosing components. The copy(s) of the manual shall be placed in the shipping container housing the main unit. Packing lists shall indicate which container contains the technical manual(s) and shall also state the approximate location therein. For ease of removability, the location of the manual shall be such that it is readily accessible when the container is opened and no subsequent damage is sustained by the flexible barrier enclosing the equipment. Multivolume manuals, each volume unit packed as specified herein, shall be assembled as a complete set and contained in a fiberboard box and closed meeting the requirements of the applicable carriers rules and regulations.

5.2.1.2 Bulk. Manuals when shipped for stock shall be furnished unwrapped. Multivolume manuals shall not be furnished in sets. Manuals shall be packed for shipment in accordance with 5.3. Containers shall be marked "FOR STOCK" (see 5.4.1 for container marking information). Changes shall be packaged separately as separate line items.

5.2.2 Data items. Each data item (see 3.3) shall be contained in a transparent or opaque unit pack (wrap, bag, envelope, or mailing tube) and sealed. Flexible item(s) in flat unit packs shall be provided with paper board or fiberboard stiffeners to prevent item and unit pack damage.

5.2.2.1 Original artwork. When original artwork is mounted on illustration boards, it shall have a protective flap. The illustration boards shall have instructions, registration marks, and so forth, as required. Original artwork shall be packed flat (never folded) except that large sheets may be rolled if this method is authorized by the agency receiving the artwork.

5.2.2.2 Photolithographic negatives and masks. Photolithographic negatives including screens and masks shall be packed flat (never folded or rolled) and double-packaged. A printing instruction sheet shall be packed with the negatives, placed unfolded in an envelope clearly marked with the publication number and titled printing and setup instructions, and packed on top of the negatives. A sheet of tissue paper shall be inserted between each negative. The interior

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material shall be waterproof and free of any chemical substances that would discolor or otherwise degrade the negatives. The exterior package shall be a standard commercial carton at least equal to Interstate Commerce Commission standards, and of sufficient strength to protect the negatives against the forms of damage that frequently occur during shipping (see 5.4.1 for marking requirements).

5.2.2.3 Magnetic and optical disks or tapes. Computer disks and tapes shall be packed flat and double-packaged. A printing instruction sheet shall be packed with the disks and tapes, placed unfolded in an envelope clearly marked with the publication number and titled printing and setup instructions, and packed on top the disks and tapes. The interior material shall be waterproof and free of any chemical substances that would degrade the disks and tapes. The exterior package shall be a standard commercial carton at least equal to Interstate Commerce Commission standards, and of sufficient strength to protect the disks and tapes against the forms of damage that frequently occur during shipping (see 5.4.1 for marking requirements).

5.2.2.4 Certified checkoff list. Checkoff lists shall be packaged in standard manila envelopes.

5.3 Packing. Packing shall be Level A, B, C, or commercial as specified (see 6.2).

5.3.1 General requirements for levels A, B and C. Containers selected (see 5.3.2), shall be of minimum weight and cube consistent with the protection required, of uniform size, and contain identical quantities of identical material.

5.3.2 Levels A, B and C containers. Material shall be packed in exterior shipping containers for the level of packing specified, in accordance with table VII of MIL-STD-2073-1, Appendix C, and herein. Unless otherwise specified (see 6.2), container selection shall be at the contractor's option.

5.3.2.1 Caseliners. Unless otherwise specified (see 6.2), level A shipping containers shall be provided with waterproof caseliners in accordance with Table VII of MIL-STD-2073-1, Appendix C, and herein.

5.3.2.1.1 Closure. Container closure, reinforcing, or banding shall be in accordance with the applicable container specification or appendix thereto except that weather-resistant fiberboard boxes shall be closed in accordance with method V and reinforced with nonmetallic or tape banding and domestic or fire retardant fiberboard boxes shall be closed in accordance with method I using pressure sensitive tape.

5.3.2.1.2 Weight. Wood, plywood, and cleated type containers exceeding 200 pounds gross weight shall be modified by the addition of skids in accordance with MIL-STD-2073-1 and the applicable container specification or appendix thereto.

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5.3.2.2 Shipments in multiple containers. For equipment shipped in multiple shipping containers, the technical manuals shall be placed in the container housing the main unit of the equipment. Packing lists, invoices, or bills of lading shall indicate the number of the container that encloses the technical manuals (see 5.4.2), the publication identification number, nomenclature, and so forth. For ease of removability, the location of the manual(s) within the container shall provide immediate accessibility when the container is opened. The shipping container housing the manuals shall be marked "MANUALS ENCLOSED".

5.3.3 Commercial. Material shall be packed for shipment in accordance with ASTM D 3951 and herein.

5.3.3.1 Container modification. Shipping containers exceeding 200 pounds gross weight shall have a minimum of two, 3-inch by 4-inch nominal woods skids laid flat, or a skid or sill type base which will support the material and facilitate handling by mechanical handling equipment during shipment, stowage and storage.

5.4 Marking levels A, B, C and commercial.

5.4.1 Container marking information. Interior packs and shipping containers shall be marked including bar coding for shipment, stowage, and storage in accordance with MIL-STD-2073-1, Appendix F. In addition to the sender and address information, the exterior of each container shall show the following, as applicable:

- (a) Publication identification numbers.
- (b) Stock number.
- (c) Equipment nomenclature.
- (d) Manual issue enclosed:
  - (1) Review draft copy (RDC), or
  - (2) Preliminary technical manual (PTM), or
  - (3) Change, or
  - (4) Revision, or
  - (5) Final reproducible copy (FRC).
- (e) For storage.
- (f) For stock.
- (g) Number of containers in shipment. Box (number) of (number).  
(To be listed on multiple container shipments.)
- (h) Replenishment materials.
- (i) Original artwork.
- (j) Negatives.
- (k) Magnetic or optical disks and tapes.

5.4.2 Packing list. A copy of the letter of transmittal, the packing list, or bill of lading shall be placed inside the container. When a shipment consists of multiple containers, the packing list material shall be enclosed in the first container and shall identify the material packed in each container.

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## 6. NOTES

6.1 Intended use. Technical publications developed in accordance with this specification are intended for use in the installation, operation, maintenance, repair, personnel training and logistics support of weapon systems and equipment or for accomplishment of assigned missions and to set a style and format standard for related publications for which no other standards exist.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification (or any TMCR referencing this specification).
- (b) The equipment or system models, configurations, and components to be covered (see 1.1).
- (c) When a new technical manual is required to support an equipment or system, the manual type must be specified (see 1.3 and 3.2.1 through 3.2.21).
- (d) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- (e) Applicable security classification and distribution statements (see 3.1.3 and 3.1.4). For classified equipment and manuals, attach a DD Form 254 specifying the following:
  - (1) Security classification.
  - (2) Downgrading and declassification notification.
  - (3) Areas requiring security protection.
- (f) When the depth of coverage is other than that necessary to maintain the equipment or system through organizational (O), intermediate (I), and depot (D) level maintenance as defined by the maintenance philosophy (see 3.1.6). When the maintenance philosophy involves maintenance of the hardware at the "O", "I", and "D" levels, the manual must be developed to cover all levels of maintenance unless a separate manual is under acquisition to cover I and or D levels.
- (g) Whether or not installation data or chapter is required. Installation chapters are required whenever the military services are expected to or may install or reinstall the equipment or system. Whenever a system or equipment is only to be installed and reinstalled by the shipbuilder or manufacturer, installation information is not required (but may be included) in the manual. However if installation information is not included in the manual, installation data must be available to the Government in other forms such as drawings, procedures, and so forth (see 3.2).
- (h) Whether the equipment or system is intended for operational (field use), service test, or experimental (R&D) - see 3.2.15 and 3.2.16. (If the equipment or system is considered to be experimental but is intended for service test, the manual should be specified as service test).

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- (i) Changes must be specified only when they pertain to technical manual corrections resulting from a hardware change or modification. They may also be specified if it has been determined that significant omissions of technical data or information has been identified. Do not specify a change to correct minor or editorial corrections. When changes are justified on the above basis, the change must include the correction of all outstanding temporary or interim changes and may include minor changes (see 3.2.1). Whenever the number of change pages is estimated to exceed approximately 25 percent of the total number of pages in the manual, an update revision must be specified (see 3.2.2).
- (j) When the total number of pages requiring change exceed approximately 25 percent of the total number of pages in the manual, a revision must be specified (see 3.2.2).
- (k) An outline and book plan must be specified whenever a technical manual is required for a new equipment or system (see 3.3).
- (l) What manual issues are required (see 3.3 and Appendix A).
- (m) A Review Draft Copy (RDC) must always be specified for every new technical manual (see 3.3 and Appendix A). An RDC must be specified for each technical manual change package, unless changes to the technical manual have been pre-approved (TMDER, ECP, and so forth) by the Government.
- (n) Supplement manuals (see 3.3) must be specified when:
  - (1) Classified information can be confined to the supplement manual such that its basic technical manual will be routed as "unclassified".
  - (2) It augments a technical manual to provide for a different model and can be justified as a cost effective method of promulgation.
  - (3) It can be justified as a practical method of promulgation.
- (o) What quality assurance and management data items are to be delivered (see 3.4 and 6.4).
  - (1) TMQA program plan.
  - (2) Validation plan.
  - (3) Validation certification.
  - (4) Evaluation records.
  - (5) Verification plan.
  - (6) Verification planning data cards.
  - (7) Verification sequence control charts.
  - (8) Verification incorporation certification.
  - (9) Schedule and status report.
  - (10) Technical manual cost report.
  - (11) Engineering judgement records report.
- (p) Specify the number of weeks required for Government review of technical manual deliverables (see 4.3).
- (q) Specify whether contractor support is required during verification (see 4.7).



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- (r) Specify simultaneous validation and verification where time and equipment facilities availability do not permit separate verification (see 4.7.1).
- (s) When preservation, packing, and marking are other than as specified (see Section 5. PACKAGING).
- (t) Specify a Preliminary Technical Manual (PTM) when it is necessary to field equipment for test and evaluation, or when an extended period of use is required prior to Government verification (normally applies to complex equipment and systems only) - see Appendix A.
- (u) When an interim issue of PTM is required (see Appendix A).
- (v) Specify if technical manual deliverables are to be encoded in digital form (for use in electronic printing or for the interchange of text and graphics data) (see Appendix A).
- (w) Specify the delivery media (reproducible camera-ready copy, direct image copies, digital file, disks, tapes, and so forth) of the Final Reproducible Copy (FRC) - see Appendix A.
- (x) Double column text must normally be specified. When increased effectiveness of presentation results, a single column format is also acceptable (see Appendix A).
- (y) Specify if photographic negatives are required to expedite the printing of the manual (see Appendix A).
- (z) Running sheets and instructions must always be specified to accompany FRC (see Appendix A).
- (aa) Specify if replenishment material is required. When replenishment material is specified, it must always be delivered to the Government for subsequent use in reprinting (see Appendix A). (No costs other than handling and shipping costs are justified on the acquisition of replenishment material).
- (bb) Specify the use of orthographic diagrams and pattern coding (see Appendix F).
- (cc) Specify the additional symbology to be provided for mechanical system diagrams (see Appendix F).

6.3 Technical manual acquisition. This specification (or a TMCR based on this specification) must be listed on the Contract Data Requirements List (DD Form 1423) in order to acquire the technical manuals described by this specification, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

6.4 Data requirements. The following Data Item Descriptions (DIDs) must be listed, as applicable, on the Contract Data Requirements List (DD Form 1423) when this specification is applied on a contract, in order to obtain technical manual management (support) data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423:

<u>Reference paragraph</u>	<u>DID Number</u>	<u>DID Title</u>
3.4.1	DI-M-2194	Manual, Technical; Quality Assurance Program Plan
3.4.2	DI-M-2195	Manual, Technical; Validation Plan
3.4.3	DI-M-2196	Manual, Technical; Validation Certification



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<u>Reference paragraph</u>	<u>DID Number</u>	<u>DID Title</u>
3.4.4	DI-M-2197	Manual, Technical; Evaluation Record
3.4.5	DI-M-2198	Manual, Technical; Verification Plan
3.4.6	DI-M-2199	Manual, Technical; Verification Planning Data Cards
3.4.7	DI-M-2200	Manual, Technical; Verification Sequence Control Chart
3.4.8	DI-M-2201	Manual, Technical; Verification Incorporation Certification
3.4.9	DI-TMSS-80064	Technical Manual Schedules and Status Report
3.4.10	DI-TMSS-80068	Report of Technical Manual Costs
3.4.11	DI-TMSS-81354	Technical Manual Research and Analysis Source Data (for Engineering Judgement Records)

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

## 6.5 Definitions.

6.5.1 Accuracy. The precision and technical correctness of the contents of a manual. Accuracy includes the requirements that the technical manual reflect the "as built" or "as is" configuration of the associated hardware.

6.5.2 Adequacy. A depth of scope of coverage sufficient to support all tasks and functions at the prescribed level of the user, consistent with the equipment to be used and the mission environment in which the manual is to be utilized.

6.5.3 Associated detail specification. The associated detail specification is an extension of a general specification that covers detailed requirements for specific types and kinds of manuals or equipments. The associated detail specification is prepared in the standard six-section format.

6.5.4 Caution. Highlights an essential operating or maintenance procedure, practice, condition, statement, and so forth, which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness. Cautions are further explained in Appendix D.

6.5.5 Change. A change is comprised of corrected replacement pages to the basic manual. It consists of technical information that improves or clarifies the basic manual without requiring rewriting or reorganization of the technical content of the basic manual.

6.5.6 Change package. A controlled change to the basic manual or revision comprised of change instruction sheet, certification sheet, title page, list of effective pages, and replacement or additional pages. Each package is identified by a unique Technical Manual Identification Number and each replacement or added page is identified by a change designator.

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6.5.7 Chapter. The first major functional division of a publication.

6.5.8 Class B overhaul. Work which requires such overhaul or repair as will restore the operating and performance characteristics of a system, subsystem, or component to its original design and technical specifications.

6.5.9 Commercial Off-The-Shelf (COTS) manuals. Manuals available off-the-shelf from a commercial source which include operation, maintenance, and other instructions for commercial equipment. Commercial manuals are developed to support the equipment in the commercial market.

6.5.10 Component. A composite fabricated unit (generally complete within itself) that is designed to perform a stated service when installed in its proper position (for example, lube oil cooler, overspeed trip, strainer, and so forth).

6.5.11 Comprehensibility. The completeness with which a user in the target audience understands the text or text-graphics combination.

6.5.12 Data base. Source data used in the development of a technical manual. These data consist of such things as specifications, standards, instructions, drawings, engineering design data, LSAR, DCN, SICR, and so forth.

6.5.13 Data base control. The systematic management and recording of the presence, accuracy, currency, and completeness of the source data.

6.5.14 Engineering technical review. The action by engineering personnel to ensure the technical accuracy and adequacy of the source data being utilized in the development of the technical manual.

6.5.15 Equipment. One or more component assemblies capable of performing a complete function and having a specified nomenclature or model identification.

6.5.16 Final reproducible copy (FRC). The final document ready for reproduction and publication as an authenticated technical manual including all necessary changes made as a result of validation or verification and Government conditions of acceptance or approval. The delivery media includes, but is not limited to, reproducible camera-ready copy, direct image copies, digital files, disks, tapes, and so forth, as specified.

6.5.17 Foldout page. A foldout page has the same height as, but is wider than, a standard 11 inch page. Foldout pages are folded either 2 or 4 times (depending on width) to assume the dimensions of a standard page.

6.5.18 Function. A group of circuits or other devices which operate together to accomplish a portion of an equipment or system objective (for example, transmit, receive, display, hoist, and control).

6.5.19 Hardware. Physical equipment such as machinery, and electronic unit, assembly or component, and so forth.

6.5.20 Icon. Icons are pictorial images which may be used in lieu of words. See Appendix D for authorized icons.

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6.5.21 In-process review (IPR). A review of contractual requirements, technical documentation, and technical manual increments which may be carried out at any time during the manual development to:

- (a) Evaluate the product during the development process;
- (b) Ensure that the technical requirement, documentation, and manual are being written according to the applicable specifications; and
- (c) Correctly reflect the approved configurations of the appropriate hardware.

6.5.22 Intermediate product. Work in progress and supporting source data.

6.5.23 Item. A nonspecific term used to denote any product, including systems, materials, parts, subassemblies, sets, accessories, and so forth.

6.5.24 Leading. The vertical spacing between lines of type measured from baseline to baseline (bottom of line to bottom of next line below). Leading is measured in points.

6.5.25 Multivolume manuals. Multivolume manuals are assigned individual technical manual identification numbers. If a volume, because of its bulk, warrants being further divided, the Government will decide how these divisions shall be identified. When specified for use by the Government, volumes shall be used when a publication exceeds 1,500 printed pages (750 sheets). Foldouts are counted in page units (sheets).

6.5.26 Note. Highlights an essential operating or maintenance procedure, condition, or statement.

6.5.27 Outline and book plan. The detailed scope of the manual with symbolic page and illustration coverage, annotated and appropriately defined to clarify the depth of coverage logically related to the subject of the manual.

6.5.28 Overhaul. The process of reconditioning a system or equipment to conform to the stated performance and technical specifications of the system or equipment with a life expectancy equivalent to similarly configured new systems or equipment. Overhaul is also performed to repair or replace parts and components that have failed or are of marginal quality because of wear, deterioration, or damage so as to preclude premature failure. Installation of authorized approved engineering or field changes may be included as part of the overhaul.

6.5.29 Part. A part is the next lower division of a publication below volume. Parts should normally be separately bound.

6.5.30 Preliminary technical manual (PTM). PTM shall be developed for interim use to make the technical information available for test, verification, training, and operational use pending receipt of final reproducible copy and distribution of printed manuals.

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6.5.31 Quality program review. A Government evaluation of quality-related data generated by the contractor as part of the quality assurance program. The Government evaluation determines contractor compliance with the approved TMQA program plan. Quality program reviews evaluate the contractor quality assurance program and should not be confused with technical reviews of technical manuals (for example, IPRs).

6.5.32 Quality review. A selective comparison of development processes and products with a given set of standards or objectives.

6.5.33 Repair. Work necessary to restore an unserviceable system or component to operational status without change in design, materials, number, location, or relationships of the component parts that have failed or are of marginal quality due to wear, deterioration, or damage. The repair process includes all necessary adjustment, alignment, and calibration procedures.

6.5.34 Replenishment material. Replenishment material consists of two copies of the final manual (all volumes, supplements, and changes thereto) and the photolithographic negatives, masks, and printing instructions. Replenishment material is used for printing additional copies of the manual when required for distribution or stock.

6.5.35 Review draft copy (RDC). The review draft copy is used for review and coordination for technical accuracy and adequacy to evaluate the contractor's progress and assess compliance with applicable specifications and terms of the contract. RDC equates to review manuscript.

6.5.36 Revision. A revision is a second or subsequent edition of a published manual which normally supersedes the preceding edition.

6.5.36.1 Complete revision. A complete revision requires rewrite or reorganization of the technical content of the material and is in accordance with the current content requirements as outlined by this specification.

6.5.36.2 Nonsuperseding revision. Normally revisions supersede the preceding edition. However, when a new manual is needed to cover a different configuration of a system or equipment for which there is a high degree of commonality, a nonsuperseding revision can be acquired to minimize cost. A nonsuperseding revision will stand on its own and shall be identified by a unique technical manual identification number.

6.5.36.3 Update revision. An update revision incorporates the basic manual, all previous changes, and new data that would require the issuance of an additional change. The update is developed by incorporating applicable portions of pages in the manual (paste-up or minor composition) without requiring rewrite or reorganization of the technical content of the material. It is developed in the style and format of the basic manual.

6.5.37 Section. The first major functional subdivision of a chapter.

6.5.38 Set. A set is a number of individual manuals or volumes which comprises a complete package of operational and maintenance information for an item.

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6.5.39 Supplement. A supplement is a subsidiary document which complements information in a related manual.

6.5.40 System. Two or more equipments (sets) or components, each having its own identity and nomenclature, arranged and interconnected to perform a specific operation or function.

6.5.41 Technical manual. Technical manuals are publications that contain instructions for the installation, operation, maintenance, training, and support of weapon systems, weapon system components and support equipment. Technical manual information may be presented in any form or characteristic including, but not limited to, hard copy, audio and visual displays, magnetic tape, discs, and other electronic devices. A technical manual normally contains operational and maintenance instructions, parts lists or parts breakdowns, and related technical information or procedures exclusive of administration procedures. Technical Orders (TO) that meet the criteria of this definition may also be classified as Technical Manuals.

6.5.42 Technical Manual Quality Assurance Program. A systemic, coordinated effort to establish a high level of confidence that the technical manual product offered conforms to established, contractually defined technical requirements. A quality assurance program includes efforts by the contracting activity and developing activity including IPRs, validation, and verification.

6.5.43 Topically Structured Technical Manual. A type of manual which relies upon a logical sequence of topics, a narrative style, and necessary illustrations and tables to provide a full description of the operation, maintenance, and repair of an equipment or weapon system. The topically structured technical manual contrasts with the less common functionally structured manual, which makes far greater use of illustrations to support its brief narrative statements.

6.5.44 Validation. The final quality assurance iteration required of the contractor or developing activity during which the technical manual is tested for technical adequacy and accuracy and compliance with the provisions of the specifications and other technical contractual requirements. Validation is accomplished by actual performance or technical manual procedures checked against the system or equipment for which the manual was written. Validation is normally conducted at the developing activity or vendor's facility. In extenuating circumstances, validation may be conducted at an operational site.

6.5.45 Verification. The final quality assurance iteration by the Government for acceptance of the technical manual during which the technical manual is tested to determine its adequacy and operational suitability for the operation and maintenance of equipment. Verification may be tailored based on the Government's confidence level in the developing activity's quality assurance program, compliance with provisions of the specifications and other technical contract requirements, and effective integration of logistic support requirements for the tasks to be performed. Verification is conducted with production equipment and with qualified fleet personnel of the prescribed skill level from the operating command or facility assigned to operate and maintain the equipment.

6.5.46 Volume. The first separately bound subdivision of a publication.

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6.5.47 Warning. Highlights an essential operating or maintenance procedure, practice, condition, statement, and so forth, which if not strictly observed, could result in injury to, or death of, personnel or long term health hazards. Warnings are further explained in Appendix D of this specification.

6.5.48 Weapon systems. Items that can be used directly by the Armed Forces to carry out combat missions.

6.5.49 Work instructions. The written directions for accomplishing tasks of a type and in the detail appropriate to the task and the people performing the task (for example, writers and illustrators guide, procedural instructions).

6.6 Superseded documents. The following documents are superseded by this specification:

- (a) DOD-STD-2139
- (b) WS-10759/1/2/3
- (c) MIL-M-15071H
- (d) MIL-O-24312B
- (e) MIL-M-24570
- (f) MIL-M-24571
- (g) MIL-T-24747

6.7 Subject term (key word) listing.

Associated detail specification  
 Change package  
 Final Reproducible Copy  
 Outline and book plan  
 Preliminary Technical Manual  
 Quality Assurance  
 Review Draft Copy  
 Revision  
 Supplement  
 Technical manual  
 Validation  
 Verification

Review activities:  
 Navy - EC

Preparing activity:  
 Navy - SH  
 (Project TMSS-N242)



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## DEVELOPMENT PRODUCTS AND REPORTS

## 10. SCOPE

10.1 Scope. This appendix establishes the requirements for the development of technical manual data products and reports [that is, outline and book plan, review draft copy (RDC), preliminary technical manual (PTM), final reproducible copy (FRC), supplements, cost reports, and engineering judgement records]. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATION

## MILITARY

MIL-P-38790 - Printing Production of Technical Manuals: General Requirements For.

## STANDARDS

## MILITARY

MIL-STD-973 - Configuration Management.

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

20.1.2 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 are those cited in the solicitation.

## PUBLICATION

## DEPARTMENT OF DEFENSE

DOD 5220.22-M - Industrial Security Manual for Safeguarding Classified Information.

(Application for copies of DOD 5220.22-M should be addressed to the Government Printing Office, Attention Superintendent of Documents, Washington, D.C. 20402.)

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30. OUTLINE AND BOOK PLAN

30.1 Outline and book plan. When specified (see 6.2), an outline and book plan shall be developed for each technical manual. The narrative outline shall be submitted to the Government for acceptance prior to development of the review draft copy (RDC). If rejected, the unacceptable portions shall be corrected and resubmitted. The book plan shall be based on the accepted narrative outline, maintained by the contractor during the technical manual development process, and submitted to the Government for acceptance when development is completed.

30.1.1 Narrative outline. The narrative portion of the narrative outline shall indicate the planned technical manual development approach, identify which options are permitted by the contract and associated detail specification, and specify options the contractor is electing to pursue. The outline shall contain the following requirements:

- (a) A text outline that shall be in accordance with the requirements of the content specification, showing volume (see 6.5.46), part (see 6.5.29), chapter (see 6.5.7), section (see 6.5.37) and paragraph titles to indicate the intended coverage of the various aspects of the equipment or system. Each paragraph title or notation shall be followed by a brief statement outlining the information to be presented. The text outline shall clearly show the specific equipment or system and related procedures and data planned for inclusion in the manual.
- (b) An illustration outline and a table outline that shall be keyed to the text outline. Each illustration and table listed in the outlines shall be described. The illustration outline shall contain figure numbers, title, information, intent, approximate size and nature of illustration (exploded view, schematic, line drawing). The table outline shall describe the tables by table number and information content.
- (c) An estimated page count for each chapter and a statement indicating the scope, depth or coverage.
- (d) A synopsis of the validation approach to the manual content requirements shall be included based on a plan for use as supplied by the Government and a logistics support analysis of the equipment. The synopsis shall indicate coverage on a comprehensive and systematic basis of the most effective and efficient method of performing necessary maintenance. The synopsis shall be correlated to the logistics support analysis reports - LSARs (if available) by direct referencing.
- (e) For equipment requiring overhaul (see 6.5.28).
  - (1) The approach to be used in presenting the overhaul strategy shall be described. A repair process flow chart similar to figure 3 shall be used to present the overhaul strategy.
  - (2) The range and depth of outline coverage shall be based upon the logistic support analysis records (LSARs) and reliability centered maintenance (RCM) program of the equipment and the complexity of the planned overhaul and shall include:

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- a. The minimum procedures and testing requirements to ensure that the class B overhaul can be performed in an efficient manner by a journeyman-level mechanic.
  - b. The minimum mandatory replacement parts consistent with the required period between planned overhauls.
  - c. Preparation of an engineering judgement record (EJR) package (see 70).
- (f) For compound items, the preferred method of data presentation is to divide the major unit into functional volumes and parts. Each assembly should be contained in a separate volume. It may be considered appropriate to present the test data record sheets for an item as a separately bound part of a volume. For HM&E equipment, examination, test, and repair action record data sheets shall be contained in a separately bound part of a volume for each item.
- (g) The outline shall fully enforce all content requirements.
- (h) Problems regarding requirements, interpretation, and application shall be identified.
- (i) Conflicts between guidance documents shall be highlighted.

30.1.2 Book plan coverage. After acceptance of the narrative outline, a book plan shall be developed with the content and format requirements of the associated detail specifications. The book plan shall portray the planned manual coverage by volume, division, and so forth, and shall reflect the approved outline. The book plan shall be developed based on the development of a table of contents for each planned volume (including separately bound parts of that volume):

- (a) A text guide shall list chapter, section, and informative paragraph titles. A brief statement (outlining the content and intended coverage) shall follow each chapter, section, and paragraph title.
- (b) A list of illustrations and a list of tables shall be keyed to the text plan. Each illustration and table listed shall be described. The illustration plan shall contain figure numbers, title, information content, and approximate size and nature for all illustrations (such as schematic, line drawing, and exploded view). A sample of each drawing type referenced in the illustration plan shall be included.
- (c) The estimated total number of text and illustration pages per chapter shall be listed.
- (d) Data for the front matter, including a brief description of the material to be presented in the foreword, shall be developed.
- (e) Data required for the technical content portion of the manual shall outline the planned coverage by proposed volumes, divisions, and so forth, in accordance with the content and format requirements of the applicable associated detail specification.

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30.2 Model manual. When specified or approved by the Government, an existing manual covering similar equipment may be used as an outline and that manual shall be marked up and submitted as a book plan. The text from the model manual may be used verbatim with changes to cover the equipment differences and to correct inconsistencies, unclear wording, or obvious editorial or typographical errors. However, the format requirements in this specification shall apply for all new manuals. All inconsistencies, unclear wording, or errors noted in the model manual shall be identified to the Government. All deviations from the model manual shall be approved by the Government.

30.3 Milestone schedule. As an addendum to the book plan, a milestone schedule for development of the publication shall be furnished for the individual contract. Milestones to be identified shall include, but are not limited to, the following:

- (a) Outline and book plan submission.
- (b) RDC drafting - 25, 50, 75, and 100 percent completion points.
- (c) Schematic preparation.
- (d) Parts listing.
- (e) Editing.
- (f) Composition.
- (g) RDC submission.
- (h) Validation.
- (i) Reproducible development completion.

30.4 Outline and book plan updating. The outline and book plan shall be kept up-to-date throughout the development of the technical manual review draft and until the draft is accepted. Significant changes to the book plan shall be submitted to the Government for acceptance. Improved data presentation shall be a prime justification in developing changes to the outline and book plan.

30.5 Outline, book plan and model manual acceptance. The outline and book plan or model manual shall be submitted to the Government for acceptance prior to development of the RDC. If rejected, the unacceptable portions shall be corrected and resubmitted. The accepted outline, book plan or model manual shall become an addendum to the applicable associated detail specification governing the development of the technical manual to the extent that it agrees with the requirements of the contract. The accepted document shall be available for review and comparison with the RDC at all scheduled in-process review conferences. Acceptance of the outline, book plan or model manual by the Government shall not waive any requirements within the scope of the contract.

#### 40. MANUAL ISSUES

40.1 Manual issues. Three types of manual issues are addressed by this appendix: Review Draft Copy (RDC); Preliminary Technical Manual (PTM); and Final Reproducible Copy (FRC).

40.2 Review draft copy (RDC). RDCs shall be developed for review and coordination for technical accuracy (see 6.5.1) and adequacy (see 6.5.2) to evaluate the contractor's progress and assess compliance with applicable specifications and terms of the contract. RDCs shall be submitted for acceptance prior to development of the PTM or FRC.

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40.2.1 RDC development. The RDC shall be developed as follows:

- (a) RDC shall be formulated in accordance with the approved outline and represent the configuration of the hardware (see 6.5.19).
- (b) The text shall be computer generated, double spaced, on one side of the paper and shall contain the exact wording and content intended for the reproducible copy. The RDC may be issued initially in single column format and may include voids where information is not available. The production method may be the most economical method at the option of the contractor. When the RDC is presented in computer or other form such that the paragraphing or symbols cannot be readily understood, it shall be annotated to make the paragraphing and symbols clear to the reviewer.
- (c) All front matter, text, tables, and illustrations shall meet the content, format, page size and image area requirements of the applicable associated detail specification.
- (d) The binding edge shall not be less than 1 inch and the outside edge not less than 1/4 inch. The method of duplication, covering and binding shall provide legible, collated copies.
- (e) Unclassified RDCs shall be duplicated and loose leaf bound in pressboard or equivalent binders.
- (f) Reproduction of pencilled illustrations are acceptable if their technical content, clarity, correctness, and adequacy meet specification requirements. Illustrations submitted for review shall be legible.
- (g) Illustrations, drawings, and tables shall be final size, complete with titles, figures, and table numbers.
- (h) Official nomenclature, common names, and equipment abbreviations shall appear in their normal-reading sequence. The nomenclature shall be used consistently in the text, figures, and tables of the text plan. Transposed nomenclature shall be used in illustrated parts breakdowns (IPBs) or indexes.
- (i) The words "REVIEW DRAFT COPY" shall be placed on the cover and title page above the technical manual identification number.
- (j) The RDC shall be complete in all respects with all in-process review comments incorporated. A completed and signed validation certificate (see figure 1) shall accompany the RDC submitted for technical review. Following review, the developing activity shall incorporate all required changes.
- (k) Appropriate EJRs shall accompany the RDC, as applicable.
- (l) Shading or color-coding is not required in the RDC but functional boundaries shall be illustrated by dotted lines. Hardware boundaries shall be indicated by dot-dash lines, with the number of dots corresponding to the level of containment (first level, second level, and so forth).
- (m) The RDC shall be proofread, technically edited, validated in accordance with the validation plan, and collated in the same manner as the final manual prior to submittal.

40.3 Preliminary technical manual (PTM). PTM shall be developed for interim use to make the technical information available for test, verification, training, and operational use pending receipt of final reproducible copy and distribution of printed manuals.



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40.3.1 PTM development. The PTM shall be developed as follows:

- (a) The PTM shall reflect the style, format and content of the RDC (when applicable) with all Government review comments incorporated and shall be superseded by a final manual.
- (b) The text shall be technically edited, validated and shall be computer generated. The text shall be typed double column and single spaced so that the conversion effort from preliminary to FRC is minimal.
- (c) All front matter, text, tables, and illustrations shall meet the content, format, page size and image and requirements of the applicable associated detail specification.
- (d) The words "PRELIMINARY ISSUE" shall be placed on the cover and title page above the Technical Manual Identification Number. Letters shall be 18-point boldface type and capitalized.
- (e) Unclassified preliminary copies may be duplicated, loose-leaf bound, and delivered in accordance with this specification.
- (f) The reproducible copy and integrally-related artwork (including schematics, wiring diagrams, and block diagrams) shall be of sufficient darkness to reproduce clearly at required reproduction size without additional treatment. Illustrations shall be final size, complete with figure numbers and titles.
- (g) The method of duplication, covering and binding shall provide legible, collated copies.

40.3.2 Interim issue of PTM. When PTM is to be provided as an interim edition, preliminary issues for training purposes or for other early uses (see 6.2), or when there is insufficient time (less than approximately 6 months) to permit acceptance and still provide printed final manuals with the delivered equipment, permission to supply PTM shall be requested from the Government. Permission shall also be obtained from the Government prior to shipping the PTM when any required data are missing. Prior to shipment with any equipment, a review copy of the PTM shall be submitted to the cognizant Government representative for approval and acceptance. The delivery of PTM does not relieve the contractor of any contractual requirements pertaining to delivery of complete, adequate, and accurate final manuals. PTMs shall be updated to represent production equipment prior to submittal with the hardware.

40.3.3 Replacing PTMs with final manuals. When the contractor is responsible for printing and distribution, a self-addressed, contractor-furnished postcard containing information equivalent to the following notice shall be attached to the title page of all PTMs which accompany the equipment:

"IMPORTANT NOTICE: This is a preliminary technical manual for (insert nomenclature of equipment), publication (insert number). A copy of the FINAL manual will be forwarded directly to you when printed. Return this card IMMEDIATELY, indicating your activity and mailing address."

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40.4 Final reproducible copy (FRC). A final document shall be developed ready for reproduction and publication as an authenticated technical manual including all necessary changes made as a result of validation or verification procedures and Government conditions of acceptance or approval. The delivery media shall include, but will not be limited to, reproducible camera-ready copy, direct image copies, digital text and graphic files, disks, tapes, and so forth.

40.4.1 FRC development. The FRC shall be developed as follows:

- (a) The FRC shall incorporate all comments resulting from the technical and format compliance reviews, approved changes resulting from verification, and any comments resulting from interim use of a PTM.
- (b) Text pages shall be prepared using a word processor or document publishing system (see 40.4.6 and Attachment A1). A master copy suitable for reproduction shall be printed.
- (c) The FRC shall include all text pages (including tabular data and emergency page markings when applicable), and reproducible artwork suitable for reproduction.
- (d) FRC shall be in accordance with MIL-P-38790 and supplied in final size.
- (e) If required, reduction shall be obtained by positive to positive production without the use of negatives (see 6.2).
- (f) Type styles and sizes (fonts) shall be comparable to those shown on figure 4. Minimum printed type size for text shall be 10-point elite type. Nomenclature callouts, tabular material, and symbols on illustrations shall be uppercase with 7-point (0.10 inch) minimum printed size. Spacing and lettering shall conserve space without lessening usability or clarity of material. Letters, lines, and symbols shall be of a uniform contrast throughout the text material and shall not touch.
- (g) The FRC shall be of a quality which will permit reduction to 16mm or 35mm negatives (multiform negatives for foldout pages [see 6.5.17]) suitable for subsequent enlargement to full size photolithographic negatives which may be used to produce offset printing plates.
- (h) There shall be no drawing data, other than horizontal lines, placed closer than 1/8-inch from the image area limit.
- (i) Running feet of text pages shall include "Original" at the inboard edge and the page number at the outboard edge.
- (j) Unless otherwise specified, the FRC shall have the following minimum acceptable features:
  - (1) Double column format for 8 1/2 by 11 inch and larger manuals, single column format for smaller manuals.
  - (2) Single spacing.
  - (3) Justified right margins.
  - (4) Headings prepared using the same software as the text.
  - (5) FRC paper stock shall meet or exceed the requirements of JCP-D10 (20 pound).
  - (6) FRC printing (or ink) shall be of such color and consistent contrast to permit quality reproduction.

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40.4.2 Final reproducible copy leading and vertical spacing. Layout shall conserve space without lessening usability or clarity of material (see figure 4). Blank pages and spaces shall be avoided whenever possible. Leading (see 6.5.24) and vertical spacing as indicated by figure 4 shall be used for best legibility and conservation of space. Double spacing of text within a paragraph, or similar wastefulness, is unacceptable. Layout practices shall not result in:

- (a) The first line of a paragraph being at the bottom of a page or column.
- (b) The last line of a paragraph being at the top of a new page.
- (c) A sidehead falling on the last line of a page or column.
- (d) Warnings, (see 6.5.47), cautions (see 6.5.4) and notes (see 6.5.26) being divided so that first lines or group of icons (see 6.5.20) appear on one page and remaining lines or group of icons on another (first lines or group of icons may appear in the left column with remaining lines in the right column on the same page).
- (e) Warnings, cautions and notes being separated from the paragraph they apply to (warnings, cautions and notes may appear in the left column with applicable paragraphs in the right column on the same page).
- (f) Undesirable location of an illustration or table.

40.4.3 Page size and reproduction area for final reproducible copy. Text and artwork shall not exceed the following dimensions for the indicated size manual. Unless otherwise specified, manuals shall be prepared in 8 1/2 by 11 inch size. When specified, manuals shall be produced in accordance with the dimensions below.

Paper Size of Printed Manuals (Inches)	Width - Text/Art		Depth - Text/Art		Depth (Including Marginal Copy)	
	(Inches)	(Picas)	(Inches)	(Picas)	(Inches)	(Picas)
4 by 5 1/2 #	3 1/8	19	4 1/2	27	5	30
4 1/2 by 7	3 5/8	22	6	36	6 1/2	39
4 by 8	3 1/8	19	7	42	7 1/2	45
4 1/2 by 8	3 1/2	21	7	42	7 1/2	45
5 1/2 by 7	4 1/2	27	5 3/4	35	6 1/4	38
5 by 8	4 1/8	25	7	42	7 1/2	45
6 1/2 by 9 1/2	5 1/2	33	8 1/2	51	9	54
9 1/2 by 6 1/2	8 1/2	51	5 1/2	33	6	36
8 1/2 by 11	7 1/4 *	44	9	54	10	60
17 by 11	15 3/4	94	9	54	10	60

# A 4 by 5 1/2 inch manual, volume, or part shall not exceed 200 pages (100 sheets).

\* Double column, each column shall be approximately 3 1/2 inches wide with an approximately 1/4 inch gutter between. Single column shall be 7 1/4 inches wide.

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40.4.4 Oversize reproducible copy. Unless otherwise specified, final reproducible copy shall be supplied final size. When specified, reproducible copy may be prepared oversize not to exceed 50 percent larger than the prescribed image area for each printed manual page size. Type shall be of such size that after final reduction the text shall be no smaller than that prescribed in figure 4. When oversize final reproducible copy is specified, reduction shall be positive to positive (without using film) in accordance with MIL-P-38790; when negatives are used, they shall be in accordance with MIL-P-38790.

40.4.5 Margin data. Margin data (generally the running heads and feet) shall be placed outside that portion of the page used for either narrative text, full page tabular data or full page illustrations, but within the printing area dimensions of the page. When applicable, margin data also consists of the change number, security classification, page content and equipment identification, figure number and figure title. When pages are deleted, a statement shall be included in the margin of the succeeding page. The margin data shall be mounted on full page illustrations, including those for foldout pages that have been prepared in exact printing size (or in the same size as text pages). Margin data shall not be on an overlay. Text may be separately prepared in single column galleys and then attached to the appropriate layout page.

40.4.5.1 Running heads and feet. Complete running heads and feet shall be included on all pages except title pages or pages otherwise blank. Blank pages which back up classified pages shall be marked with the security classification of the backed up page.

40.4.5.2 Running heads.

40.4.5.2.1 Security classification. The security classification, including unclassified pages, of classified manuals shall be at the top center of each page in bold face type in accordance with DOD 5220.22-M. For foldouts, the security classification shall be marked in bold face type, 3/4 inch from the right-hand edge and repeated continuously to the left with four inches of space between each marking.

40.4.5.2.2 Technical manual identification number. The technical manual identification number, as assigned for each volume and part, shall be in bold face type at the upper outer edge of each page and outer segment (page unit) of each foldout page.

40.4.5.3 Running feet.

40.4.5.3.1 Page number. Page numbers shall be located at the lower outer edge ending at the outside margin and shall be in bold face type. Even numbers, including zero, shall be assigned to left-hand pages and odd numbers to right-hand pages. The page number for a foldout page shall be so placed (lower outer edge ending at the outside margin) that the number will be visible when the printed page is folded.

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40.4.5.3.2 Issue indicator. When specified (see 6.2), the issue indicator of basic manuals, revisions and the change designator for change pages shall be located at the outer edge of all pages on the same line as, and 1/2 inch to the inside of, the page number. When specified, the word "Original" shall be included on basic pages.

40.4.5.3.3 Security classification. The security classification, including unclassified pages, of classified manuals shall be at the bottom center of each page in bold face type in accordance with DOD 5220.22-M. For foldouts, the security classification shall be marked in bold face type, 3/4 inch from the right-hand edge and repeated continuously to the left with four inches of space between each marking.

40.4.5.3.4 Foldout figure number and title. The figure number and title for a foldout page shall be so placed (lower outer corner) that the number will be visible when the printed page is folded.

40.4.5.4 Binding edge. When specified, the binding edge shall indicate the equipment or subject to which the manual applies and relate to the prime title. Appropriate abbreviations may be used. Top-bound manuals shall place this information on the top, left-hand corner.

40.4.5.5 Outer edge. When specified, significant reference information such as chapter, section or subject titles or paragraph number or figure number shall be used or added. Appropriate abbreviations may be used. Top bound manuals shall have this information placed on the top, right-hand corner.

## 50. SUPPLEMENT

50.1 Supplements. When specified, supplements shall be developed. They shall conform in style and format with the existing manual.

50.1.1 Classified supplements. The title pages of both the basic manual and the supplement shall contain a cross-reference note. Supplements shall contain the minimum amount of information required to protect security and maintain continuity of thought. Government approval is required for each supplement.

50.1.2 Safety supplements. All text, lettering, numbering, and so forth, for safety supplements shall be in red. Detailed requirements for formal safety supplements (see figure 5) are as follows:

50.1.2.1 Safety supplement margin. The abbreviated title of a safety supplement shall have multiple "SS" along the top, bottom, and side borders with the word "SAFETY SUPPLEMENT" at the bottom of the page.

50.1.2.2 Title designation. The words "SAFETY SUPPLEMENT" shall be positioned above the words "TECHNICAL MANUAL". The nomenclature shall be the same as the basic manual.

50.1.2.3 Supplement notices and replacement notices. A notice shall reference the basic manual supplemented, and, if applicable, reference any publication(s) replaced. For example:

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"This publication supplements SW515-A1-MMI-000/ISS, dated 13 September 1979 and supersedes interim safety supplement to SW515-A1-MMI-000/ISS, dated 23 December 1980, with no changes to the text."

50.1.2.4 Responsibility notice. The responsibility notice shall be positioned as shown on figure 5.

50.1.2.5 Distribution statement. Unless otherwise specified, the distribution statement from the basic manual shall be used for supplements.

50.1.2.6 Publication date. The publication date shall be the same as the date of the replaced interim safety supplement unless the formal supplement contains additional changes.

50.1.2.7 Security information. The security markings shall be the same as for other title pages.

50.1.3 Operational supplements. Detailed requirements for formal operational supplements (see figure 6) shall be the same as for formal safety supplements except:

- (a) The margin shall consist of multiple "OS" in lieu of "SS".
- (b) The words "OPERATIONAL SUPPLEMENT" in lieu of "SAFETY SUPPLEMENT".
- (c) The supplement shall be printed in black.

50.1.4 Routine supplements. A routine supplement title page will be the same as operational supplement title page except that the title shall be the single word "SUPPLEMENT" and margins shall be blank.

50.1.5 Incorporation of supplements into manuals. Whenever practical, supplements, other than those of a higher classification, shall be incorporated into the manual's next revision.

## 60. TECHNICAL MANUAL COSTS

60.1 Cost reports. Technical manuals shall be acquired in a cost-effective manner. Cost and pricing data shall be obtained for each new, revised or changed manual. A separate analysis shall be provided together with supporting documentation for each manual developed. The cost of technical manuals shall be limited to the effort and material needed to produce the manual from source data.

## 70. ENGINEERING JUDGEMENT RECORD (EJR)

70.1 Engineering judgement record (EJR). EJR records shall accompany HM&E and ordnance TRSs submitted, but shall not form a part of the TRS. The EJR shall contain the engineering analysis and reasoning in support of all deviations to tolerances, limits, and other parameters included in the TRS. Each deviation shall be identified with the associated paragraph numbers of the TRS. If deviations from specification requirements are necessary, requests for deviation shall be submitted together with a separate engineering analysis in accordance with established procedures in MIL-STD-973. The format of a typical EJR is shown on figure 7. The Government will retain this record for reference and information.



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- (a) First time acquisitions. Concurrent with the first acquisition of a new system, equipment, or component design, a concise formal EJR shall be developed for each data entry.
- (b) Reacquisitions. For TRSs or TRS change pages developed for existing equipment or systems, a formal EJR is not required for each data entry.
- (c) Deviations. When changes or deviations from existing documents are proposed with regard to clearances, tolerances, materials, procedures, or the implementation of new procedures, worksheets justifying the change or deviation shall be submitted. Departure from design specifications shall only be authorized in accordance with MIL-STD-973.

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DIGITAL ENCODING OF TECHNICAL PUBLICATIONS

10. SCOPE

10.1 Scope. This attachment specifies the digital encoding or digitization requirements associated with the development and delivery of technical manuals conforming to the format requirements of this specification. Manuals developed in general accordance with this specification shall conform to a document type definition defined in Appendix B of MIL-M-38784. This attachment is mandatory for each FRC or final manual deliverable, and the information contained herein requires compliance. Unless otherwise specified in the contract, these requirements are not applicable to other technical manual products such as review draft copy (RDC), preliminary technical manual (PTM), and so forth.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

- MIL-M-28001 - Markup Requirements and General Style Specification for Electronic Printing Output and Exchange of Text.
- MIL-R-28002 - Raster Graphics Representation in Binary Format, Requirements for.
- MIL-M-38784 - Manuals, Technical: General Style and Format Requirements.

STANDARDS

MILITARY

- MIL-STD-1840 - Automated Interchange of Technical Information.

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

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30. SOURCE FILE DEVELOPMENT REQUIREMENTS

30.1 General requirements. Technical manual and artwork shall meet the requirements of this specification, including the requirements specified for FRC printed form and style (see Appendix A, 40.4). All corrections required due to verification and review of the preliminary manuals shall be incorporated. Technical manual in digital form shall conform to the requirements specified in MIL-STD-1840, MIL-M-28001, MIL-R-28002, and the requirements set forth in this attachment.

30.2 Textual source file requirements. Textual material marked in accordance with MIL-M-28001 is referred to as a text source file. A complete SGML-tagged source file(s) of all text data (SGML Instance) is a mandatory part of each final technical manual product.

30.3 Graphic source file requirements. Illustrations or graphic material developed in accordance with MIL-M-28002 is referred to as a graphic source file. Raster illustration or graphic source files for all figures and illustrations shall be a mandatory part of each final technical manual product.

30.4 Source file interchange format. The format of all digital source files shall be in accordance with MIL-STD-1840. It is the source files to which all subsequent changes and updates must be made to maintain the technical publication throughout its operational life. When corrections are made to a working, intermediate, or output file, corrections must be incorporated in the source file which is the primary final product.

30.5 Inspections. The Government reserves the right to perform any of the inspections set forth in MIL-M-28001 to ensure that supplies and services conform to prescribed requirements.

40. DIGITAL FILE REQUIREMENTS

40.1 Files and file formats, general. The following specific digital source files and products are required for the final issue of each technical manual. Technical publication information consists of text and associated illustrations in digital form. This information shall be organized into file sets. Each requisite file of a set shall be encoded in a format specified in MIL-STD-1840, Section 5, and be accompanied by the applicable data file header records as defined in MIL-STD-1840, Section 5.

40.2 Declaration file format. The declaration file shall be in 7-bit ASCII and shall uniquely identify the delivery document. The declaration file shall be developed in accordance with the requirements of Section 5 of MIL-STD-1840. There shall be one declaration file provided with each final manual delivered in digital form. (Declaration files may also contain the characters permitted by Section 1 of FIPS PUB 1-2.)

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40.3 SGML conforming text source file format. The file set of a technical manual containing SGML conforming files shall consist of SGML coded text source files with at least one text source file per document, mandatory. Each file shall be accompanied by identifying data file header records. The text source files shall be ASCII, SGML coded text files tagged in accordance with MIL-M-28001 as specified by the document type definition in Appendix D, Section 30, of MIL-M-28001 and the following.

- (a) Text files shall be provided on 9-track magnetic tape at 6250 characters per inch (CPI) or 1600 if so specified in the contract in data format conforming to MIL-STD-1840. Media other than magnetic tape (for example, magnetic diskettes, optical disks, and so forth) shall be provided when specified in the contract.
- (b) The appropriate document declaration set shall be referenced in the SGML text using the following public identifier:

```
<!DOCTYPE doc PUBLIC "-//USA-DOD//DTD MIL-M-38784C 900102//EN" >
```

- (c) Document numbers for the following items must be physically present in the text stream using the appropriate attribute as defined in MIL-M-28001: chapter, section, paragraph, figure, table, footnote, appendix, steps, and list items.
- (d) All internal (cross) references shall be tagged as defined by the document type definition in Appendix B of MIL-M-38784. For internal references, a reference identifier (ID) shall be provided which specifies the unique ID of that part of the manual which is being referenced. Accordingly, an ID value shall be provided for the appropriate reference within the manual. For external references, the referenced document number shall be provided.
- (e) The following information shall be tagged (as defined by the DTD):

Cross reference	National stock number
Technical manual identification number (Doc No)	Part description
Equipment model number	Part number
Equipment serial number	Start and end of change
Footnote	Start and end of emergency information
Graphic	Start and end of emphasis *
Index flag	Test equipment
* For use only when format specification cannot provide desired emphasis.	

- (f) Hyphenation and spell checking. The processing system that produces the text digital products required by this paragraph must electronically spell check the document text. Line ending machine generated hyphens are not permitted.

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- (g) Page integrity. Page integrity is the maintenance of physical or logical page boundaries at specific places in a publication. The processing system that prepares the digital products must provide page break indicators in the tagged text files for use in maintaining page integrity during future updates to the technical manual. The page break indicator as defined by the document type definition in Appendix B of MIL-M-38784 and associated page number shall be used.

40.4 Document type definition (DTD) data file format. A document type definition shall be used to define the organization and logical structure of elements, entities, and attributes allowed in a particular document. It shall also be used to control automated processing functions (such as parsing) that support quality assurance requirements. The document type definition data file shall be in accordance with the document type definition in Appendix B of MIL-M-38784 and shall define the structure and content of the technical manual.

40.5 Output specification (OS) and formatting output specification instance (FOSI). When specified, the Government will provide a FOSI for use by the contractor. The FOSI provides a set of formatting characteristic values used to rigorously describe composition processing functions to be performed on the elements of a text document to provide the required format and style. The FOSI shall be expanded by the contractor to contain values for characteristics for every context in which a tag has a unique formatting requirement. Each unique tag shall be accompanied with a description of its attributes if it effects the formatting. Technical manuals conforming to this specification and encoded in accordance with MIL-M-38784 shall (if specified in the contract) be accompanied by a FOSI which is which incorporates any contractor unique attributes for output format and style stated in this specification.

40.6 Illustration data source file format. Each set of text source files for a technical publication shall be supported with an illustration data source file for each illustration in the technical publication.

- (a) Raster illustration data files shall be in accordance with the requirements of MIL-R-28002.
- (b) Each illustration data file shall be accompanied by identifying header records (see Section 5 of MIL-STD-1840).
- (c) A printout of all raster file header records will accompany all digital raster illustration files.
- (d) Where there are multiple instances of the same illustration in different locations of the technical publication, a single illustration file may be used to satisfy all of the illustration instances.
- (e) All digital raster illustrations shall be cropped and sized to fit the designated window for printing with no further manipulation.
- (f) The use of color and photographs is prohibited.
- (g) The fixed-length blocks of the raster files are to be padded using ASCII Decimal 32 (space) to the appropriate size.

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- (h) For documents conforming to this specification, 8 1/2 inch by 11 inch or smaller illustrations are to be MIL-R-28002 type I files. All larger sizes are to be MIL-R-28002 type II files.

40.7 Page description language (PDL) data files. Unless otherwise specified, the PDL shall be as follows. Output page description language files shall be provided as allowed by MIL-M-28001. The page description language shall be postscript or a postscript compatible language. The file format shall be written with 256 byte ANSI type F fixed-length records with block length of 2048 bytes. All data header records shall be as defined in Section 5 of MIL-STD-1840. The data header record shall be written in the first physical block of the file, with the block padded using ASCII Decimal 32 (space) to the appropriate size. There shall be only one postscript or postscript compatible file for the final issue of each technical manual.

40.8 Hardcopy print from PDL files. A hardcopy printout of the PDL files shall accompany each final technical manual deliverable.

40.9 Special word data file format. Any special word data files and their format (see MIL-STD-1840) shall be as specified.

50. SPECIAL SOURCE FILE REQUIREMENTS

50.1 Acquisition specification file format. When specified, technical manuals shall be developed in accordance with this specification and provided in a special digital file format as specified in the acquisition contract. Unless otherwise specified, special contract digital files shall only be provided supplemental to the SGML files defined herein.

50.2 Commercial digital file format. When specified, technical manuals shall be developed in accordance with this specification and provided in a standard off-the-shelf commercial file format as defined in the contract. Unless otherwise specified, commercial digital files shall only be provided supplemental to the SGML files defined herein.



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## APPENDIX B

## STYLE OF WRITING

## 10. SCOPE

10.1 Scope. This document establishes the requirements for the style and level of writing to be used in the development of technical manuals, changes, and revisions. This general style of writing supplements the various requirements cited in specific associated detail specifications. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## STANDARDS

## MILITARY

- MIL-STD-12 - Abbreviations for Use on Drawings, Specifications, Standards, and in Technical Documents.
- MIL-STD-1309 - Definition of Terms for Automatic Electronic Test and Checkout.

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

20.1.2 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 are those cited in the solicitation.

## PUBLICATION

## DEPARTMENT OF DEFENSE

- JCS Pub 1 - DOD Dictionary of Military and Associated Terms.

## GOVERNMENT PRINTING OFFICE

- Z253.U58 - US Government Printing Office Style Manual.

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

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DEPARTMENT OF THE NAVY

EL160-AA-LST-010 - Baseline Word Lists for NAVSEA/SPAWAR Technical  
Manuals.

SL160-AA-LST-010 - Baseline Word Lists for NAVSEA/SPAWAR Technical  
Manuals.

(Application for copies of Department of the Navy publications should be  
addressed to the Standardization Document Order Desk, Building 4D, 700 Robbins  
Avenue, Philadelphia, PA 19111-5094.)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)/INSTITUTE OF ELECTRICAL  
AND ELECTRONICS ENGINEERS (IEEE) STANDARDS

IEEE Std 945 - Preferred Metric Units for Use in Electrical and  
Electronics Science and Technology, Recommended  
Practice for.

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

E 380 - Use of International System of Units (The Modernized Metric  
System).

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

30. STYLE OF WRITING

30.1 Style of writing. Writing style shall be in accordance with the GPO  
style manual. Style of writing shall ensure:

- (a) Technical content shall be presented in language free of vague and  
ambiguous terms, using the simplest words and phrases which will  
convey the intended meaning. The U.S. Government Printing Office  
(GPO) Style Manual shall be used as a general guide for  
capitalization, punctuation, compounding of words, numerals in the  
text and spelling of nontechnical words. All essential  
information shall be included, either by direct statements or by  
reference. Sentences shall be short and concise. Punctuation  
shall be used in a manner which aids in reading and prevents  
misreading. Sentences shall be rewritten when extensive  
punctuation is necessary for clarity. Technical words shall be  
used only when no other wording will convey the intended meaning.

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- (b) For maximum clarity and usefulness, there shall be consistency in terminology and organization within the same publication or series of publications. Nomenclature shall be consistent within a publication and throughout parts lists, parts breakdowns and other directly related publications.
- (c) Quotation marks and underscoring shall not be used for emphasis.
- (d) Words which have more than one meaning which will fit the context in which they are used, such as "replace" for "reinstall," shall not be used.
- (e) Chapter, section and paragraph headings shall be descriptive of the contents of the division they head; "General" and "Miscellaneous" shall not be used unless no other title will suffice.
- (f) Statements which explain applicability for individual items of equipment shall use specific serial number(s), block designation(s), specific model designation(s) or similar identification. Such terms as "on later equipment" and "on early serial numbers" shall not be used.
- (g) Technical publications shall make no reference to age, sex, race or national origin. Use sex neutral terms, except avoid use of the word "person" (terms such as "midshipman" and "workman" are considered sex neutral). Terms such as male and female connectors, pins, and so forth, are acceptable.

30.1.1 Support of user tasks. To the extent possible, information shall be presented that:

- (a) Directly supports the immediate task of the user.
- (b) Minimizes need for reading, studying, and conceptualizing skills.
- (c) Minimizes need to refer to other documents or text material.

30.1.2 Standard english grammar. Rules of grammar for standard American English shall be used. Colloquial, substandard, and slang expressions shall not be used. Infinitives may be split and sentences may be ended with prepositions in cases where not doing so sounds awkward or stilted and is likely to distract the user's attention from comprehending the content.

30.1.2.1 Grammatical person and mood. The second person imperative mood shall be used for procedures, for example, "Remove test set from carrying case." Third person indicative mood shall be used for description and discussion, for example, "When switch A is in the ON position, lamp (34) lights."

30.1.2.2 First person pronouns. First person pronouns should be used, to avoid indefinite passive construction; for example, "We found that..." rather than "It has been found....".

30.1.2.3 Positive form. Procedural steps shall be in positive form ("Close the container" rather than "Do not leave the container open") unless the meaning demands the negative form.

30.1.2.4 Concrete and specific language. Concrete and specific language shall be used to reduce vagueness. Examples are as follows:

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- (a) Example 1: (1) Abstract and general: "Precautions should be taken against fire."  
(2) Concrete and specific: "Periodically inspect fire doors and automatic sprinkler system."
- (b) Example 2: (1) Abstract and general: "It is wise to make the area comfortable and to make provisions for shutting out noise from the shop."  
(2) Concrete and specific: "Air-condition the area and soundproof the walls."

30.1.2.5 Use of "shall", "will", "should" and "may". Use "shall" whenever a manual expresses a provision that is binding. Use "should" and "may" whenever it is necessary to express nonmandatory provisions. "Will" may be used to express a declaration of purpose. It may be necessary to use "will" in cases where simple futurity is required, for example, "Power for the meter will be supplied by the ship."

## 30.2 Sentences and phrases.

30.2.1 Complex sentences. If a sentence has more than one clause and is more than 20 words in length, it shall whenever possible be rewritten as two or more simple sentences.

30.2.2 Sentences in procedures. Sentences directing the actions of the user shall be in the active voice and imperative mode. If more than one person is involved, the directions shall be in the active voice, indicative mode, third person.

30.2.3 Word order. Sentences and clauses shall be written using simple word order (subject, verb, object) to the extent possible. Modifiers, including prepositional phrases, shall be as close as possible to the word modified. These word order requirements shall be relaxed only to the extent necessary to avoid ambiguity or distortion of meaning. Procedural steps shall start with an active verb; lubricate, remove, tighten, and so forth.

30.2.4 List form. If any series of three items or more appears in a sentence, the sentence shall be written so the items will appear in explicit list form as follows:

- (a) All dirty, greasy, or water-repellent surfaces are then rubbed or scrubbed with swabs or brushes.
- (b) Using swabs or brushes, rub or scrub all surfaces which are:
- dirty  
greasy  
water-repellent.

30.3 Simple versus complex phrases. Complicated phrases shall be avoided. Examples are as follows:

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<u>Simple</u>	<u>Unnecessarily elaborate</u>
About	As to, with regard to
After	Subsequent to
Because	Inasmuch as, for the reason that
Require	Necessitate
Enough	Sufficient
Find out	Ascertain
For	For the purpose of
Get	Acquire, obtain, receive
If	In the event that
Now	At this time, presently
Since	Inasmuch as
To	In order to

40. LEVEL OF WRITING

40.1 Readability. Unless otherwise specified in the associated detail specification, the Reading Grade Level (RGL) shall be nine. Technical manuals shall be written to the capability of the target audience for which they are intended. The method employed to determine readability of narrative material is optional; however, it must meet the quality assurance provisions identified in Section 4 of this specification. The overall grade level (OGL), determined in 4.6, shall not exceed the appropriate RGL by more than one grade level. The grade level (GL) of each sample, shall not exceed the appropriate RGL by more than three grade levels. Nonnarrative material, such as procedural steps, is not subject to RGL.

40.2 Sample selection. Samples of text shall be analyzed for readability. Select samples as follows:

- (a) Count the number of pages of text in the publication. The count shall include all full and partial pages that contain text in the form of consecutive sentences. The count shall not include pages containing only illustrations, tables, lists, and so forth. Record the number of text pages.
- (b) The basic number of samples is determined by the following:

<u>NUMBER OF TEXT PAGES</u>	<u>DIVISOR DIVIDED BY "N"</u>	<u>BASIC NO. OF SAMPLES</u>	
		<u>MIN</u>	<u>MAX</u>
90 and above	10	9	30
54 to 89	9	6	9
32 to 53	8	4	6
1 to 31	6	2	4

- (c) Divide the number of text pages by the appropriate divisor, "N". Round off the quotient to the next lowest whole number. For example: quotients of 17.3 and 17.7 shall both be rounded off to 17. This quotient shall equal the basic number of samples to be analyzed.



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- (d) For publications that contain fewer than 12 pages, randomly select two samples and mark them for analysis.
- (e) For publications that are 12 pages or more, randomly select a number between one and "N". The number selected shall be marked as the first page of text to be analyzed. Starting at the selected page, mark every "Nth" page of text to the end of the publication. The marked pages shall identify starting points for the basic samples to be analyzed.
- (f) Check marked pages to verify that at least one sample has been selected for each chapter of the publication. If any chapter (see 6.5.7) has been missed, randomly select one text page from that chapter and add it to the basic samples to be analyzed.

40.3 Raw data collection. For each sample marked, raw data must be collected. Data collection will consist of counts of the numbers of words, sentences, and syllables in each sample. The size of each sample is based on the number of words to be analyzed. Samples shall start at the beginning of the first full paragraph on each marked sample page. If a sample falls on a page containing procedural instructions, start sample at beginning of first full sentence on page. Headings, captions, and paragraph titles shall not be counted in the sample.

40.4 Word count. For each sample, count the number of words as follows:

- (a) For each sample, count all words up to the end of the sentence containing the 200th word. If the marked sample page contains fewer than 200 words, the sample can be extended to the next page of text; but, do not extend the sample into a new chapter or text pertaining to a completely new subject.
- (b) Count as a word all numbers, letters, symbols, and groups of letters surrounded by white spaces. Hyphenated words and contractions count as one word. For example: each of the following count as one word: couldn't; GFE; that is; 32,008; 19-inch; +250F, left-hand. Thus a sentence like "The left-hand MLG door shouldn't open more than 250." consists of 9 words.
- (c) Record the number of words in each sample.

40.5 Sentence count. For each sample, count the number of sentences as follows:

- (a) Count all sentences in sample including the sentence that contains the 200th word.
- (b) Count as a sentence each unit of thought that can be considered grammatically independent of another sentence or clause. A period, question mark, exclamation point, and semicolon usually denote independent clauses and thus mark the end of a sentence.
- (c) Record the number of sentences in each sample.

40.6 Syllable count. For each sample, count the number of syllables as follows:

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- (a) For most words, count syllables the way the word is normally pronounced aloud. For example: "at" is one syllable, "maintain" is two syllables, "area" is three syllables, "panoramic" is four syllables, and "recuperated" is five syllables.
- (b) Count all numbers as one syllable. For example: 5.1, 65 and 300 all count as one syllable each. However, if a numeric expression contains several numbers separated by hyphens, count each number as a syllable. For example: the expression 9-1025-240-10 is counted as four syllables.
- (c) Acronyms and abbreviations are counted as one syllable unless they actually spell out a word of more than one syllable. For example: Hz and DVM each count as one syllable but TRADOC and ARRCOM each count as two syllables.
- (d) Count as one syllable all words that are included in a baseline word list for Navy technical manuals (see SL160-AA-LST-010/TM-WORDS; EL160-AA-LST-010/TM-WORDS) and all expanded versions of those lists that are authorized for technical manual acquisitions.
- (e) Record the number of syllables in each sample.

40.7 Grade level calculations.

40.7.1 Overall grade level. The Overall Grade Level (OGL) of a publication is calculated as follows:

- (a) Add the total number of words (W) from all samples combined.  
Record total.
- (b) Add the total number of sentences (S) from all samples combined.  
Record total.
- (c) Add the total number of syllables (P) from all samples combined.  
Record total.
- (d) Calculate the average sentence length (A). Divide total number of words (W) by total number of sentences (S):  $(A = W/S)$ . Round off quotient to the nearest one hundredth. Record quotient.
- (e) Calculate the average number of syllables per word (B). Divide total number of syllables (P) by total number of words (W):  $(B = P/W)$ . Round off quotient to the nearest one hundredth. Record quotient.
- (f) Calculate the OGL of the manual by the following formula. Round off the OGL to the nearest integer.

$$\text{OGL} = 0.39(A) + 11.8(B) - 15.59$$

SAMPLE COMPUTATIONS TO DEMONSTRATE USE OF FORMULAS:

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<u>SAMPLE</u>	<u>TOTAL NO.</u> <u>WORDS</u>	<u>TOTAL NO.</u> <u>SENTENCES</u>	<u>TOTAL NO.</u> <u>SYLLABLES</u>
1	250	30	500
2	220	35	475
3	245	28	420
4	223	22	400
5	256	32	510
6	215	27	398
7	219	26	395
8	230	30	400
9	225	29	380
<u>10</u>	<u>226</u>	<u>28</u>	<u>370</u>
TOTALS: 10	W = 2309	S = 287	P = 4248

$$A = W/S \quad A = 2309/287 \quad A = 8.05$$

$$B = P/W \quad B = 4248/2309 \quad B = 1.84$$

$$OGL = 0.39(A) + 11.8(B) - 15.59$$

$$OGL = 0.39(8.05) + 11.8(1.84) - 15.59$$

$$OGL = 3.14 + 21.71 - 15.59$$

$$OGL = 9$$

40.7.2 Sample grade levels. Calculate the Grade Level (GL) of each sample as follows:

- Calculate the average sentence length (L). Divide the number of words in the sample (V) by the number of sentences in the sample (T):  $(L = V/T)$ . Round off quotient to the nearest one hundredth.
- Calculate the average number of syllables per word (D). Divide the number of syllables (C) in the sample by the number of words (V) in the sample:  $(D = C/V)$ . Round off quotient to the nearest one hundredth.
- Calculate the Grade Level of each sample (GL) by the following formula. Round off each GL to the nearest integer.

$$GL = 0.39(L) + 11.8(D) - 15.59$$

SAMPLE COMPUTATIONS TO DEMONSTRATE USE OF FORMULAS:

<u>SAMPLE</u>	<u>TOTAL NO.</u> <u>WORDS</u>	<u>TOTAL NO.</u> <u>SENTENCES</u>	<u>TOTAL NO.</u> <u>SYLLABLES</u>
1	V1 = 250	T1 = 30	C1 = 500
2	V2 = 220	T2 = 35	C2 = 475
	L1 = V1/T1	L1 = 250/30	L1 = 8.33
	D1 = C1/V1	D1 = 500/250	D1 = 2
	L2 = V2/T2	L2 = 220/35	L2 = 6.29
	D2 = C2/V2	D2 = 475/220	D2 = 2.16

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GL1 = 0.39(L1) + 11.8(D1) - 15.59  
 GL1 = 0.39(8.33) + 11.8(2) - 15.59  
 GL1 = 3.25 + 23.6 - 15.59  
 GL1 = 11

GL2 = 0.39(L2) + 11.8(D2) - 15.59  
 GL2 = 0.39(6.29) + 11.8(2.16) - 15.59  
 GL2 = 2.45 + 25.49 - 15.59  
 GL2 = 12

## 50. REFERENCES

50.1 References. References shall be kept to a minimum and shall be limited to Government approved documents such as military specifications and standards, technical manuals, drawings, engineering change data, and other approved material which will enhance the clarity and support the repair requirements and processes delineated in the manual. When commercial documents are the only suitable reference material available, approval shall be requested of the Government upon request of the manual developing activity. Strong justification must be provided. Referencing shall conform to the following:

- (a) Where a small amount of information is needed (fewer than two pages), the applicable material shall be copied verbatim.
- (b) Where a large amount of material is required (more than two pages) the applicable material shall be referenced fully, including the publication number and title. An example is NAVSEA 0900-LP-038-6010 (Chrome Plating). Reference to alternative repair procedures and drawings required to refurbish parts is acceptable if that refurbishment information is not routinely required.
- (c) Where the reference is to an entire content of another document, the reference shall be only to the title of the publication and the publication identifying number. It is not considered necessary to repeat quality control standards or other approved routine procedures which have been addressed during specialty training. For example, the requirements of MIL-STD-278 (Welding) or NAVSEA 0948-LP-045-7010 (Level I Material) shall not be repeated but invoked through reference.

50.1.1 Text references. The text shall refer to:

- (a) Only models or types covered by the manual. To facilitate coverage of modified or additional models or types at a later date, references should be held to a minimum consistent with clarity.
- (b) The basic number of Government specifications and standards. When the contractor cannot find out the Government specification number, the contractor shall request this information from the Government, furnishing complete information concerning the material's composition, properties, characteristics, applications, manufacturer's specification number, and so forth.

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- (c) Temperature readings as calibrated on the equipment. If other than Fahrenheit, the equivalent in Fahrenheit shall follow in parentheses. General temperature references, such as room temperature, shall normally be given in degrees Fahrenheit.
- (d) Speed, distance and other instrument readings, as calibrated on the equipment.
- (e) Switch positions and panel markings exactly as marked on the equipment. However, symbols on panel markings may be spelled out when they cannot be produced by the composing equipment used to prepare the PTM or FRC, such as the symbol for "ohm", "infinity", and so forth.
- (f) Measurements in U.S. standard units (ounces, pounds, gallons, inches, feet, knots, miles, and so forth) except instances in which metric measurements are required. When the metric system is used on the equipment, conversion to U.S. standards shall follow in parentheses. If the content specification so requires, conversion of U.S. measurements to metric measurements shall be indicated.
- (g) Illustrations by figure number, including section letter and number when applicable, and the sheet number for multisheet illustrations, when applicable. References shall be made only to illustrations within the same manual or another volume of the same manual.
- (h) Figure numbers first, followed by the index number (see 3.5.7). For example: "(Figure 2-6, 34)." However, when multiple references in a paragraph refer to the same figure, only the first reference need indicate the figure number. For example:

"4.8.1 Disassembly of Air Valve. Disassemble the air valve (Figure 4-2) as follows:

- a. Unscrew safety disc retainer (2) from valve body (1).
- b. Remove safety disc (3) and safety disc washer (4) from valve body (1)."

When the sequence is unbroken for procedures requiring two or more pages, the figure number followed by a dash and the word "Continued" shall be repeated after the first reference on each succeeding page. If two or more figures are involved in the same sequence, the figure with the greater number of items shall be cited as described above. Index callouts for items on remaining figures shall have the index number follow the figure number, for example "(Figure 3-5, 21)." In such cases, the paragraph lead-in shall contain a statement similar to the following: "Item numbers below refer to Figure 3-4 unless otherwise indicated."

- (i) Parts on diagrams by enough of their reference designation to identify the item. For example: Resistor A6R11.
- (j) Tables by table number. Reference shall be made only to tables within the same manual or another volume of the same manual.

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- (k) Other supporting paragraphs in the same manual or another volume of the same manual, by exact paragraph title (without the paragraph number) in capital letters, followed by the volume, part, chapter and section number in parentheses.
- (l) Other subordinate paragraphs of the same primary paragraph as "above" or "below."
- (m) Other technical manual identification numbers including exact paragraph title, when applicable, but omitting dates, page, figure and paragraph numbers. Reference may be made only to publications in the publication system(s) of the Service(s) that will use the publications and are authorized at user level.
- (n) Footnotes, when essential for reference, explanation, comments, and so forth. Footnotes shall be numbered. Identical footnotes shall not be repeated within the chapter. Footnotes in the text shall not be used for mandatory requirements. Footnotes to the text shall be placed at the bottom of the page with a one inch horizontal rule placed flush left two spaces below the text and the footnote placed under the rule.
- (o) Series of items as follows:
  - (1) By following the basic number with "-series" when all numbers in the series are included. For example: "SE377-C2-FCB-series" includes all technical manual identification numbers beginning with SE377-C2-FCB.
  - (2) By following the basic number with "series" (without dash) when the basic number is immediately followed by a letter or is succeeding a higher number. For example: 781-series could include 781A, 781K, and so forth; DD Form 1570-series could include DD Form 1571, 1575, 1577, and so forth.
- (p) When a reference applies only to one sentence, it shall be enclosed in parenthesis. For example: "...which will be used for this purpose (Figures 2-9 and 2-10)."
- (q) When a reference applies to the entire paragraph it shall be enclosed in parenthesis. For example:
 

"5.3 Inspection Requirements (Figure 3-2). Inspection shall be ..... system." When a reference applies to the entire paragraph, but the paragraph has no title, it shall be enclosed in parenthesis outside the sentence. For example: "...technical data change request. (SG120-AC-MMO-010)."

50.1.2 Text reference placement. References shall conform to the following:

- (a) When a reference applies to one item within a sentence, place the reference parenthetically immediately after the item being referenced, for example: "The test set (figure 1-1) comprises a main panel (figure 1-2) and a power supply (figure 1-3)."

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- (b) When a reference applies to an entire sentence, place the reference at the end of the sentence with a period outside the parenthesis; for example: "This characteristic causes the first portion of control movement to be less effective (see figure 6-3)." or show the reference in a complete sentence: "The procedure for making the adjustment is shown on figure 6-23."
- (c) When reference applies to an entire paragraph or paragraphs, place the reference after the paragraph title, for example: "6-2 Simulation Diode Monitor (figure 6-56)."
- (d) When reference is made to items in figures by reference designations, the numbers shall be indicated in the following manner: "The ON-OFF switch (158, figure 3-6) on the center console controls the TWT cooling."

50.2 Consolidation of material. To the extent possible, all information required to complete a single task shall be put in one location in the manual. Information and artwork shall be repeated as necessary to fulfill this requirement. The need for the user to refer to other parts of the manual or to other information sources during performance of a task shall be minimized.

50.3 Reference to zones. In reference to zones, the numeral shall be listed first to avoid possible confusion with references designations, for example: use "3C" instead of "C3".

50.4 Enclosures. Enclosures may be used to include closely-related material which is not an inherent part of the manual. The enclosures, identified in full, shall be listed by numbers, for example, (1), (2), and (3), in the order they are mentioned in the text. Enclosures shall be inserted immediately after the last Appendix. The page designation shall be "Enclosure \_\_, page \_\_ of \_\_."

## 60. USAGE OF TERMS

60.1 Abbreviations and acronyms. The use of abbreviations and acronyms shall be such that there is no need for experienced users to consult a glossary of abbreviations and acronyms. Abbreviations and acronyms should be used for those systems, subsystems, equipment, components, organizations, or other items which are ordinarily referred to by their abbreviations or acronyms by experienced personnel. When abbreviations or acronyms are used as markings on the equipment, the same abbreviations and acronyms shall be used in the technical manual. Use of abbreviations and acronyms shall be held to a minimum and each shall be spelled out the first time it appears in each chapter, section, part, job guide, work package or other division where confusion may exist or usability would be enhanced. An excellent rule to follow is; "when in doubt, spell it out." Abbreviations and acronyms which are accepted as words (radar, sonar, laser, and so forth) need not be spelled out. When a phrase is being abbreviated or acronymed, the first letter of each word shall be capitalized and elements shall not be separated by periods. For example: Offensive Avionics System (OAS). Abbreviations and acronyms used shall be in accordance with the requirements of MIL-STD-12, except that abbreviations may be plural (s) or possessive ('s) after the first use. If a manual is prepared on composing equipment which cannot produce a certain abbreviation or symbol, such as "+" for "plus or minus", a



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substitute symbol, such as "+/-" or "+ or -", or an abbreviation, such as "POM", may be used. New abbreviations and acronyms shall not be created for words or terms that already have abbreviations and acronyms established in MIL-STD-12. All abbreviations and acronyms used in the manual shall be explained in the manual's foreword, preface, or introduction.

60.2 Automatic electronic test and checkout terminology. Terms used for automatic electronic test and checkout shall be in accordance with MIL-STD-1309.

60.3 Military terms. Military terms used shall be in accordance with Joint Chiefs of Staff (JCS) Pub 1 or any dictionary or glossary of military terms of the appropriate Service.

60.4 Synonyms. Use of synonyms to provide variety in technical writing can lead to confusion. If there are several synonyms for a concept or object, only one shall be selected and used consistently throughout the technical manual. For example, do not use the terms unit, assembly, equipment, component, and hardware interchangeably to refer to the same item.

60.5 Shortened equipment names. In each section supporting a single user task, official terminology shall be used for the first reference to a hardware item. Official terminology shall be used wherever the use of a shortened name might be ambiguous.

60.6 Nomenclature. Nomenclature associated with systems, equipment, and components shall be introduced by means of illustrations coordinated with descriptive text.

## 70. ORGANIZATION OF TASKS

70.1 Organization of the technical manual. To ensure comprehensibility (see 6.5.11), technical manuals shall be organized on the basis of the user's need for information. In complex equipment or systems, or systems where hierarchies of functional and physical relationships exist, corresponding technical tasks shall be grouped together in order of importance. An overview of the hierarchical arrangement of tasks by which the manual is organized shall be provided. This overview may be illustrated as a family tree or top-down breakdown of the tasks. The hierarchical arrangement shall be described in the introductory chapter of the technical manual.

## 80. USE OF METRICS

80.1 Metric practices. Metric practices, measurement units, symbols, and so forth, shall be in accordance with ASTM E380-91 and IEEE Std 945-84.

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## MANUAL ARRANGEMENT

## 10. SCOPE

10.1 Scope. This appendix documents the arrangement of the technical manual in accordance with a standardized format. It describes the prescribed arrangement for front matter, technical content, appendices, glossaries indices, and deficiency reports. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## STANDARDS

## MILITARY

MIL-STD-1806 - Marking Technical Data Prepared By or For the Department of Defense.

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

## 30. ARRANGEMENT

30.1 Arrangement. Each manual shall be arranged into volumes according to a standardized format (as applicable):

- (a) Front matter.
- (b) Technical content subject matter.
- (c) Appendices.
- (d) Glossaries.
- (e) Indices.
- (f) Technical Manual Deficiency Reports (TMDERs).

## 40. FRONT MATTER

40.1 Front matter. Unless otherwise specified, material preceding the first chapter shall consist of the following as a minimum in the order specified:

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MATERIAL

- (a) Cover and Title Page or Abbreviated Title (as applicable)
- (b) Change Instruction Sheet (applicable only to changes, see MIL-M-24784/1)
- (c) List of Effective Pages
- (d) Change Record Page
- (e) Table of Contents
- (f) List of Illustrations
- (g) List of Tables
- (h) Foreword, Preface, and Introduction
- (i) Safety Summary (as applicable)
- (j) Frontispiece

40.2 Cover and title page. Manuals shall have either a cover or title page, or an abbreviated title. When specified, there shall be a cover and title page. The cover and title page shall contain the information indicated by figure 8. Figure 8 also lists the requirements for abbreviated titles. Abbreviated titles shall be used only when specified. Unless otherwise specified, if there is both a cover and title page, the date shall be omitted from the cover page. When specified, a manual shall require a backbone for binder or cover. FRC for the backbone or cover of a manual shall be in accordance with figure 9. The technical manual identification number shall appear in the upper left-hand corner of the cover and title page, and will be furnished by the Government. When specified, certain information such as the supersedure notice, supplement notice, disclosure notice and destruction notice, as applicable, may be placed on the reverse side of the title page if additional space is needed to avoid overcrowding of the title page (that is, small technical manuals such as job guides and work cards). The reverse side of the title page, when used as a continuation of the title page, shall be numbered.

40.2.1 Review draft copy. When specified, the words "Draft" or "Final Draft" shall be centered above the words "TECHNICAL MANUAL."

40.2.2 Preliminary technical manual. When applicable, the word "PRELIMINARY" shall be centered above the words "TECHNICAL MANUAL" (or type of publication).

40.2.3 Title. The technical manual title as indicated by the applicable content specification shall consist of the following, located as shown on figure 8.

- (a) WARNING (if the manual contains unverified data).
- (b) Heading "TECHNICAL MANUAL"
- (c) Type of Manual
- (d) Maintenance Level (if restrictive)
- (e) Prime title (name and nomenclature)
- (f) Subtitle (as applicable)
- (g) Manufacturer

40.2.3.1 Title warning. When specified, a manual containing unverified data shall have the following warning centered above the heading TECHNICAL MANUAL:

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This manual contains unverified procedures. Refer to the Verification Status Page(s) prior to performing any operation or maintenance procedures.

40.2.3.2 Type of manual. The type of manual (for example, operation instructions, illustrated parts breakdown, repair parts and special tools list, maintenance instructions, and so forth) shall be placed beneath the "TECHNICAL MANUAL" heading.

40.2.3.3 Maintenance level(s). The level(s) of maintenance, as appropriate, shall be placed beneath the manual type. When only one maintenance manual is being acquired to support a weapon, equipment or hardware, no level shall be specified unless restrictive, since it will be the only manual available for repair and maintenance at any designated maintenance level (Organizational, Intermediate or Depot).

40.2.3.4 Prime title. The nomenclature of the equipment, type, model, part number or subject (blocks, serial numbers or registration numbers, if appropriate) shall be positioned below the words identifying the manual type or maintenance level, if applicable. When specified, the national stock number and identification of other equipment covered in the manual shall be indicated. The classification of the equipment nomenclature shall be indicated (U), (C), (S), as specified in DOD 5220.22-M if the publication itself is classified. The prime title shall be the same on all volumes and parts of a multivolume or part technical manual set.

40.2.3.5 Subtitle. A subtitle shall be used and located immediately below the prime title to indicate the contents of every separately bound volume and part of a technical manual.

40.2.3.6 Manufacturer. When specified, the identification of the manufacturer of the equipment shall appear below the equipment nomenclature or subtitle, as applicable.

40.2.4 Contract number. When specified, the original contract number shall be placed on all new issues and carried forward on all subsequent cover and title pages. If the contract number for a change or revision is different from the original number, the number applicable to the change or revision shall be indicated on the cover and title page in addition to the original number. No more than two contract numbers, the original and the latest, need appear.

40.2.5 Seal. The Department of the Navy Seal, with command identifier, is placed below the contract number(s).

40.2.6 Supersedure notice. Unless otherwise specified, the supersedure notice shall include a list of all currently superseded supplements and Rapid Action Changes (RAC). Superseded supplements and RACs shall normally be listed individually, but when several alphabetically or numerically sequenced supplements and RACs are superseded, they shall be grouped. When specified, Final

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Reproducible Copy (FRC) that supersedes a Preliminary Technical Manual (PTM) shall include the supersedure notice. The applicable portions of the following supersedure notice shall be used:

"This (manual, change, revision or RAC) supersedes (applicable manual, change, revision number or portions of) dated (date of superseded document), Change (change number) dated (change date), including (superseded supplement or RAC numbers)."

40.2.7 Supplement notice. A supplement notice is used to show dependent and supporting publications when one cannot be used without the other. They apply to supplements, supplemental or partial manuals, and basic manuals. Dependency is shown by such statements as "INCOMPLETE WITHOUT SWXXX-XX-XXX-XXX" or "USE WITH SWXXX-XX-XXX-XXX". Supporting publications are depicted by such statements as "THIS PUBLICATION SUPPLEMENTS SWXXX-XX-XXX-XXX". Cross-reference notes to supplements, or to augmented manuals, shall be placed on the cover and title page initially, or at time of change or revision.

40.2.8 Volume notice. When specified, the cover and title page of each volume shall contain a statement that the applicable volume is incomplete without the other volumes in the set.

40.2.9 Disclosure notice. When specified by the Government, a special disclosure notice will be placed on the cover and title page.

40.2.10 Distribution statement. All technical manuals shall have a distribution statement placed on the cover and title page. The appropriate distribution statement, selected from MIL-STD-1806, will be provided by the Government. Selection of the statement shall be in accordance with the provisions of MIL-STD-1806. Unless otherwise specified, Distribution Statement C shall be placed on the cover and title page of each manual, manual supplement, manual revision or change, as follows:

"Distribution Statement C: Distribution authorized to US Government agencies and their contractors; (fill in reason); (date of determination). Other requests for this document shall be referred to (insert name of controlling DOD office)."

40.2.11 Export control notice. When required by the provisions of MIL-STD-1806, the following Export Control Notice shall be placed on the cover and title page of each manual, manual supplement, revision or change:

"WARNING: This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U.S.C. SEC 2751, et seq) or the Export Administration Act of 1979, as amended, Title 50, U.S.C., App 2401 et seq. Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of DOD Directive 5230.25."

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40.2.12 Destruction notice. All technical documents marked with distribution statements B, C, D, E, F or X shall be marked with the destruction notice from DOD 5230.24 on the cover and title page as follows:

"Destruction Notice: Destroy by any method that will prevent disclosure of contents or reconstruction of the document."

40.2.13 Authority notice. The authority notice will be provided by the Government. Manuals to be jointly used shall show a joint authority notice.

40.2.14 Publication date. The publication date of the manual shall be the cutoff date from which no further changes to the manual are permitted without issuing a formal change. This is normally the "approved date", that is, the date the Government accepts the manual subject to the inclusion of specified comments. If the Government does not advise the contractor the exact date to use, the publication date shall be the date at which the last material to be included was received (copy freeze date). The day, month, and year shall be given in that sequence. For example: "7 JULY 1988."

40.2.15 Change letter and date. The change letter and date shall be placed on the cover and title page as follows:

"CHANGE A 15 OCTOBER 1992" or "CHANGE 1 15 OCTOBER 1992"

40.3 List of effective pages. A list of effective pages shall be in accordance with figure 10. The list of effective pages shall back up the title page and be numbered. When the last page is a right-hand page, it shall not be backed up and will list the next succeeding page as blank, for example, "B/(C blank)". The list of effective pages shall be a complete list of all manual pages, including title page, the list of effective pages, verification status pages, table of contents pages, safety summary pages, blank pages, deleted pages, added pages and foldout pages. The list of effective pages shall include a statement of the total number of pages in the manual. The list of effective pages shall be updated for each change or revision. The listing shall be held to a minimum by grouping numbers where applicable. The page numbers for a blank page and the printed side of the sheet shall be listed as separate numbers even though a double number will appear on the printed side of the sheet. Appropriate change numbers shall be placed in the "Change No." column. The words "Deleted" or "Blank" shall be placed along side the page number of pages so effected.

40.3.1 Acquiring service identification. The abbreviation of the acquiring Service, for example, USAF, shall be placed in the lower right corner of the list of effective pages (page "A" only). If a Service acquires a manual for exclusive use of another Service, the symbol in the lower right-hand corner of the page shall still show the abbreviation of the acquiring Service.

40.3.2 List of effective pages for multivolume manuals. A list of effective pages covering all volumes shall be developed for the basic manual and shall be included in Volume I. In a multivolume manual, each of the volumes, except Volume I, shall include the listing of pages provided in that particular volume.



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40.4 Change record. Unless otherwise specified, a change record, when included, shall be in accordance with figure 11, and shall be included in each separate volume. The change record should not back or be backed up. These pages shall not be numbered.

40.5 Table of contents. A table of contents listing parts, chapters, sections and paragraphs in the same order and with the exact titles used in the text, with page number, shall be placed at the beginning of each publication (see figure 12). In publications containing alphabetical indexes, only primary and first subordinate paragraphs shall be listed in the table of contents. There shall be no table of contents preceding individual parts, chapters or sections. Each manual or volume in a set of manuals shall contain its own table of contents. Volume I or the first manual of the set shall contain a complete table of contents covering the entire set. Entries shall indicate the volume in which the referenced material appears; for example, "Operating Instructions, Vol I". Layout shall conform to figure 12 except that a single column format shall be used when the manual is prepared in single column.

40.5.1 Table of contents for review draft copy. The page number column for tables of contents may be left blank when working on RDC during the early stages of development. The page number column may be filled, if the composition equipment can produce the table of contents automatically.

40.6 List of illustrations. Publications containing ten or more illustrations (including charts and graphs assigned figure numbers) shall have a list of illustrations showing the figure number, title, and page number of each figure. This list shall include foldout pages, schematics, and so forth. The security classification, if any, of illustration titles shall be indicated. Layout shall conform to figure 13 except that a single column format shall be used when the manual is prepared in single column. Each manual or volume in a set of manuals shall contain its own list of illustrations. In addition, Volume I or the first manual of the set shall contain a list of illustrations for all volumes or manuals in the set.

40.7 List of tables. Manuals containing ten or more tables (including charts assigned table numbers) shall have a list of tables showing the table number, title, and page number of each table. The security classification, if any, of table titles shall be indicated. Layout shall conform to figure 14 except that a single column format shall be used when the manual is prepared in single column. Each manual or volume in a set of manuals shall contain its own list of tables. In addition, Volume I or the first manual of the set shall contain a list of tables for all volumes or manuals in the set. When both are brief, the list of illustrations and list of tables may be included on the same page.

40.8 Foreword, preface or introduction. A foreword, preface or introduction (see figure 15) shall contain the purpose and scope of the manual plus any other information required by the content specification. The foreword, preface or introduction shall define abbreviations and nonstandard symbols, including any icons used in the manual. The first volume of a manual shall contain general information and reporting requirements (for example, general circuit board data, feedback reports, special technical manual use requirements, error reporting,





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- (a) All capitals.
- (b) Boldface type.
- (c) Stand alone (no text on the line).

50.2.2 First subordinate paragraphs. First subordinate paragraphs are used to divide text under primary headings into two or more subjects. There shall be at least two first subordinate paragraphs when a primary subject is subdivided. First subordinate paragraphs begin with first subordinate sideheads which shall be prepared as follows:

- (a) All capitals.
- (b) Boldface type.
- (c) With text being run-in.

50.2.3 Second subordinate paragraphs. Second subordinate paragraphs are used to further subdivide material under first subordinate paragraphs. Second subordinate paragraphs normally begin with second subordinate sideheads which shall be prepared as follows:

- (a) Upper and lowercase.
- (b) Boldface type.
- (c) With text being run-in.

50.2.4 Third and fourth subordinate paragraphs. Third and fourth subordinate paragraphs are used to further subdivide material under second subordinate paragraphs. Third and fourth subordinate paragraphs begin with subordinate sideheads which shall be prepared in the same manner as second subordinate sideheads.

50.2.5 Paragraph headings. Paragraph headings (titles) are identified as primary sideheads, first subordinate sideheads, second subordinate sideheads, and so forth (see figure 17). Each paragraph heading (sidehead) shall describe that paragraph's contents and start with a significant word. Periods shall follow paragraph titles. There shall be two spaces between the paragraph number and the title.

50.2.5.1 Informative headings. Headings shall be informative and not merely labels. Headings shall serve two purposes. First, they shall make access to information easier by permitting the reader to scan a page to find the information needed. Second, they shall alert the reader to the type of information contained in the text to follow. Examples are as follows:

Label heading

Procedure  
Instrumentation  
Discussion  
General description

Information heading

Procedure for recording temperature  
Heat measured by thermocouples  
Reasons for waveform variations  
Symbols created for radar PPI

50.2.5.2 Headings and relevance. A paragraph or procedure heading shall uniquely identify the content of the material that it heads. All material under a single heading shall be consistent with the heading.

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50.2.5.3 Heading length. Headings shall be limited to 10 words or less. Only 10 percent of all headings shall be more than 7 words in length.

50.2.5.4 Headings per page. To facilitate the user's search for information in the technical contents sections of the manual:

- (a) If more than half of a page consists of text, there shall be at least two headings on the page.
- (b) If one-fourth to one-half of a page consists of text, there shall be at least one heading on the page.

50.2.5.5 Primary sideheads. Primary sideheads divide text within chapters or sections into two or more portions. There shall be at least one primary sidehead in each chapter or section. Primary sideheads stand alone (are not run in with text) and shall appear in capital letters. They shall begin at the left margin and shall be underscored.

50.2.5.6 Subordinate sideheads. Subordinate paragraphs shall be numbered. First subordinate paragraphs shall have a sidehead. Second and subsequent subordinate paragraphs should, but are not required to, have a sidehead. The first letter of the first word and of each principal word shall be capitalized, and the title shall be underscored. The text shall begin on the same line as the title and paragraph number and be separated by a period (if using a title) and two spaces. Carry over lines for all subordinate paragraphs shall return to the left margin. Breakdowns beyond the third subordinate shall not be used without the approval of the contracting activity. Figure 17 shows samples of decimal paragraph numbering and decimal paragraph numbering with added material. Single column format shall use the same conventions as double column.

50.3 Procedures. Step-by-step procedures (see figure 18) for removal, disassembly, repair, and inspection of the repairable items shall be developed only as required. Procedural steps and checklist items shall be numbered. Extensive use of uniform standards and methods is encouraged. Instructions shall be limited to areas where the sequence of operations is not standard shop practice or where special techniques are required for access to a part requiring repair. Instructions on the tagging, labeling, and match-marking of parts shall be included in the procedure. When examinations and inspections must be performed prior to or during disassembly, the procedure shall so specify.

50.3.1 Procedural step content. A procedural step shall be limited to a single operation or to repetitions of a single operation with the following exceptions:

- (a) If simultaneous operations are required, they shall be listed together in the same step.
- (b) If the step is a major step in a dual-level presentation, the major step shall express the action with a single verb; for instance, "Turn equipment ON".

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- (c) If the step represents a detailed procedure, as in (b), but the procedure is so basic that the details should rarely be needed by the intended users, or if the procedure is very frequently repeated, such as turn on, turn off, and calibration procedures, the step shall refer to the procedure with a single verb and cite a reference to the detailed steps. For instance, "Turn equipment ON (see 3-46 for details)."
- (d) Verification of the result of an operation may be included in the step. For example, "Press pushbutton A to be sure indicator A is lit."

50.3.2 Procedure length. Each separate procedure shall be limited to a maximum of 10 steps.

50.3.3 Indentations. Procedural steps in a paragraph structure shall be indented. Procedural steps in other structures, for example in a table, shall have substeps indented two spaces. Each level of substep shall be indented an additional two spaces. When step numbers require double characters (aa), (10), (aa), and so forth), the number shall be indented only one space in order to maintain right justification of the numbers. For example:

(z) xxxxxxxxxxx	(9) xxxxxxxxxxx
(aa) xxxxxxxxxxx	(10) xxxxxxxxxxx

All lines on warnings, cautions and notes shall be indented five spaces or characters from both left and right margins. When the right margin is unjustified, indentations of five spaces shall be from the maximum allowable width of the typed text.

50.3.4 Dual-level presentation. If users of a procedure are expected to vary widely in experience and capability, the Government may direct that certain procedures be presented in a dual-level format. In this format, detailed steps appropriate for inexperienced users shall be listed under major steps. The major steps, without reference to the detailed steps, shall be sufficient to support the performance of experienced users (see figure 18). Dual-level, step-by-step procedures shall be provided in any of the following cases:

- (a) When accomplishment of the required action would not be obvious to a journeyman mechanic unfamiliar with the peculiar equipment covered by the manual.
- (b) When a peculiar or special action is required.
- (c) When safety-related or precautionary procedures are required to prevent personnel injury or equipment damage.
- (d) When the required action involves an area with a known history of failure due to improper procedures.
- (e) When, because of complexity of a particular procedure, it is necessary to maintain the continuity of the manual.
- (f) When verification of the manual demonstrates the need for a step-by-step procedure to satisfactorily complete the required action.



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50.3.5 Introduction to procedure. Prior to the listing of procedural steps, introductory information shall be provided to help the user carry out the procedure without interruption. Examples of relevant introductory information:

- (a) References to relevant explanatory, descriptive, or theoretical material.
- (b) Number and qualifications of personnel required to carry out the procedure.
- (c) Test equipment required.
- (d) Special range of shop tools required.
- (e) Supplies and materials required.
- (f) Condition of the equipment at the beginning of the procedure, and references to procedures required to establish this condition.
- (g) List of any steps in the procedure that are discussed elsewhere in the manual, with references to those procedures.
- (h) Warning, if applicable, to note and obey safety notices in the text.

50.3.5.1 Lead-in. Procedural steps shall not be prefaced by a lead-in which duplicates the heading, for example:

"Disassembly of a sensing unit. The sensing unit is disassembled according to the following procedure: . . ."

50.3.5.2 Relevance of procedural text. A procedure shall present only that information necessary for completing a task or preventing error.

## 60. APPENDIXES

60.1 Appendixes. Each appendix shall contain a statement delineating its purpose and application. Appendixes shall immediately follow the last chapter of the manual. Appendixes shall begin on a right-hand page. Pages, paragraphs, illustrations and tables for appendixes shall be numbered. Each manual or volume in a set of manuals shall contain its own appendixes. In addition, Volume I or the first manual of the set shall contain a list of appendixes for all volumes or manuals in the set. Appendixes shall be used to separate relatively bulky information from the body of the manual when such separation will increase the clarity of the overall manual. When used, appendixes shall be identified by capital letters (for example, (A), (B), and (C)).

## 70. GLOSSARIES

70.1 Glossaries. Glossaries shall be used in technical manuals only when the terms are not adequately defined in the text, in the Navy, DOD or standard dictionary, or contained in the manual foreword, preface, or introduction. If a glossary is required, it shall immediately precede the alphabetical index, if any. Page numbers for a glossary shall be consecutively numbered as specified in Appendix G. Each manual or volume in a set of manuals shall contain its own glossary. In addition, Volume 1 or the first manual of the set shall contain a glossary for all volumes or manuals in the set.



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## 80. INDEX

80.1 Alphabetic index. Unless otherwise specified, an alphabetical index shall be developed when the number of titled paragraphs in a publication exceeds 100 (see figure 19). When specified, an index shall be prepared regardless of the number of paragraphs. It shall list pertinent subjects under every topic for which users are likely to look. "See" and "see also" references may be included to guide the user to other pertinent entries. All applicable paragraph numbers for each item shall be indicated. The alphabetical index shall be so constructed as to enable the user to easily locate any part, information or operation described in the text. Alphabetical indexes shall begin on a right hand page. Page numbers for alphabetical indexes shall be consecutively numbered. The alphabetical index shall be located at the end of the publication but will be located before foldout page(s). Each manual or volume in a set of manuals shall contain its own index. In addition, Volume I or the first manual of the set shall contain an index for all volumes or manuals in the set.

## 90. FORM FOR REPORTING DEFICIENCIES

90.1 Technical manual deficiency evaluation report (TMDER)/User activity technical manual comment sheet (UATMCS). The three copies of this form shall be included at the back of each separately bound volume or part of a manual. These forms shall be located immediately following the last page in the volume or part. The TMDER (see figure 20) shall be used to provide feedback on corrections and suggested improvements to the methods and procedures specified by a NAVSEA technical manual. The technical manual identification number and title shall be preprinted on each form by the developer. For SPAWAR's technical manuals, deficiencies shall be reported by a user activity comment sheet (see figure 21).

90.2 Instructions to manual users. The following statements are examples of instructions to be included in the general information section or foreword, as applicable, of each technical manual:

- (a) For materials under NAVSEA's cognizance, errors, omissions, discrepancies, and routine suggestions for improving technical manuals shall be reported to the Commanding Officer, Port Hueneme Division, Naval Surface Warfare Center (PHD NSWC) (Code 5B00), Port Hueneme, CA 93043, on a Technical Manual Deficiency and Evaluation Report. To facilitate such reporting, three copies of Form 4160/1 are included at the end of this manual. All comments will be thoroughly investigated and originators advised of actions taken. Extra copies of NAVSEA Form 4160/1 may be requisitioned from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.
- (b) For materials under the Space and Naval Warfare Systems Command (SPAWAR) cognizance, all changes for improving technical manuals shall be reported on a UATMCS to the Commanding Officer, Naval Electronic Systems Engineering Center (NESEC), P.O. Box 55, Portsmouth, VA 23705-0055, Attention: SPAWAR Technical Data Center. To facilitate such reporting, three copies of the UATMCS are included at the end of this manual. All comments will be thoroughly investigated and originators advised of actions taken.

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Extra copies of the UATMCS may be requisitioned from the Standardization Document Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

- (c) Urgent priority technical manual deficiencies shall be reported by Naval message with transmission to PHD NSWC (Code 5B00), Port Hueneme, CA or NESEC, Portsmouth, VA (as applicable); the designated In-Service Engineering Agent (specify by short title from the U.S. Navy Plain Language Address Directory); the technical manual maintenance activity; and the commodity life cycle manager as multiple addressees. Local message handling procedures shall be used. The technical manual deficiency shall identify each message processed by technical manual identification number and title.

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## APPENDIX D

## SAFETY AND HEALTH WARNING AND CAUTIONS

## 10. SCOPE

10.1 Scope. This appendix documents the safety, health warnings and caution requirements associated with the operation and maintenance of shipboard systems and equipment. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## STANDARDS

## MILITARY

MIL-STD-1285 - Marking of Electrical and Electronic Parts.

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

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

20.1.2 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 are those cited in the solicitation.

## PUBLICATION

DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION  
(OSHA)

Public Law 91-596.

Executive Order 12196.

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

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30. WARNING, CAUTIONS, AND NOTES

30.1 Warnings, cautions, and notes. Unless otherwise specified, warnings and cautions shall precede the text but follow paragraph headings to which they apply. Notes may precede or follow applicable text, depending upon the material to be highlighted. Warnings, cautions and notes shall not contain procedural steps nor shall the headings be numbered. When a warning, caution or note consists of two or more paragraphs the heading WARNING, CAUTION, or NOTE shall not be repeated above each paragraph. If it is necessary to precede a paragraph by both a warning and a note, or a caution and a note, and so forth, warnings shall precede cautions, which in turn shall precede notes. Figure 22 illustrates the styles. Warnings, cautions and notes shall be short, concise and used only to emphasize important or critical data. Warnings and cautions may be worded positively or negatively and shall state the hazard and result or reason, unless obvious. Attachment D1 of this appendix provides additional guidance for inclusion of warnings and cautions. Unless otherwise specified, icons shall be used as described in Attachment D1.

40. HAZARDS

40.1 Health hazards. Procedures prescribed for the operation of equipment shall be consistent with the safety standards established by the Occupational Safety and Health Act (OSHA) Public Law 91-596 and Executive Order 12196. When exposure to hazardous chemicals or other adverse health factors or use of equipment cannot be eliminated, guidance pertaining to the exposure shall be included in the Safety Summary or a Warning. A list of personnel protective devices shall be included.

50. NUCLEAR SURVIVABILITY

50.1 Nuclear hardness. If equipment to be operated, maintained or overhauled has nuclear survivability requirements (that is, over pressure and burst, thermal radiation, electromagnetic pulse or transient radiation effects on electronics), applicable cautions shall be incorporated into technical publications to ensure that hardness of equipment is not degraded during operation and maintenance.

50.2 Nuclear hardness symbol. Unless otherwise specified, all Hardness Critical Processes (HCP) shall be marked with the symbol:

HCP

When approved by the Government, the symbol **\*\*HCP\*\*** may be used in lieu of the boxed HCP symbol. The symbol shall be prepared in the same style and size as the applicable paragraph sidehead. The symbol shall not be included in the paragraph title in the table of contents. Use of the symbol is as follows:

- (a) When the entire procedure and all subordinate paragraphs and steps relate to establishing nuclear hardness, the symbol shall be inserted immediately following the paragraph number:

for example: "1.2 HCP LRU REPAIR."

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- (b) When all subordinate paragraphs and steps do not contribute to establishing nuclear hardness, only those which do contribute will be annotated with the symbol.
- (c) Maintenance actions which could degrade hardness, but which are not directly involved in establishing nuclear hardness, will not be annotated with the symbol, but will be preceded by a caution.

50.3 Nuclear hardness symbol explanation. When applicable, the foreword, preface, or introduction shall include the symbol and an explanation of the HCP symbol and other pertinent information as necessary to emphasize the uniqueness of hardness features. This shall include an explanation that all paragraphs, procedures and steps identified by the symbol must be followed as written to ensure nuclear hardness is not degraded. This explanation shall be preceded by a CAUTION heading.

## 60. ELECTROSTATIC DISCHARGE SENSITIVITY


60.1 Electrostatic Discharge Sensitive (ESDS) parts. If equipment to be handled or maintained contains ESDS parts, components or circuits, applicable cautions and symbols shall be incorporated into technical publications to ensure ESDS parts are not damaged or degraded during handling or maintenance.

60.2 ESDS symbol. Unless otherwise specified, all paragraphs which address handling or maintenance which could damage ESDS parts shall be identified by the MIL-STD-1285 sensitive electronic device symbol.



When approved by the Government, the symbol **\*\*ESD\*\*** may be used in lieu of the ESDS symbol. The symbol shall be prepared in the same style and size as the applicable paragraph sidehead. The symbol shall not be included in the paragraph title in the table of contents. Use of the symbol is as follows:

- (a) When the entire procedure and all subordinate paragraphs and steps describe handling or maintenance which could damage ESDS parts, the ESDS symbol shall be inserted immediately following the paragraph number:

for example "1.2  LRU REPAIR."

- (b) When all subordinate paragraph and steps are not related to handling or maintenance which could damage ESDS parts, only those related will be annotated.
- (c) Maintenance actions which could damage ESDS parts, but which are not directly related to handling or maintenance of ESDS parts, will not be annotated with the ESDS symbol, but will be preceded by a caution.
- (d) Illustrations, drawings and schematics shall be marked with the ESDS symbol in accordance with DOD-STD-1686.

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60.3 ESDS symbol explanation. When applicable, the foreword, preface, or introduction shall include the symbol and an explanation of the MIL-STD-1285 ESDS symbol.



Other pertinent information shall be included as necessary to emphasize the uniqueness of ESDS parts. This will include an explanation that the ESDS symbol requires that all ESDS parts be handled according to ESDS device handling procedures in DOD-STD-1686. This explanation shall be preceded by a CAUTION heading.

## 70. ENERGY EFFICIENCY

70.1 Energy efficiency requirements. When specified, technical manuals covering products that directly consume energy in normal operations, and that commonly have a method of expressing energy efficiency, shall include their energy efficiency.

## 80. ENVIRONMENTAL PROTECTION STANDARDS

80.1 Environmental protection. All technical manuals that require the use, transportation, handling, storage or disposal of fuels, toxic and hazardous substances, chemicals, ordnance and munitions, and so forth, shall meet the requirements of the Federal Environmental Protection Standards.

## 90. EMERGENCY INFORMATION

90.1 Emergency page markings. Pages containing emergency information shall have a broken black border in accordance with the requirements of figure 23. FRC for emergency pages shall be 1/4 inch oversize to ensure proper printing of the bleed borders. Emergency page markings are not considered margin data.

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## ATTACHMENT D1

GUIDELINES FOR INCLUSION OF OCCUPATIONAL  
SAFETY AND HEALTH WARNINGS AND CAUTIONS  
IN TECHNICAL MANUALS

## 10. SCOPE

10.1 Scope. This document includes requirements for the inclusion of Occupational Safety and Health (OSH) guidance in the text of technical manuals. The intent is to provide sufficient information to allow a standardized approach to the task, eliminate confusion, and improve the technical manual development process overall. This Attachment is a mandatory part of this specification. The information contained herein is intended for compliance.

10.2 Philosophy. This specification contains definitions, examples, and general information. This appendix must be used in conjunction with this specification. This specification does not contain the following philosophies, which are critical to the effective inclusion of OSH guidance in technical manuals:

- (a) Technical manuals cannot be made to be stand-alone safety and health documents. They are but one component of a comprehensive safety and health system that includes, among other things, ongoing industrial hygiene programs, ongoing ground and system safety programs, safety education programs, and worker management involvement. Technical manuals therefore should support, and be supported by the entire system.
- (b) The "cry wolf" syndrome definitely applies to WARNINGS in technical manuals and should be avoided. Simply stated, if you warn about everything, you warn about nothing.
- (c) Personnel or equipment hazards cannot be controlled strictly through the inclusion of WARNING or CAUTION statements; they are too easily overlooked. Therefore, after exhausting design and engineering considerations, the premium must be on writing effective and safe task procedures. Then WARNINGS and CAUTIONS may be needed to alert and emphasize, but not to provide procedures.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).



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STANDARDS

MILITARY

MIL-STD-882 - System Safety Program Requirements.

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

30. GENERAL GUIDANCE

30.1 Human factors. Technical manual procedures are subject to being overlooked or circumvented when they are deemed unworkable or impractical. Careful consideration of environmental factors, equipment design or layout, human nature, and other human factors will help ensure the overall integrity of the task procedures.

30.2 When to use WARNING or CAUTION statements.

- (a) As indicated by the definition in this specification, WARNING statements are reserved for the protection of personnel and CAUTION statements are reserved for equipment or system protection. Do not use CAUTIONS for health hazards.
- (1) WARNINGS and CAUTIONS should be used for those unique conditions, steps or processes that require additional emphasis because of the inherently dangerous nature of the task or the potential for a "surprise" not otherwise readily obvious from the procedure.
  - (2) A WARNING should be used to advise of injury or occupational illness potential, but only based on the reasonable likelihood that the reader's health or safety will be impacted in such a manner as to cause immediate concern and a disabling injury or occupational illness will result if the task procedure or stated precaution are not closely followed. Injury is defined as a traumatic bodily harm caused by a single or 1-day exposure to an external force, toxic substance (usually associated with accidents and spills in work places where the specific agent is not normally in the environment), or physical agent which will result in restricted duty, lost time, or worse. The occupational illness is defined as any abnormal physical condition or disorder, other than one resulting from an injury (as defined above), caused by repeated exposure to chemical, biological, or physical agents associated with the occupational environment which will result in restricted duty, lost time, or worse.

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- (3) Specific direction as to which specific procedures require the use of warnings or cautions should be obtained from the Logistics Support Analysis Record (LSAR) and system safety. The responsible safety office also should be requested to review technical manual procedures for compliance with safety concerns.
- (b) Risk assessment - and the related issue of whether or not additional emphasis is required - is somewhat subjective. Decisions concerning these issues should be based on as much information as possible including historical mishap data from related systems, research, and the experience of all those involved in the technical manual development process. Often, the latter is the best indicator of the need for additional comment. Through the acquisition phase of major weapon systems, the decision to include a WARNING or CAUTION statement in the text can often be made by consulting the Operating and Support Hazard Analysis (O&SHA), Preliminary Hazard Analysis (PHA) or one of the other system safety engineering analysis called for by MIL-STD-882 and MIL-STD-1388-2.
- (c) WARNINGS or CAUTIONS are not to be used for environmental protection concerns or security information.

30.3 Wording and structure of WARNING and CAUTION statements.

- (a) A WARNING or CAUTION statement should consist of four parts: a signal word (WARNING, CAUTION or Icon), a concise statement of the hazard, minimum precautions, and the possible result if the WARNING or CAUTION is disregarded, unless obvious. In cases where hazardous materials are being used and the conditions on 30.5e(2) exist, a hazardous material Icon(s) shall be used. A sample format of these Icons is presented on figures 24 thru 27. See paragraph 70 for guidance on constructing the Icons.
- (1) The signal word will always be included using one of the styles, or similar, referenced in this specification. Whichever style is used, it must be used consistently.
- (2) The remaining parts can be arranged in any way that gets the point across; however, following the format of statement first, precaution second, and result third is often the most clear and concise method. Brevity is important. If the possible result is obvious, it need not be included.
- (3) A precaution is a short statement of hazard mitigation that tells the reader to take care, for example "use eye protection", or "keep arms and hands clear". Certain precautions may reference other publications or direct people to consult with another agency (for example, "...consult Bioenvironmental Engineering"). However, guidance of this nature should be considered for inclusion in a safety summary (see 30.5).

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- (b) WARNING or CAUTION statements shall never contain procedures critical to the effective and safe completion of the task. For example:

"WARNING

Cleaning with compressed air can create airborne particles that may enter eyes or penetrate skin. Pressure shall not exceed 30 psig. Wear goggles. Do not direct compressed air against skin."

- (c) Negatively worded statements (for example, "Failure to adhere..." or "Do not use ...") are acceptable and sometimes the best way to convey the message.
- (d) Multiparagraph or excessively long WARNINGS and CAUTIONS are not specifically disallowed by this specification but lengthy statements are a good indication that the task procedures are not written with the needed safety steps or procedures included.
- (e) Pay strict attention to the definitions of "shall", "will", "should", and "may" in this specification. The use of these words must be consistent with exposures or conditions which require comparable WARNINGS or CAUTIONS.

30.4 Placement of WARNING or CAUTION statements.

- (a) This specification contains general requirements.
- (b) WARNINGS or CAUTIONS should be placed in the text immediately prior to the step or procedure to which they apply. The same WARNING or CAUTION need not be repeated within a procedure as long as the emphasis and impact of the WARNING or CAUTION is not lost because of a break in the procedures.
- (c) There is no stated maximum on the number of unrelated CAUTIONS or WARNINGS that can be placed on a page. Under no conditions should they be so numerous so as to obscure the procedures. Properly written procedures should eliminate the need for consecutive WARNINGS. Sandwiching short (one line or two line) procedures between WARNINGS and CAUTIONS should be avoided.

30.5 Safety summary sheets or sections.

- (a) All technical manuals containing warnings or cautions shall have a Safety Summary. In conjunction with properly written procedures, the Safety Summary, which can contain general safety precautions, can eliminate the need for many WARNINGS or CAUTIONS.
- (b) Provide a Safety Summary in accordance with this specification in the front of the manual preceding the first text page. The safety summary provided on figure 16 is only an example of the type, depth, and format of general shop safety information necessary. It is not all inclusive. Only the first two paragraphs (see figure 16), or similar wording detailing the significance and use of WARNING and CAUTION statements, should be considered common to

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- all Safety Summaries. Additional paragraphs can be added depending upon the class of hazard found in the technical manual.
- (c) Nearly any topic can be considered for inclusion in a Safety Summary: mechanized material handling equipment; overhead lifting devices; wood or metal working machine use and guarding; and so forth. General precautions related to storage, and so forth, can also be included.
- (d) Safety summaries are an excellent place to provide general safety or health instructions, but they must be tailored to the technical manual.
- (1) Live circuitry guidance is probably not applicable to a corrosion control technical manual. This does not preclude the possibility, however, of a WARNING in the text of a corrosion control technical manual if the text establishes the likelihood of exposure to injurious current.
- (2) The converse is also true. It would be appropriate to include live circuitry guidance in the Safety Summary of a maintenance manual. However, WARNINGS inserted in the text prior to every point of potential current exposure would not be required, as long as the procedures identify the proper controls, for example, "discharge capacitor XXXX," or "...turn off power and tag out (lock out) switch." It is reasonable to assume a trained maintenance technician is fully aware of the hazards of live circuitry; emphasis beyond a Safety Summary would be needed only in the event that the equipment, procedures or work environment presented an unusual situation to the technician.
- (e) Inclusion of general guidance in a Safety Summary does not preclude the need for a WARNING or CAUTION if the text calls out a nonroutine use or application.
- (1) For example: in a parts cleaning technical manual, general guidance in the Safety Summary related to air pressures (30 PSIG), chip guarding, eye protection, and so forth, would suffice as long as the task procedures include the minimum required controls (pressure regulation, and so forth) as procedural steps. A CAUTION may still be required, however, if the text specifies 15 PSIG for a delicate piece of equipment that would be damaged if the technician proceeded under the general guidance included in the Safety Summary.
- (2) Many industrial hygiene and occupational health concerns can be addressed in the same manner. In technical manuals that frequently call for routine solvent applications, WARNINGS would not be needed throughout the text as long as the minimum required controls are called for in the task procedures. General guidance regarding solvents could be included in the Safety Summary. Additional emphasis would then be required only if a procedure calls for a nonroutine application, such as heating the solvent, or an unusual,

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potentially more toxic solvent. In that event, a WARNING could be used depending on the ability of the process to cause immediate safety or health concerns. This approach can be used for many of the occupational health concerns associated with commonly used substances, for example, hydraulic fluids, oils, fuels, paints, thinners, adhesives, sealants, and so forth.

- (f) WARNINGS or CAUTIONS should not simply be extracted from the text and inserted verbatim in a Safety Summary. An acceptable approach would be to provide a general summary of guidance, classed by exposure. WARNINGS or CAUTIONS must still be placed in the text, however, based on the risk associated with the steps or procedure.
- (g) Excessively long Safety Summaries are discouraged. If a technical manual requires extensive safety or health guidance, a safety section or chapter should be considered.

#### 40. QUALITY CONTROL

40.1 Rewrite. The Government will recommend rewrite under the following conditions:

- (a) When any part of a procedure, WARNING, CAUTION, or Safety Summary is not consistent with existing Occupational Safety and Health Administration and Service safety requirements or is detrimental to existing Service safety and health programs.
- (b) When WARNING statements are misused for equipment protection or otherwise misused outside of the intent of this specification and this appendix.
- (c) When CAUTION statements are misused for personnel protection, or otherwise misused outside of the intent of this specification and this attachment.
- (d) When WARNING or CAUTION statements contain procedural steps, they should be included in the task description. Minimum protective equipment requirements or minimum precautions are allowable.
- (e) When WARNING or CAUTION statements are excessively long.
- (f) When WARNING or CAUTION statements are so numerous on a page that necessary task procedural steps are visually obscured.
- (g) When Safety Summaries are used to the exclusion of WARNINGS and CAUTIONS in the text unless indicated by the nature and class of hazard associated with the text, or when otherwise used outside of the intent of this specification (that is, they should provide tailored, general guidance).
- (h) When WARNINGS or CAUTIONS are extracted from the text verbatim and inserted in the Safety Summary.
- (i) When statements detailing the significance and use of WARNING and CAUTION statements are not provided in the Safety Summary.
- (j) When the wording of WARNINGS or CAUTIONS varies throughout the text even though the same or very comparable conditions are being emphasized.

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- (k) When a WARNING does not serve to prevent disabling injury or death, or a CAUTION does not serve to prevent damage or destruction of equipment.
- (l) When a procedure lacks required emphasis because of its inherently dangerous nature or a step requires additional emphasis because of its critical safety impact.
- (m) When WARNINGS or CAUTIONS contain vague precautionary statements such as "avoid all contact", or rely too frequently on references to other technical manuals or outside agencies. In these cases, inclusion in a Safety Summary or input conditions page will be recommended as appropriate.
- (n) When WARNING or CAUTION statements contain general safety precautions.

## 50. POINTS OF CONTACT

50.1 Coordination. All those involved in the technical manual development process must remember that the OSH guidance included in technical manuals is not the only line of defense against serious mishaps, but it is sometimes the last. The effective inclusion of OSH guidance can almost never be accomplished by a single individual with a distinct background. It must be a coordinated effort among system experts, safety professionals, technical writers, and the potential user. Questions arising from this process should be referred to the appropriate Safety Office and the Government acquiring activity. Do not ignore existing contractual or Command requirements.

## 60. CONSTRUCTION OF HEALTH HAZARD ICONS

60.1 Reason for developing the icon. Samples of the icons are shown in an example Safety Summary on figure 16. Figure 24 thru 27 show the icons in detail. The major reason for suggesting the use of icons for hazardous materials is to save space in the manuals while still conveying a clear message of the hazard to the technician using the manual. Since the icon presents a visual image of the hazard rather than a more abstract message, recognition should be much faster than with a worded warning. The task of the graphic designer, in this case, is to make the icon as small as possible, while maintaining enough quality in the image to provide almost instant recognition. An optimum image height of 1/2 inch (three lines) has been selected as the best compromise between image quality and space savings. A bold rectangular outline with rounded corners was also selected for the icon. To maintain image quality, the width of the icon may vary. Icon height will remain the source.

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ATTACHMENT D1

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## APPENDIX E

## TABULAR MATERIAL

## 10. SCOPE

10.1 Scope. This appendix documents the form and format requirements for data to be presented in tables, charts and graphs. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 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 are those cited in the solicitation.

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9086-CZ-STM-000/CH 90 - Inspections, Tests, Records, and Reports.

(Application for copies should be addressed to the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 200 - Reference Designations for Electrical and Electronics Parts and Equipments.

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017 or from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

## 30. TABULAR, CHART, OR GRAPH FORM

30.1 Tables, charts, and graphs. Reference data (other than illustrations, drawings, diagrams) shall be presented in tabular, chart or graph form. Any other type of data which lends itself to tabular, chart or graph form may also be so presented. Tables, charts and graphs shall be so designed that they are easily understood. Charts shall be presented as tables or illustrations, whichever is most appropriate. Graphs shall be considered illustrations, and be assigned figure numbers. Figure 28 provides an example of a typical table. Tables shall include the following:

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- (a) Center the word "Table", the applicable number, and the title above the head rule.
- (b) Capitalize the word "Table" and each principal word in the title.
- (c) Capitalize each principal word in column heads.
- (d) Single space entries within the table.
- (e) Align related entries in different columns.
- (f) Align entries within columns as follows:
  - (1) For decimal data, decimal points shall be aligned.
  - (2) For mathematical notation, multiplication signs shall be aligned.
  - (3) All other numeric data shall be aligned flush right.
  - (4) Alphabetic or alphanumeric data shall be aligned flush left.
- (g) Indent carryover lines two spaces.
- (h) Specify units of measurement in row or column headings.
- (i) Arrange row entries in tables in groups of up to five rows. Groups shall be separated with white space if no entries are blank, and with light horizontal lines if any entries are blank. At least 25 percent of the area within tables and between columns and groups of rows shall be white space.

30.2 Table outline. For RDC, the point at which a table or (when appropriate) chart is to be placed shall be indicated by a break in the text and the insertion of the table number and title. Outlines shall be placed at the end of the first paragraph or subparagraph to which they pertain. The table number shall begin at the left margin and there shall be a double space above and below the outline. For the PTM or FRC, the table is mounted in place and the outline becomes the table title.

30.3 Table titles. Tables shall be assigned table titles. The title shall follow two spaces after the table number and shall be centered above the applicable table. The first letter of the first word and of each principal word shall be capitalized. Full page tables, placed sideways on a page, shall be turned 90 degrees counterclockwise. The table number and title for a turned table shall also be turned 90 degrees counterclockwise to stay centered above the table. Table titles should begin with an identifying name. For example:

"Table 3-1. Guidance System Test Points"

The title shall be short and describe the contents or purpose of the table. Tables applicable to one Service, in a manual that will be used by more than one Service, shall be identified. For example:

"Table 2-3 (Army Only). Fuel Indicator Correction Factors."

30.4 Boxhead titles and rules. The first letter of the first word and of each principal word of boxhead titles shall be capitalized; the remaining letters shall be lowercase. Tables shall be so designed that related entries in different columns are aligned (see figure 29). Carry over lines of tabular material shall be indented two spaces unless adequately spaced between entries. Tables shall be vertically ruled as required for clarity. A horizontal rule shall be placed at

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the beginning (head) and at the end (foot) of a table and following column heads (boxhead titles). The closing rule is omitted at the foot of a continued table; the opening rule is omitted at the head of the continuation of the table. For preprogrammed tables, with columns ruled for continued tables, the opening rule may be included at the head of the continuation of the table.

30.5 Continued table material. When a table is continued on a following page, the number and title shall be repeated at the head of the columns on all following pages of the table, followed by a dash and the word "Continued." Boxhead titles shall also be repeated. The above information shall not be repeated on a following page when the page is a foot page of a head to foot tabular arrangement. When a table entry is continued, the entry or its identifying number or letter from the first column shall be repeated in the first column followed by a dash and the word "Continued." The abbreviation "Cont" may be used when table columns are too narrow for "Continued" to be spelled out.

30.6 Footnotes. The footnotes, which shall be kept consistent with clarity, shall be placed immediately below the table in which they are referenced. If a table is continued onto other pages, all footnotes shall be placed at the bottom of the page on which they are referenced or at the end of the table and the directory note "See footnotes at end of table" shall be placed at the bottom of pages containing footnote references. For footnotes coming before the end of the table, and for a directory note, a one inch horizontal rule shall be placed flush left below the table and the footnote or directory note placed under the rule. Footnotes at the end of the table shall be started on the second line below the closing rule. All table notes and footnotes shall be indented five spaces from the left margin of the table and carry over lines shall return to the left margin of the table.

30.7 Tabular material. When a small amount of tabular information is to be inserted, and will not require referencing from adjacent text, it may be included within a paragraph of text without identifying it as a table.

30.8 Line graphs. Line graphs shall conform to the following:

- (a) The number of ideas conveyed per graph shall be minimized. Line graphs shall have a maximum of four lines (that is, lines that show the relationship of variables). Such lines shall be coded for easy identification.
- (b) If there is a natural orientation for the axes (for example, altitude on vertical axis), the axes shall be so oriented.
- (c) Grid lines shall support the intended use (that is, more grid lines shall be provided where accurate interpretation is required). Grid lines shall be no less than 0.1 inch apart when reduced to final size and shall be lighter than the graph line.
- (d) Graph scales shall be linear unless they must be nonlinear for proper comprehension and use. They shall include the zero value of the variables. One line break may be used per scale in order to include the zero value if this same space without jeopardizing clarity.
- (e) For complex graphs, instructions shall be provided for use and interpretation.

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40. EXAMPLES OF TABULAR DATA

40.1 Parts list for HM&E equipment. Parts lists for HM&E equipment shall be in accordance with MIL-STD-100, if suitable. Part or Identifying Number (PIN), CAGE code and quantity shall be included in all parts lists. Parts list for HM&E equipment shall be in tabular form similar to MIL-STD-100 or the following (see figure 30):

- (a) Column 1, figure and index (find) number. This column shall contain the figure number and index number which shows the location of the part.
- (b) Column 2, name (nomenclature) and description. This column shall contain the designation name of the part and descriptive data to identify the parts of the equipment. Descriptive information shall include the PIN of the part whenever available. Those parts which do not have a PIN shall include physical characteristics (material, grade, series, dimensions, specification, and any other information necessary to order replacement parts from the original supplier of the part without going to the prime contractor. The preceding requirement must include all the information necessary to acquire parts when parts are acquired from multiple commercial sources.
- (c) Column 3, Quantity. This column shall identify the quantity of parts required.
- (d) Column 4, Commercial and Government Entity (CAGE) code. This column shall contain the original item manufacturer's CAGE identification code. CAGE code 81849 shall be used for military parts and code 80058 for Joint Electronics Type Designation System (JETDS) items.
- (e) Column 5, Original manufacturer's part number. This column shall be the part number assigned by the original manufacturer of the part. Part numbers are not required for common hardware items that are available from many sources. For Part or Identifying Number, see MIL-STD-100.

40.2 Parts list for electronic equipment. Parts lists for electronic equipment shall be in accordance with MIL-STD-100, if suitable. Part or Identifying Number (PIN), CAGE Code and quantity shall be required in all parts lists. Parts list for electronic equipment shall be in tabular form similar to MIL-STD-100 or the following (see figure 31):

- (a) Column 1, Reference designation. This column shall contain the reference designations of all parts listed in sequential order. The unit numbering method of assigning reference designations, as specified in IEEE Std 200, shall be used to identify units, assemblies, subassemblies and parts. Mechanical part (MP) numbers shall be assigned to mechanical parts subject to replacement, such as handles, slides, and so forth, that are included in the allowance parts list (APL) but not assigned MP numbers in the engineering drawings. With the exceptions of screws, nuts, bolts, and other attaching hardware, every functioning part in the equipment shall have a reference designator. The parts list shall

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be divided and arranged by major units in numerical sequence (for example, unit 1 with its parts will precede unit 2 with its reference designations parts, and so forth). When reference designations have been cancelled for more than two consecutive items, only the first and last of the designations are to be listed, separated by the word "through". For example: 3A1R69 through 3A1R100 not used.

- (b) Column 2, Notes. This column shall contain equipment reference information such as serial number, model number, configuration data, and so forth.
- (c) Column 3, Name and description. This column shall include descriptive data to identify the parts of the equipment and aid in determining substitutes. Such information shall consist of the name, electrical or mechanical characteristics, and PIN of the item, and when applicable, attaching hardware. Common parts (for example, washers, springs, nuts, bolts, and so forth) shall be identified only by the PINs. Those parts not having a PIN shall also include physical characteristics (material and sufficient dimensions) to identify the parts within the set the manufacturer's part number and CAGE or the equipment contractor's part number and CAGE, federal supply code (FSC) number. FSC code 31349 shall be used for military parts and code 80058 for JETDS items, and drawing number. Replaceable mechanical parts that are assigned as "MP" numbers in accordance with (a) preceding, shall include the manufacturer's part number or engineering drawing number along with the name and description of the item. The statement "Same as . . .," or equivalent, shall not be used for describing identical parts. For identical parts that are used more than five times in the equipment, the complete list of common item descriptions and reference made there to by the item number. Attaching hardware, with quantity required, shall be identified by the assigned letter code. For example, C(4) would be the third listed piece of attaching hardware in which four pieces are used. When nonstandard parts have been approved and there are multiple sources, each source shall be cited in the description. If selected values for critical parts are required, sufficient information, such as criteria for selection and range of values, shall be provided to permit the repair activity to make selection. For each part, the part number of the actual item manufacturer shall be used, unless the part is physically modified by the equipment contractor.
- (d) Column 4, Figure and item number. This column shall reference the parts location illustration by figure number and item number enclosed in parenthesis (for example, 6-119(17)).

40.3 Protective device index. This index shall be in tabular form (see figure 32). The index shall include the reference designation, front panel marking of the device, trip-out value of the circuit breaker, and rating of fuses, name of the circuit protected, and a reference to troubleshooting diagrams.

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40.4 Relay, switch, and indicator lamp index. A relay coil, switch, and indicator lamp index shall be prepared in tabular form. The first column of each index shall list each relay coil, switch, or lamp alphanumerically by reference designation. Subsequent columns of the relay index shall give the name of the functional bus and shall identify the coil supply voltage, including polarity and frequency, as appropriate. Subsequent columns in the lamp index shall identify the lamp name and the energizing bus voltage. Subsequent columns in the switch index shall identify the switch bus and the switched voltage. In all of the indexes, columnar references shall be made by figure number, sheet, and zone to a troubleshooting diagram where the item is active. Figure 33 is an example of a typical index of this type.

40.5 Standard log forms. Guidance regarding standard log form requirements should be obtained from the Government; sample forms are contained on figures 34 and 35 and listed in NAVSEA S9086-CZ-STM-000/CH 90.

40.5.1 Format. The following consideration should be given in development of the log form.

- (a) Log forms shall be planned in columnar format for simple use, with adequate space for identification, data and check off. The time line should normally be on an hourly or daily basis and may be arranged on a vertical (left side) or horizontal axis (top), depending on the number of monitoring points.
- (b) Sheets shall have one dimension of 8-1/2 inches. Sheets should limit the second dimension to 11 inches when practical, by using the reverse side for continuation.
- (c) Monitoring points should indicate the normal values for each monitoring point, and should indicate the maximum (MAX) and minimum (MIN) tolerance for which normal operation can be expected.
- (d) Values, that were to fall below the minimum or above the maximum, that would present danger to personnel, or would cause damage to the equipment, should be indicated in "red" or by bold face type or other method to be conspicuous.
- (e) Instructions for use of the form shall be included on the form or with the set, when necessary. Codes, such as H - High; L - Low; B - Bubbles that are used should be described in the instructions or in a legend.
- (f) Action procedures shall be indicated for danger readings (see (d)) such as shutdown; cutback; open valve, and so forth in the instructions or by a separate related column.
- (g) Space should also be provided to indicate the make, size, model, application, and location of the equipment, or other relevant information.
- (h) Space for signing the watch, normally on the reverse side.
- (i) Space should also be provided, if required, for certification by the watch officer, engineering officer, and so forth, normally on the reverse side.

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40.6 Troubleshooting index. The troubleshooting index shall be in tabular form. The index shall list all equipment, list all major and supporting functions (in alphabetical order), provide references to the technician (to the appropriate procedures), and list diagrams that are to be used to troubleshoot a specific function (see figure 36).



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## APPENDIX F

ILLUSTRATIONS, DRAWINGS,  
AND SKETCHES

## 10. SCOPE

10.1 Scope. This appendix documents illustration requirements. It describes illustration use and placement, photographs and line drawings, artwork, engineering drawings and other types of illustrations. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## STANDARDS

## MILITARY

- MIL-STD-17-1 - Mechanical Symbols (Other than Aeronautical, Aerospacecraft and Spacecraft Use), Part-1.
- MIL-STD-17-2 - Mechanical Symbols for Aeronautical, Aerospacecraft and Spacecraft Use, Part 2.
- MIL-STD-100 - Engineering Drawing Practices.

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

20.1.2 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 are those cited in the solicitation.

## NAVAL SEA SYSTEMS COMMAND

- OP 1700 V1 - Standard Fire Control Symbols.
- OP 1700 V2 - Standard Fire Control Symbols for Missile Related Quantities.
- OP 1700 V3 - Standard Fire Control Symbols for Missile Related Quantities.
- 0967-LP-000-0120 - Electronics Installation Maintenance Book Circuits.

(Application for copies should be addressed to the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)/INSTITUTE OF ELECTRICAL,  
ELECTRONICS ENGINEERS (IEEE), AND SOCIETY OF AUTOMOTIVE ENGINEERS  
STANDARDS

- ANSI Y14.15 - Electrical and Electronics Diagram (Including Supplements Y14.15a and Y14.15b).
- ANSI Y10.20 - Mathematical Signs and Symbols for use in Physical Sciences and Technology.
- ANSI Y32.10 - Graphic Symbols for Fluid Power Diagrams.
- IEEE Std 200 - Reference Designations for Electrical and Electronics Parts and Equipments.
- IEEE Std 315 - Graphic Symbols for Electrical and Electronics Diagrams.
- ANSI/IEEE 991 - Standard for Logic Circuit Diagrams.
- SAE HRP 4382 - Hydraulic System Diagrams and Associated Tables for Marine Vehicles.
- SAE AS 1290 - Graphic Symbols for Aircraft Hydraulic and Pneumatic Systems.

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

(Application for copies of IEEE standards should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017 or from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

### 30. ILLUSTRATION TYPES

30.1 Examples of illustration types. The following are example illustration types, as applicable:

- (a) Isometric projection exploded views.
- (b) Illustrated parts breakdown.
- (c) Engineering drawings.
- (d) Sectional views.
- (e) Assembly, disassembly, reassembly, installation, and fabrication drawings.
- (f) Schematic diagrams, block diagrams, and timing circuit diagrams.
- (g) Item location illustrations.
- (h) Test setup diagrams.
- (i) Wiring diagrams.

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- (j) Gearing and linkage diagrams.
- (k) Piping diagrams.

30.2 Illustration selection criteria. Exploded view isometric drawings shall be used whenever necessary to show the proportionate size of machinery parts, proper relation to other parts, and assembly or disassembly sequence. It is preferable that all parts be exploded in isometric projection of their line of assembly axis. Sectional views or item location drawings should be used to indicate where critical measurements shall be taken or when the information presented is easier to understand when depicted as a cross-sectional view. Parts should be numbered in disassembly order sequence, with a parts list including part name, quantity, and number on each figure. As a rule, sectional drawings are not needed when isometric drawings are available. For general drawing requirements see 40.1.

30.3 Block diagrams.

30.3.1 Functional block diagrams. On functional block diagrams, the generation paths of all major output functions shall be depicted in condensed form by appropriate flow line connections of functional blocks. The functional blocks shall be chosen for the most logical presentation of signal paths without regard to physical hardware boundaries. One block may be a portion of one physical assembly, while another may encompass two or more assemblies, in whole or in part. Also, one block may contribute to two or more generation paths. Where functional blocks do not coincide with physical assemblies, physical orientation shall be provided either by adding dashed borderlines with identifying captions or by adding "part \_\_\_\_" captions near the functional blocks. All major function outputs shall be identified by name or fire control symbol, as applicable, and generation paths shall be individually identified. Coded flow lines or coded directional arrows correlated by an accompanying legend may be used. The number of diagrams required for clarity depends upon the variety of major output functions and the changes imposed by different operational modes. In any case, differences in generation paths for different modes shall be clearly indicated. Figure 37 shows a typical equipment functional block diagram.

30.3.1.1 Overall functional block diagram. The overall functional block diagram shall show the major functions of the equipment correlated in a logical manner to show outputs, inputs, cooling, built-in-test-equipment, air pressurization, power distribution, and so forth (see figure 38). Hardware packaging shall be subordinated to the functional arrangement (see figure 39). The following shall apply:

- (a) For multifunction equipments, whether single or multiunit, each major function shall be represented by a block and shall show the functional generation of outputs, cooling, air pressurization, power distribution, and so forth. All functions covered in Chapter 5 shall be shown on this diagram.
- (b) The blocks shall be connected by lines and arrowheads showing the direction of the flow.
- (c) Each block shall be identified by the functional name only.
- (d) Each functional input and output shall be identified by title. Waveforms shall be included as applicable.

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- (e) Modes of operation shall be identified by title or symbols, as applicable.
- (f) Ancillary equipment shall be shown by blocks when the ancillary equipment is associated with major functions. Ancillary blocks shall be identified by nomenclature and shall be identified as "(Ancillary)".

30.3.2 Summary block diagrams. For large and complex equipments, such as fire control radars, summary block diagrams shall be provided for each Case B signal flow or related group of signal flow diagrams. The summary block diagrams shall serve as an aid for training and for fault isolation down to a particular portion of a related signal flow diagram. Each summary block diagram should be limited to one sheet whenever possible. Figure 40 is an example of a summary block diagram for use with Case B signal flow diagrams.

30.4 Cable run diagrams. Isometric diagrams shall be used to indicate the location of all cable runs between compartments or areas. Each cable run diagram (see figure 41) shall indicate by deck, compartment, and frame identification the location of all cables shown on the interconnecting diagrams.

30.5 Control diagrams. Control diagrams shall be included for all control circuits. Control circuits shall be grouped according to energizing voltage, control function, mode of operation, or physical limits of cabinet or assembly, as applicable. Supporting information required to clarify the use of the diagram shall be provided in the general notes. The functional name and reference designation for each relay, switch, lamp, and so forth, shown shall be included. All relay energizing circuits shall be shown with all tie points and terminals and with switches and relay contacts in their operating positions. All terminal connections, switches, interlocks, contacts, or other relays in series with the energizing path, plus lamps or indicators (electrically connected in the energizing or indicating status of contact closures), shall be shown. The following note shall appear on all control diagrams: "All switches and relay circuits are shown in operating positions." In cases of multiple operating positions, switch and relay positions shall be explained by a specific note on the diagram.

30.6 Diagrams and wire run list. Diagrams and wire run lists shall be arranged functionally and shall be in accordance with MIL-STD-100. When wiring diagrams are included in a manual, wire run lists shall not be included.

30.7 Engineering drawings and wire run lists. Engineering drawings and wire run lists, which are in accordance with MIL-STD-100, are acceptable only if they meet the content, arrangement, legibility and format requirements of the contract and content specification, and the style, format and production requirements contained in this document. They must have all unnecessary data removed that would reduce the comprehension or clarity of the illustration and must be reduced or redrawn to meet foldout restrictions. When wiring diagrams are included in a manual, wire run lists shall not be included.

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30.8 Equipment illustration. For installations consisting of more than one unit or assembly, a pictorial illustration representing the equipment, or all units comprising the equipment shall be included and shall be designated figure 1-1 (see figure 42). If two units of the equipment differ between models, the alternate units shall be shown side by side (if clarity is not sacrificed) and designated by applicable model numbers. If more than two units differ, two frontispieces should be furnished and designated as figures 1-1 and 1-1A. The illustration shall show the major units of the equipment, relative size of each unit, basic interconnections between units, and their relationship with other equipment. The illustration shall be a left-hand full page or foldout (never backed up) and shall be assigned the folio (blank/1-0).

30.9 Exploded views. Exploded views of the equipment shall be used in parts breakdowns and for reference in disassembly and assembly instructions. Index numbers shall be used to identify parts. If the equipment is of such a nature that it cannot be adequately illustrated by a single exploded view, it shall be exploded by subassemblies as separate views. In such cases, an exploded view showing the complete equipment exploded into its major subassemblies shall be shown first. Parts which attach and connect the major assemblies together shall be shown on this illustration. These views and those in parts breakdowns shall be the same, with the sequence of index numbers in the order of disassembly. Parts in an exploded view shall be shown in proportional size (see figure 43). The spacing of parts shall achieve maximum clarity and effective use of space. The relationship of parts shall be shown by the use of assembly lines where the main line of exploded parts has been broken into two or more groups for convenience of layout on the page. Leader lines and index numbers shall be used to assist in locating parts. Parts for which disassembly is not required, such as wafers, switches, and so forth, need not be exploded.

30.9.1 Sectional views. Sectional views (see figure 44) may be illustrated for units with few components as long as clarity is not sacrificed (see 50.14).

30.10 Frontispiece illustration. A frontispiece shall illustrate the system, equipment or repairable item covered in the manual (see figure 45). It shall be placed on the page preceding Chapter 1.

30.11 Function diagrams.

30.11.1 Single-function diagrams. When specified (see 6.2), single-function diagrams for nonprogrammable devices which result in a unique output function may be prepared to the requirements of signal flow diagrams (see 30.22).

30.11.2 System control function diagrams. System control function diagrams shall be provided for all system control circuits. The control function diagrams shall be at the system level but shall be constructed in accordance with 30.5. The diagrams shall show essential fault isolation test points or comparable indicators, and shall include appropriate references to equipment manuals.

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30.11.3 System data function diagrams. System data function diagrams shall show in detail the system information needed to isolate faults within signal or data flow paths. Data function diagrams shall include tolerance values and shall contain references to equipment publications where necessary. All inputs required to develop the output shall be shown. The data function diagrams shall be constructed in accordance with 30.22.

30.12 Hydraulic and pneumatic schematics. Hydraulic system diagrams shall be developed in accordance with SAE HRP 4382. Where necessary, hydraulic and pneumatic schematics may be prepared as orthographic diagrams and pattern coded (see 6.2) to show hydraulic and pneumatic devices, and associated mechanical and electrical devices and actuating mechanisms, using standard symbols where possible, see figure 46. The illustration shall be developed for color symbolization only if such patterns are not adequate and if the contracting activity authorizes use of color. Illustrations planned for color shall be developed in accordance with 50.16. A series of hydraulic schematics can show mechanical actions and sequential functions of parts through a complete cycle. Arrows shall be used to show directional flow.

30.13 Ladder diagrams. Ladder diagrams shall be prepared in accordance with the following:

- (a) Diagrams shall be used to illustrate schematically the energizing path and circuit connections for all relay coils and contacts, indicator lamps, solenoids, interlocks, clutches, and motors, other than those shown on signal flow and power distribution diagrams; these shall include parts energized by a bus, or by automatic or manual switching.
- (b) All such items, including those not illustrated on the ladder diagrams, shall be listed in associated ladder indexes.
- (c) Relay ladder diagrams shall include all relay contacts that are in series with the energizing path of the coils.
- (d) Relay coils and contacts and other applicable parts shall be grouped on the ladder diagrams in a manner consistent with the equipment design or construction, such as, energizing voltage, control functions, mode of operation, or physical limits of cabinet or subassembly. Supporting information required to clarify the selected grouping of components, and the mode or switch positions assumed on the diagram, shall be provided in general specific notes on the apron of the diagram.
- (e) Control voltages and energizing buses shall be represented by horizontal lines located at the top of the illustration. Circuit components and relay wires shall be shown in vertical lines, except that connecting elements between vertical strings may be horizontal. Common returns and ground shall be represented by horizontal lines at the bottom of the diagram. Long series string, which have many references or circuit elements, can be doubled back to accomplish the required vertical arrangement. Ladder circuits may be arranged in one or more horizontal rows. Modification of this standard arrangement may be permitted for complex energizing paths, if a net gain in diagram usability can be achieved through more efficient layout.



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- (f) All energizing paths illustrated shall be shown as they are physically connected, with switches in normal positions. However, all relay contacts shall be shown in de-energized condition, unless otherwise specifically and clearly noted. All terminals, connector pins, switches, and contacts of other relays in series with the energizing path shall be shown, plus indicator lamps that are electrically connected in the energizing path or that are indicating the status of contact closures. All relays and lamps shall be identified by functional title where applicable.
- (g) Terminal board connections and relay contacts in the energizing paths shall be identified.
- (h) The color of indicating lamps shall be included. Indicator lamps and controls shall be labeled by reference designation and by the panel inscription that appears where they are mounted.
- (i) Actuating conditions of other than manually operated control and switches shall be noted.

30.14 Line drawings, engineering drawings and photographs. Line drawings shall be used in lieu of photographs. Figure 47 is a typical line drawing. Engineering drawings are acceptable if they meet the format and content requirements of this specification and the legibility requirements of the basic specification. Photographs may be used when in conformance with 60.

30.15 Logic diagram. Logic diagrams shall be provided for digital devices and digital circuitry of conventional analog equipment in accordance with ANSI/IEEE 991. Distinctive shapes shall be utilized. Internal and external data shall be included as shown on figure 48. Logic diagrams shall cover digital functions such as Input-Output Control, Memory Control, Data Transfer, Clock-pulse generation and distribution, and so forth. Emphasis shall be placed on functional development and presentation rather than on hardware groupings.

30.15.1 Basic logic diagrams. Basic logic diagrams shall depict logic functions with no reference to physical implementations. Basic diagrams shall consist primarily of logic symbols which are used to simplify logic relationships to make them comprehensible. Nonlogic functions are not normally shown (see figure 49).

30.15.2 Detailed logic diagrams. Detailed logic diagrams shall depict all logic functions and nonlogic functions, socket locations, pin numbers, test points, and other physical elements necessary to describe the physical and electrical aspects of the logic. The symbols shall be connected by lines that represent signal paths. The diagrams shall illustrate signal priority based upon the weapon function of the equipment (see figure 46).

30.15.3 Digital logic diagrams. Digital logic diagrams shall illustrate logical functions of modules, nests, and assemblies. Design or engineering drawings shall be used as source data to develop digital logic diagrams. Diagrams shall illustrate combinational, storage, delay, and sequential functions to define processing of variable signal input(s) and resultant output(s). Graphic symbols for logic diagrams shall be in accordance with IEEE Std 315.

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30.15.4 Fault logic diagrams. Fault logic diagrams shall be based on a fault indication observed during troubleshooting (see figure 50). The diagrams shall comprise a branching series of questions pertaining to fault isolation. Each question shall pertain to a further observation or measurement, and shall result in a "yes" or "no" answer, thereby progressively narrowing the possible functional area of the fault. Tolerance values shall be presented in those instances where a definitive "yes" or "no" is not obtained. This progression and elimination shall isolate the functional area of the equipment containing the fault and then refer the user to the portion of the manual containing that information needed to complete the fault isolation and repair. Each diagram shall include or make reference to information necessary to establish the test or operating conditions required for starting the fault isolation procedure. Only three types of blocks shall be used. Shaded blocks (right and bottom border lines weighted) shall contain questions which may be answered from observation, without changing test setup and without special equipment. Single-line blocks shall contain questions requiring measurement by special setup of external test equipment. Double-line boxes (conclusion boxes) shall list the functional area within an equipment that is the probable source of malfunction and shall reference a procedure or another diagram for further isolation or correction of a fault.

30.16 Piping diagrams. Piping diagrams shall be developed for fluid cooling, air, gas, steam, oil and hydraulic systems. Fluid symbols shall be in accordance with ANSI Y32.10, with hydraulic systems supplemented by SAE AS 1290. These diagrams shall show, when significant, flow rate, temperature, pressure, and all devices which measure, control, or modify the flow (see figure 51). Also, a test data table shall be included on the apron of figure 51 and reference shall be made to appropriate corrective actions and functional descriptions.

30.16.1 Simplified piping diagrams. These diagrams (hydraulic, pneumatic, or fluid) shall show the interconnection of components by piping, tubing, or hose, and sequential flow in the system. Pumps, heat exchangers, valves, gauges, and so forth, shall be clearly identified.

30.16.2 System piping run diagrams. Isometric diagrams shall be used to indicate the location of all system piping runs between compartments and areas. Each piping run diagram shall indicate by deck, compartment, and frame identification the location of all pipes, valves, fittings, tanks, and so forth.

30.17 Power distribution diagrams. Power distribution diagrams shall depict the distribution of primary ac power, secondary ac power, and dc power from the terminal board, breaker, or fuse box to the various assemblies, subassemblies or modules of the equipment (see figure 52). Normally, a separate diagram shall be developed for each voltage level used within the equipment. The following rules apply in the preparation of power distribution diagrams:

- (a) Show and identify motors, transformers, regulators, power supplies, assemblies, subassemblies, and modules.
- (b) Show and identify all power line devices such as fuses, circuit breakers, switches, and relay contacts.
- (c) Show and identify all connections including plugs, jacks, and terminal boards in the distribution path.

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- (d) Use dot and dash lines to set off hardware boundaries such as units, assemblies, and subassemblies. Identify each unit, assembly, and subassembly by reference designation. Include a figure reference to the schematic diagram covering the unit, assembly, and subassembly.
- (e) Reference all relay contacts to the appropriate control diagrams. All relay contacts shall be shown in the operating condition.
- (f) Include voltages and tolerances, as required.
- (g) Show and identify all metering circuits and indicators.
- (h) Show all grounds, commons, neutrals, and return lines.
- (i) Display the power path from left to right and from top to bottom, whenever practicable.
- (j) Conspicuously mark on the diagram the functional names of all "main line" switches and circuit breakers. In addition, set off any power control markings engraved or stencilled on the equipment in a rectangular box, for example:

MAIN POWER

- (k) Show all relay coils in series with the main power distribution path. Relay control circuits shown on control diagrams need not be repeated on distribution diagrams.
- (l) Add the following note to all control diagrams: "All switches and relay circuits are shown in operating positions."

30.18 Printed-circuit board. Printed-circuit boards shall be illustrated foil side up (see figure 53). When printed wirings appear on both sides of the board, both sides shall be illustrated. All parts mounted on the board shall be outlined in black solid (front) or dashed line (rear) (even though mounted on the reverse side of the board) and their connections to the printed wiring clearly illustrated. If insufficient room exists, separate illustrations, top and bottom views, shall be provided. Each part shall be labeled with the applicable reference designation. To facilitate parts location, a locating grid and corresponding guide chart shall be provided when more than 30 items are mounted on a board.

### 30.19 Pyramids.

30.19.1 Detail pyramids. For Case A, a set of troubleshooting diagrams shall be developed to illustrate the functional dependency and continuity of equipment outputs for specified modes of operation. These diagrams shall be made up of functional dependency boxes arranged in a pyramid format. Pyramids shall result from paralleling the coverage of signal flow diagrams for all output functions. Figures 54 and 55 are examples of detailed pyramids for electronic and electro-hydraulic-mechanical equipment, respectively. Each pyramid shall describe circuitry as it exists in an energized condition on the associated signal flow diagram. The box at the top or apex of the pyramid shall represent the output function of the signal flow diagram and shall reflect the result of all boxes illustrated below it on the diagram; feedback-type loops excepted. An in-tolerance indication by the signal characteristics of the apex box shall

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absolutely represent an in-tolerance condition of all boxes below it. If any condition, circuit or component represented by boxes below the apex box is out of tolerance, the function described by the apex box must absolutely indicate an out-of-tolerance condition. With the exception of a feedback-type loop, all characteristics of the output function must be presented in the apex box.

30.19.1.1 Apex boxes. Every pyramid shall have an apex box and no other box in the pyramid shall occupy the same level on the sheet occupied by the apex box. A descriptive title of the signal or a fire control symbol from OP 1700 shall be centered on the first line of the apex box. Below the descriptive title, enter a thorough description of the characteristics of the output function and instruction for measuring these characteristics within required tolerances. Where this description becomes too lengthy, a note may be used in the apex box and the description placed in a specific note on the apron of the sheet. Each detail pyramid shall be identified in the upper right-hand corner of the apex box by an alphanumeric code. A code letter signifying mode of equipment operation will be prefixed to an Arabic numeral in separate sequence for each mode. The following are examples of codes provided to establish standard modes of operation for all equipment.

A	Acquisition or Search Mode
D	Designate Mode
R	Air Ready Mode
T	Track Mode
Lo	Load
La	Launch
P	Point

The specific coded symbols to be used shall be determined by technical direction based on the maintenance analysis, or should be requested from the Government.

30.19.1.2 Functional dependency boxes. All boxes on the pyramid diagram, other than the apex box, shall be functional dependency boxes. Functional dependency boxes are graphical representations of a test point and all of the circuitry between it and the test point associated with the next functional dependency box below it in the dependency chain. Each functional dependency box shall contain an identification of the test point, test equipment required, test setup, test point location, panel or circuit indications, waveforms, and references to other documents available for use in isolating and correcting the trouble. WARNINGS and CAUTIONS shall be placed on the apron of the diagram and shall precede notes. The order of applicable information shall be in accordance with figure 56. Reference shall be made to specific notes contained on the apron of each diagram for information that is too lengthy for inclusion in the boxes. All functional dependency boxes within a pyramid below the apex box shall be identified by a descriptive title and an Arabic number. The number shall appear in the upper right-hand corner of each box in line with the top line of the title. To number functional dependency boxes on a pyramid, begin at the top level to the left and number each successive box appearing to the right in an ascending numerical order. When the top line of boxes has received numbers, proceed to the next lower level and repeat the process until all boxes have been numbered. Apply this numbering procedure only to the complete, unbroken, pyramid.

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30.19.1.3 Quick-look features. If a reading direct from a dial, a meter, or an indicator on the equipment panel can be considered as a testable point, such readings shall be placed inside a quick-look feature box at the bottom of the functional dependency box to which it applies. The order of presenting the information will be panel nomenclature followed by the circuit symbol appearing on the schematic diagram. Examples of quick-look features are shown on figure 55.

30.19.1.4 Feedback loops. Special consideration shall be given to the preparation of pyramid encompassing feedback loops. In some equipment where a loop is comprised of numerous functional elements, the loop must be broken in a manner that will facilitate troubleshooting. Figures 57 and 58 illustrate how the signal flow diagram and the corresponding pyramid for a typically complex feedback loop can be arranged. In the case illustrated, output of the total loop is made up of the forward loop response of the track loop plus the output of the angle receiver when all loops are closed. The output of the track loop is made up of the forward loop response of the stabilization loop plus the output of the gyro and track amplifier (in series). To facilitate troubleshooting, the breaking of the track loop at the output of the gyro shall be explained by instructions contained in notes. The output of the stabilization loop is made up of the track loop plus the output of the cathode follower, demodulator, and gyro amplifier in series. The stabilization loop also may be broken in accordance with instructions in notes, while the track loop remains open. In pyramid functional dependency boxes portraying feedback loops shall have a general note stating that preliminary checks must be made prior to using the pyramid to isolate a problem. Such checks shall include acceleration, deceleration, and synchronizing tests.

30.19.1.5 Cross-referencing in pyramids. Referencing in pyramids shall be in accordance with the following: Point-to-point referencing can be categorized as Case A1 and Case A2 and illustrated on figure 59. Case A1 is a layout problem that occurs whenever a pyramid diagram is too large to be included on one sheet without any breaks. As shown in the illustration, both TO and FROM notations are to be used for Case A1 in abridged form; that is, on the same sheet, TO BOX 13 S115 or FROM BOX 1 SH 1. Case A2 occurs when an output function becomes a subordinate parameter of another output function as a result of mode switching or when two or more output functions use common circuitry or mechanisms below a point of convergence. In Case A2 the display of interrelated functions is a matter of engineering judgement. Figure 59 shows an acceptable way of separating the generation paths by placing that portion that is common in one diagram and cross-referencing this diagram on the other diagrams. In Case A2 the junction pyramid box is repeated on each diagram and its number in each case must correspond with that assigned in the natural arrangement of each individual diagram. Only FROM notes shall be used to indicate where each "incomplete" diagram is continued on the other diagram. Case A2 references shall be unabridged, that is, FROM BOX T2, Fig. 3-18, SH 1 (referencing an apex box) or FROM BOX 7, Fig. 3-20, SH 1 (referencing a functional dependency box).

30.19.1.6 Layout of detailed pyramids. Boxes shall be spaced horizontally at a consistent distance between centerlines or multiples thereof. Vertical spacing between boxes shall be consistent where possible, except that the tops of boxes in any one level shall line up. Where a series of functional dependency



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boxes results in a chain too long for the available intelligence area in height, the chain shall be broken into suitable lengths and the subordinate sections displayed in successive columns to the right on the same sheet. If required, a large pyramid shall be broken into two or more sheets.

30.19.2 Summary pyramid diagrams. If required by engineering determinations and equipment complexity, summary pyramids shall be provided to show the complete format of the corresponding detail pyramid in condensed size, to fit on one foldout page without breaks if possible. The apex box and each functional dependency box shall contain the same identifying numbers and the same titles that appear on the detail pyramid. No other text, data, or waveforms shall be included in boxes (permitting minimum height), except that information inside quick-look borders shall be given. General and referenced notes are not required. Figure 54 is one sheet of a detailed pyramid of which figure 60, is the summary pyramid.

30.20 Reference diagrams. This section shall contain such detailed interconnection and schematic (electronic, electrical, hydraulic, and mechanical) diagrams as are required to supplement the troubleshooting diagrams for final specific fault isolation. For digital equipment, detailed logic diagrams of repairable modules or assemblies shall be provided in addition to schematics when it is impractical to include sufficiently detailed logic information on signal flow diagrams for guidance in final fault isolation. The detailed reference diagrams shall include those referenced in other less detailed maintenance and troubleshooting diagrams in the manual. Engineering design or manufacturing drawings shall be used for these diagrams whenever required. Wiring information in the form of wiring diagrams or tabular point-to-point wire running lists shall not be included unless specified by the contracting activity. For examples of types of reference diagrams, refer to the following illustrations: interconnection diagram, figure 61; electronic schematic, figure 62; electrical schematic, figure 63; hydraulic schematic diagrams, figure 51; mechanical schematic diagram, figure 65; and detailed logic diagram, figure 48. Schematic diagrams shall be used to illustrate electrical, hydraulic, mechanical, and electronic functioning of units and assemblies. Interconnection diagrams shall be laid out to show only external connections by unit assemblies or equipment.

30.21 Schematic diagrams.

30.21.1 Maintenance schematic diagrams. Maintenance schematic diagrams shall include unit-to-unit interconnection diagrams, intra-unit interconnection diagrams, and unit, assembly, and subassembly schematic diagrams. Complete coverage of the equipment shall be provided by these diagrams (see figure 66). Maintenance schematic diagrams shall be prepared in accordance with the following:

- (a) The schematic diagram for each unit shall be drawn so that, together with the interconnecting diagrams, all circuit elements are included and all circuits can be traced from unit to unit.
- (b) Schematic diagrams shall be zoned by alphanumeric coordinates in accordance with 5.11. The location of all circuit elements by zones shall be included in a table located on the apron of diagrams containing more than 100 parts. When a part such as a relay or a twin tube is drawn in sections at different locations, list as many coordinates as necessary to locate all sections.

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- (c) Major and minor signal paths shall be represented by different line weights. The heavier line weight shall show the major signal path. Whenever possible, signal flow shall be from left to right and from top to bottom. Arrowheads denoting the direction of signal flow shall be placed on the signal flow lines.
- (d) The use of ground and voltage buses is discouraged except in the power supply. However, voltage bus connections can be shown by broken lines directly beneath the connection. As a substitute for ground buses, individual grounds should be used and appropriate notes shall be included to indicate sources. If separate ac, dc, and signal grounds are actually used in the equipment, they shall be shown by keyed symbols.
- (e) All significant voltages at buses, tube pins, transistor elements, and so forth, shall be shown except when this data can be presented best in a voltage chart (see 30.21.1j). Indicate whether the voltage is ac or dc; dc voltages shall be shown by polarity. Where critical voltages occur within the equipment, tolerances for those voltages shall be shown in the illustrations.
- (f) The functional names of all operating controls and adjustments shall be conspicuously marked on the schematic. For example:

VERT CENT    BIAS ADJ , and so forth

In addition any operating front panel markings on the equipment shall be set off in a rectangular box. For example:

RF GAIN    AGC ADJ , and so forth

The functional name of all stages (tubes, transistors, and so forth) also shall be included.

- (g) The function, source, and destination of all input and output circuits shall be identified and indicated by figure number.
- (h) Power and signal frequencies shall be designated in hertz (Hz). Resistance values, if more than 1 ohm, shall be noted for all wire-wound devices such as motors, relay coils, and transformers.
- (i) Rated current and voltage values of primary and secondary windings of power transformers shall be indicated.
- (j) A resistance and voltage chart for a schematic diagram shall be provided on the apron or on preceding page size pages. This chart shall give the normal resistance and voltage to ground (or other points of significance) for each tube socket pin. In addition, list all conditions which effect the resistance or voltage values given, such as control settings, equipment connections, tubes removed from sockets, and so forth. If semiconductors (transistors, diodes, and so forth) are employed in circuits, adequate caution notices must be included to prevent damage to



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- these devices when making resistance measurements in the circuit. No intra-element resistance measurements (that is, between emitter, base, and collector) are required to be made on transistors. Also, resistance of power supply buses and other points of significance shall be indicated.
- (k) Each schematic diagram shall be identified by the reference designation number, located in the lower right-hand corner of the image area.
  - (l) Schematic diagrams shall be presented in alphanumeric order corresponding to the referenced designation of units, assemblies, subassemblies, and so forth. When two or more identical assemblies, or modules are used, redundant schematic diagrams need not be repeated. However, a table which cross references the reference designation to the figure number of the common schematic diagram shall be provided immediately preceding the schematic diagram. Schematic diagrams covering more than one unit, assembly, or module shall include on the apron or convenient location of the illustration (see figure 66) for identification purposes, all the reference designations of the unit, assemblies, and modules to which they refer (for example 1, 1A1, 2A7, 3A19).
  - (m) Circuit elements shall be grouped functionally and arranged to make signal flow obvious from left to right and top to bottom. Circuit elements shall not be arranged to fill up white space or to maintain tube or transistor alignment. Circuit elements shall be arranged in textbook form for the convenience of the user. Layout shall not be distorted to achieve fit.
  - (n) Breaks in lines shall be used as frequently as possible to avoid cluttered diagrams. Add necessary notes or text to explain how to use break symbols, where to find mating ends of broken lines on drawing, and so forth.

30.21.2 Mechanical schematic diagrams. These diagrams shall show sufficient detail to explain the operational sequence and arrangements of a mechanical device including the electrical control circuits (see figure 65). Nomenclature, symbols, part or identifying numbers (PIN), and necessary descriptive data shall be shown as required. Gears, shafts, clutches, levers, mechanically-driven switches, motors, synchros, and so forth, shall be shown in functional arrangement. Gear ratios or number of teeth and direction of rotations, and so forth, shall be given. Symbols used on these diagrams shall conform to MIL-STD-17-1 and MIL-STD-17-2, and additional symbology provided by the Government (see 6.2).

30.21.3 Simplified electrical and electronic schematic diagrams. These diagrams shall show, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. These diagrams shall be arranged functionally to show the operation of the circuits in the same manner as illustrated in NAVSEA 0967-LP-000-0120.

30.22 Signal flow diagrams. Signal flow diagrams shall consist of detailed block diagrams illustrating the functional development of each major function from its origin to its measurable output (see figure 67). The flow path shall begin with one or more initial inputs (or appropriate interface conditions) and proceed through each unit, assembly, and subassembly influencing the signal flow. Each

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hardware level block shall reference a schematic diagram to isolate the faulty part. All items shown on the signal flow diagram shall be identified by their reference designations. The following shall apply:

- (a) Titles of diagrams shall correspond to the signal flow described.
- (b) Diagrams shall depict such signal flow as: receive, transmit, RHI display, PPI display, bearing data, antenna rotation, elevation data, and so forth.
- (c) All test points necessary to isolate the trouble to the lowest level of hardware block (for example, subassembly) shall be shown. Include test parameters required to define satisfactory operation. Where signal flow diagrams depict signal flow in more than one mode of operation, that data shall be presented on the apron for all modes. Apron notes shall also include test data for test equipment setup. All inputs and outputs shall have signal description information.
- (d) References shall be made to the functional description, troubleshooting procedures, corrective actions, and so forth, as appropriate, by paragraph number. Normally these references shall be included with the notes.
- (e) The display of more than one function or mode of operation on one diagram shall be allowed only if clarity is not sacrificed and the functions are relatively simple.
- (f) Screwdriver adjustments, dial adjustments, and adjustable controls shall be shown.
- (g) The reference designations (for example, 1A1A2) shall be placed in each hardware block. Reference to the figure number of the schematic diagram shall be placed adjacent to the reference designation.
- (h) All input and output signals and connectors and terminals in the signal path shall be shown. Identify the signal, and show all lead numbers, connector numbers, and terminal identifiers.
- (i) All built-in controls and monitoring devices shall be shown. Do not show external test equipment, unless it is a permanent part of the equipment.
- (j) Hull grounds, chassis grounds, signal grounds, and power grounds shall be shown.
- (k) All leads of components such as motors, generators, synchros, and so forth, shall be identified.
- (l) All relay coils that are energized by the signal shall be shown.
- (m) All relay contacts and relay terminals in the flow path shall be shown and identified. All relay contacts shall be depicted in operational mode. References to control diagrams on which the relay coils appear shall be shown adjacent to the relay contacts.
- (n) All switches which affect signal flow shall be shown and identified. Switch terminals and panel markings corresponding to the switch positions shall also be shown.
- (o) Mechanical couplings of all controls, switches, potentiometers, synchros, and so forth, shall be shown.
- (p) Signal paths shall be identified by weighted lines and arrowheads.
- (q) Test instruction procedures and test data shall be shown on the apron pages of the diagrams.

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30.22.1 Types of signal flow diagrams. Signal flow diagrams may be either a physical dependency type or a functional dependency type.

- (a) Major subdivisions on the physical dependency type will be shown as either cabinet, chassis, or unit limits indicated by broken lines.
- (b) Functional dependency type, as it relates to functional dependency boxes are shown in solid lines.
- (c) The method selected shall remain consistent for all signal flow diagrams in the manual. When a functional dependency box area is used on a signal flow diagram, it shall correspond in every detail with its associated functional dependency box on the respective pyramid. This will give both detail pyramids and signal flow diagrams reference to common schematic diagrams.
  - (1) When the cabinet or chassis limit method is used, both diagrams shall refer to schematic diagrams but they will not necessarily group test and testable points together. A functional dependency box of a detail pyramid could be a part of one or a group of several chassis assemblies.
  - (2) Where the functional dependency method is used to subdivide signal flow diagrams, reference can be made directly to alignment procedures specified for a pyramid.
- (d) The determination of descriptive limits, physical or functional dependency, shall result from the maintenance analysis. Figures 67 and 68 are examples of signal flow diagrams subdivided by physical limits and functional dependency limits, respectively. Figure 69 is an example of a signal flow diagram for digital circuitry. Additionally, for Case B signal flow diagrams, the density of content shall be such that complete flow to the output function is depicted on one sheet whenever possible.

30.22.2 Types of elements on signal flow diagrams. The following functional elements such as connections, monitoring devices, and test points with values, are to be shown on signal flow diagrams, as applicable.

- (a) All adjustable parts or subassemblies. Identify any screwdriver setting, dial setting, or adjustable knob.
- (b) Amplifiers. Identify all leads or terminals that are part of the depicted signal flow.
- (c) Chassis and cabinet (unit) limits. Show the enclosures where the functional elements are installed. Identification of cabinets, major assemblies, and chassis within a cabinet, including unit designations, shall be placed in the upper left-hand corner of each outline. Reference to schematics and applicable maintenance requirement cards (MRCs) should be placed immediately below the unit designation.
- (d) Coaxial cable and waveguides. Label the signal being transmitted and show significant functions.

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- (e) Intercabinet and intracabinet connections. Label all connections other than soldered joints. Identify the lead, connector, or terminal number of both sides of the connection. Where the location of the connection in an equipment is obvious from adjacent unit limits, it need not be indicated beside the connection; but, where it is not obvious, added information identifying the physical location of the connection shall be placed adjacent to the symbol.
- (f) Dials and meters. Show dials and meters, which are a physical part of the equipment as required by engineering layout, as quick-look features with the panel nomenclature within the quick-look box. Do not show any meters that must be plugged in to take a measurement.
- (g) Fire control symbols and mathematical quantities. Identify all applicable quantities defined in OP 1700 by the corresponding standard fire control symbols. The contractor's symbols, where different, or mathematical quantities shall be entered beneath the standard symbols.
- (h) Grounds. Differentiate between hull ground, chassis ground, and common returns. Use appropriate symbols and identifiers, which shall be specifically identified in apron notes.
- (i) Hand-set values for static tests. Hand-set values shall be indicated by use of a rectangular box tied with a dashed line to the generation path signal to indicate the mechanical connection. The rectangular box shall contain the panel nomenclature of the dial, indicator knob, and the hand-set values below the nomenclatures. If more than two values are to be shown, (see (n)).
- (j) Motors and generators (electrical). Do not show any internal parts of electrical motors and generators, but identify all leads.
- (k) Potentiometers. Give the range of the potentiometer if it is restricted to less than full travel. Show mechanical coupling if motor-driven.
- (l) Relay coils and solenoids. Give the reference designation or other specific identifiers. Identify coil terminals.
- (m) Relay contacts. Identify the energizing bus above and give the relay reference designation below. Identify associated terminals. All contacts shall be depicted assuming the relays in de-energized condition, unless otherwise specifically and clearly noted.

## NOTE

When relay pin or terminal identification is difficult because of a specialized type of relay, a relay pin identification diagram shall be provided that presents a schematic bottom view of the relay(s) shown on the signal flow diagram. The pin or terminal identification diagram should be located on the apron of the signal flow diagram if space permits, otherwise the information should be placed on a separate sheet ahead of the signal flow diagram. Figure 70 shows a relay pin identification diagram.

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- (n) Readout values for static tests. If only one or two problems are used, show values in a box representing the test point or dial (see (i)). If more than two problems are used, indicate the panel nomenclature of the readout device in the box and place the values for the respective problems in a table on the apron as a specific note.
- (o) Scale factors. Show scale factors where applicable, such as, at outputs of computing amplifiers, computing potentiometers, and resolvers. For transformers where scale factor values are involved, show the relative values at both the primary and secondary windings.
- (p) Switches. Identify switch terminals. Identify actuating condition for other than manually actuated switches, including pressure limits for hydraulically or pneumatically actuated switches.
- (q) Summing network. Identify leads or terminals of summing networks. Show impedance value or ratio to unit impedance for each input lead, as applicable.
- (r) Terminal boards. Identify the terminal board. Show only the terminals that apply to the circuit. Identify leads or terminal numbers, as applicable.
- (s) Testable points. Identify all applicable testable points. Give the same information for a testable point as required to be illustrated for a built-in test point jack. The information to be provided at a testable point on a signal flow diagram is the same as required for a functional dependency box on a pyramid, except that test point location and schematic diagram reference need not be repeated here if otherwise obvious. Information shall appear in the same order as in the pyramid box when the functional dependency method of signal flow diagram subdivision is used.
- (t) Transformers. Indicate both primary and secondary sides; identify all leads or terminals.
- (u) Synchros and resolvers. Identify the functional type of synchro. Identify all leads. Show mechanical coupling if motor-driven. Indicate relative speeds when multispeed synchros are used.
- (v) Valves. Illustrate fluid transmission from valve ports in path of signal flow. Give pressure limits for pressure control of bypass valves.
- (w) Pumps or compressors. Illustrate pump in operation giving flow rate. Also indicate pressure, if pressure control is integral with the pump.
- (x) Mechanisms. Illustrate mechanisms, as required to show continuity and sequence of mechanical actions, contributing to the output function.
- (y) Flasks or accumulators. Indicate working pressure range of flasks and accumulators. Also give allowable overall leakage rate, if applicable.
- (z) Motors and actuators (hydraulic or pneumatic). Include as required.
- (aa) Waveforms (Case A only). Indicate or reference the expected waveform for the signal at all applicable testable points. Waveforms should be photographs or realistic representations of actual waveforms as seen on an oscilloscope utilizing a white



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- image on black background. Stylized waveforms shall be shown as a normal line drawing with black lines. Waveform characteristics and measurements may be superimposed on the image or referenced in an associated table. If a grid is superimposed on the image, vertical amplitude and horizontal time scales shall be included.
- (bb) Waveforms (Case B only). Validated waveforms or voltages shall be provided for each test point shown, where such data will provide additional information useful in troubleshooting and circuit analysis. The waveforms must contain sufficient information and detail, including tolerances, to enable complete evaluation of the test point monitored. The waveforms and supporting notes should be placed on the apron of each diagram or on a separate sheet preceding the diagram. Waveforms may be placed near the applicable test points only when they will not cause undue clutter, possible misinterpretation, or require the diagram to be expanded to the extent that an additional sheet would be required to depict the total signal flow. Waveforms shall not be provided for power supply or bus voltages, ground or return jacks, or any parameter that is obvious or that cannot be typically presented.
- (cc) Fixed resistors, capacitors, and coils. Fixed resistors, capacitors, and coils shall be shown if their presence contributes significantly to modification of the signal. These components need not be identified by reference designation or value unless they reveal a test point; in which case, a validated waveform or voltage shall be provided.

30.22.3 Cross-referencing in signal flow diagrams. Cross-referencing in signal flow diagrams shall be in accordance with the following. Where substantial portions of circuitry or mechanism are common to two or more output functions, or in different modes of operation for the same output function, the common portion of generation paths shall be shown on one diagram and cross-referencing used for referring to the common points from other signal flow diagrams. Cross-referencing in signal flow diagrams can be used for the same reasons set forth in Case A1 and Case A2 for pyramids (see 30.19.1.5), with the following additional requirements.

- (a) Each signal break, whether a point of coincidence between diagrams or between sheets of the same diagram, shall be identified by the name of the signal or by specific connecting terminals to permit cross-referencing. Except where lines cross from one sheet to the following sheet, signal flow diagram zones shall be included in the reference and referenced points need not be brought out to either end of the sheet.
- (b) Since the signal flow diagrams are read in either direction, a TO or a FROM notation shall be given at each signal break on a page from Case A referencing; for example, FROM 80J04, S112(A5). For each end of a break, the choice of TO or FROM shall be in accordance with the direction of flow in that path.
- (c) For Case A2 referencing, use a FROM notation only, on the diagram requiring completion of common generation path by reference, giving the name of the signal or the terminal designation, the figure number, sheet number, and zone number, in that order.

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- (d) In those instances where referencing is required and the signal does not have a name, a common referable point or a connecting terminal between changing sheets, use an upper case letter inside a circle to indicate where the signal path stops on one sheet and picks up on another. The reference notes will include this circled letter, for example, TO B Fig. 3-19 SH 2 (A5).
- (e) In those instances when a signal flow between the point of origin and final output become modified by an interfacing equipment, depict the logic treatment of that signal within the interfacing equipment.

30.23 System fault logic and troubleshooting-maintenance dependency-matrix diagrams. System fault logic diagrams shall be developed for fault indications observed during either scheduled tests or operation. Fault logic diagrams shall be constructed in accordance with 30.15.4. These diagrams shall isolate the functional area of the equipment at fault and then refer the user to the equipment technical manual containing the information needed to complete the fault isolation and repair. Each diagram shall include or make reference to information necessary to establish the system test or operating conditions required for starting the fault isolation procedure. The conclusion boxes shall list the equipment or functional area within an equipment that is the probable source of malfunction and the technical manual reference or references for further isolation and repair of the fault. Troubleshooting-maintenance dependency-matrix diagrams in accordance with 30.26 may be substituted for or augment fault logic diagrams.

30.24 System interconnection diagrams. System interconnection block diagrams shall be prepared in accordance with ANSI Y14.15 and shall be presented with each equipment or component shown as a block. All cables running between equipments shall be identified by cable number. The number of active and spare leads in each cable shall be included. The illustrations shall also indicate all junction boxes, switchboards, and so forth, into which interconnection cables enter or leave.

30.25 Timing circuit diagrams. Timing circuit diagrams shall be provided for all significant timing relationships (see figure 71). These diagrams shall show the exact timing relationships and the origins of all timing signals (conventional and digital).

30.26 Troubleshooting-maintenance dependency-matrix chart. When specified (see 6.2), matrix charts shall show the functional dependency of output signals or indications upon circuit elements, circuits, modules, and so forth (see figure 72). These charts shall be developed in accordance with the following:

- (a) Each vertical column is annotated to represent a circuit element, circuit, assembly, and so forth.
- (b) The horizontal rows are annotated to represent a procedural step which results in an observable output or indication.
- (c) Symbols shall be used, in the body of the grid, to show the relationship between circuit elements, circuit, and so forth, and observable output or indication.
- (d) All circuits, assemblies, modules, and so forth, shall be exercised in a manner to permit logical diagnosis.



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- (e) All outputs shall be clearly defined and performance specifications given.
- (f) All symbols shall be defined.
- (g) Use of chart shall be fully explained.

## 40. GENERAL ILLUSTRATION INFORMATION

40.1 Illustrations, drawings, and sketches. Style and techniques shall be of a quality which will produce artwork that will clearly, adequately, and economically portray the information to be illustrated. Illustrative material shall be used to: describe an item or idea if this can be done more efficiently and effectively by graphic methods; clarify text; present phases difficult to describe by text alone; call attention to details; and furnish graphic identification of parts and tools. Multiple sheet, or sequence number illustrations, in addition to step-by-step operational type, may be used for depicting disassembly, assembly, removal, installation, and so forth. Illustrations, other than foldouts, shall be located as near as possible to the point at which they are first referenced, except where this would require unnecessary duplication of illustrations.

- (a) Illustration use. Liberal use of illustrations is encouraged to ensure clarity of descriptive text and procedural steps. Exploded views shall be used to the greatest extent possible. Redundant drawings shall not be included. When only a part of an existing drawing is required, only that section of the drawing shall be provided.
- (b) Illustration placement. Each illustration shall be included as part of a paragraph or follow as closely as possible to its first reference in the narrative text. Use of fold-out illustrations is discouraged. However, when an illustration does require a foldout sheet, such as for a large schematic diagram, it shall be located at the end of its relative discussion in the text and shall be printed with an apron. Foldup-foldout (map fold) illustrations are strictly prohibited.
- (c) Illustration titles. Illustrations shall be assigned figure titles. The title shall follow two spaces after the figure number and shall be centered below the applicable illustration (except for foldout figures). The first letter of the first word and of each principal word will be capitalized. Full page illustrations, placed sideways on a page, shall be turned 90 degrees counterclockwise. The figure number and title for a turned illustration shall be placed at the bottom of the page with the manual in its normal position. When the majority of illustrations are turned, the figure number and title shall also be turned to appear below the illustration. Figure titles should begin with an identifying name. For example:

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"Figure 3-1. Guidance System Gyroscope Assembly."

The title shall be short and describe the contents or purpose of the illustration. Illustrations applicable to one Service, in a manual that will be used by more than one Service, shall be identified. For example:

"Figure 2-3 (Navy only). Fuel Indicator."

- (d) Material or parts list. A material or parts list shall be included with each drawing. Only those parts referenced in the text shall be identified on the drawing. When specifying disassembly in accordance with disassembly sequence numbers, all parts shall be listed. Text and illustrations shall complement each other to communicate the required information. Nomenclature shall be consistent throughout the manual.
- (e) Acceptability of drawings and illustrations. Engineering drawings and illustrations that are not prepared primarily for illustration purposes are acceptable if the copy print is legible, reproducible, and readable when reduced to manual size. All irrelevant material shall be removed.
- (f) Callouts. Illustrations shall identify key part locations with callouts neatly placed around the drawing. Care shall be taken not to introduce clutter and distractions. The associated operator's manual identification numbers should be included as a cross-reference indicator to aid the user. Cite the method used to present data as a note in the drawing.
- (g) Drawing reduction. Drawings which are to scale but not dimensioned shall be reduced for inclusion in the manual. A line approximately three to six inches long, indicating the actual scale of the subject drawing, shall be added to the drawing before reduction. The scale shall then be reduced in the same proportion as the drawing.
- (h) Drawing identification. Drawings and sketches reproduced or modified from an existing approved blueprint or drawing shall contain information identifying the drawing.

## 50. ILLUSTRATION DETAILS

50.1 Scale. Illustrations shall be prepared to as small a scale as possible consistent with effective use of space, with all essential detail legible; be same size as areas they will occupy in the manual page, or be of such oversize as to permit uniform reduction to this size.

50.1.1 Letter size. The scale shall be such as to provide for a minimum final letter size, when printed, as required by figure 4.

50.2 Border rules. Border rules shall not be used for single illustrations, but shall be used to separate multisection illustrations on the same page (see figure 44).

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50.3 Use of human figures. Where it is necessary to illustrate an operation, procedure, or installation, illustrations may include a human figure or parts of the body. Jewelry shall not appear in any illustration. The human figure shall not be permitted to obscure details of the equipment necessary for a complete understanding of its operation. The human figure shall be clothed as designated by the Government. A cross section of races and sexes shall be used.

50.4 Credit lines. The artist's name shall not appear on any artwork; neither shall a manufacturer's name, symbol, or trademark appear on artwork for the purpose of identifying the illustration. A contractor's identification number may be used. When used, such numbers shall be in approximately 4- to 6-point type and placed in the lower right-hand corner of the illustration sufficiently removed to avoid being confused as part of the illustration or margin data.

50.5 Callouts. Index numbers, reference designations, nomenclature, leader lines, legends, procedures, and so forth, shall be used, when necessary, to identify significant features. Callouts shall be prepared by a mechanical or electronic method, rather than freehand lettering, except that engineering drawings prepared are acceptable. Unless otherwise specified, type size shall be no smaller than 8-point and no larger than 10-point. Lettering shall be in upper case. Nomenclatures shall appear on illustrations only if it can be done without crowding or reducing type size so as to make reading difficult (diagram callouts shall be no smaller than 8-point). Callouts shall be placed in the background areas of illustrations when practical. Care shall be taken not to introduce clutter and distractions.

50.5.1 Index numbers. Index numbers for each separate figure shall start with Arabic numeral 1 and continue consecutively. All multisheet illustrations shall be considered one figure. Sequence on exploded views used to show assembly or disassembly shall be in disassembly order. Otherwise, sequence shall be from top to bottom or clockwise, when possible. New callouts inserted between items when an illustration is changed shall be the same as the preceding index number with an added decimal number, for example, 22.1, 22.2, and so forth. When it is necessary to add a callout between items which have already been added by the preceding method, an alpha character shall be used (for example, a callout added between 22.1 and 22.2 would be 22.1A). This system shall also be used in basic publications when errors are discovered so late in development that renumbering of all following index numbers would delay submittal. Suffixed index numbers need not be eliminated for a revision unless the illustration must be reaccomplished. All functional items shown on exploded views shall be identified except for exploded views used for disassembly or assembly.

50.5.2 Nomenclature. Nomenclature of more than one line shall have the left margin justified. All lines of copy shall parallel the horizontal edges of the figure, whenever possible. When specified, a cross reference shall list the official nomenclature and its corresponding acronym or general usage nomenclature.

50.5.3 Leader lines and arrowheads. Leader lines and arrowheads may end close to the callout and object, or may touch the objects to which they apply. Lines shall be uniform, short and straight as possible; however, dog leg shaped lines are permitted. Lines and arrowheads shall not cross or come in contact with other callout lines or arrowheads nor shall they obscure essential details. A

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line should be highlighted or changed from black to white to make the line easier to follow. Arrowheads may be added for clarity. Arrowheads shall be uniform in shape and size when multiple arrowheads are used on a page.

50.6 Legends. Unless the legend is contained as part of the figure, legends shall be placed four spaces above the cutline (RDC) or illustration (PTM and FRC) and shall be headed by the word "Legend" followed by the number of the figure to which it is applicable (see figure 73). The entire legend shall be indented 5 spaces. If the legend is continued, the figure number and title shall be repeated, followed by a dash and the word "Continued". Only that information which is necessary to clearly identify the items shall be included in the legend. Where methods such as the tabular presentation technique (as in an Illustrated Parts Breakdown) are used, no legends are required. When index numbers are used, a legend consisting of their numerical listing and their identification shall be included on, adjacent to (same page) or facing, the artwork.

50.7 Steps. Essential illustrations depicting mechanical operations shall be included as necessary. Operational or procedural illustrations shall have one or more text steps with each illustrated step. It is not necessary to illustrate each step of a maintenance procedure, such as the removal of screws with an ordinary screw driver, lifting off a cover after the screws have been removed, and so forth. Procedural illustrations should supplement the text by clarifying procedures which are of a special nature or are not obvious. The text step shall be as close to the illustrated step as possible. Steps shall be identified in the order in which they are to be accomplished (see figure 74). Alternate types of operational and procedural step illustrations are acceptable (see figure 75).

50.8 Reference designations. The application of reference designations shall be in accordance with MIL-STD-100. Reference designations marked on equipment take precedence.

50.9 Crop and size marks. Each separately supplied illustration shall have the reproduction area defined by crop marks appearing on each of the four corners marking the horizontal and vertical dimensions of the area to be reproduced. The lines shall extend no closer than 1/4-inch to the outside of the reproduction area. The exact reproduction size shall be indicated between crop marks. Marks shall not be drawn with ball point pen or grease crayon. Crop marks shall be approximately 3/8-inch long and shall not cross or touch (see figure 76).

50.10 Illustration cutline. For RDC, the point at which an illustration or (when appropriate) chart is to be placed shall be indicated by a break in the text and the insertion of the figure number and title (see figure 77). Cutlines shall be placed at the end of the first paragraph or subparagraph in which they are referenced, unless they require a foldout. The figure number shall begin at the left margin and there shall be a double space above and below the cutline. Cutlines for foldout illustrations shall be placed at the end of the text. For the PTM and FRC, the illustration is mounted in place and the cutline becomes the figure title.

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50.11 Zoning on diagrams. Diagrams containing the symbols for more than 100 parts shall be zoned. Diagrams shall be divided into equally spaced horizontal zones (ordinates) designated A, B, and so forth, from bottom to top along the outside left and right borders. Diagrams shall be divided into equally spaced vertical zones (abscissa) designated 1, 2, 3, and so forth, from right to left along the outside top and bottom borders. The zone size shall be as needed to clearly locate referenced points. The location of all circuit elements by zones shall be included in a table located on the apron.

50.12 Notes for diagrams. Notes on diagrams shall be confined to clear spaces of the image area. Notes for foldout diagrams, with the exception of installation control drawings, shall be placed on the apron. Notes shall be identified with the legends GENERAL NOTES and SPECIFIC NOTES, as applicable. General notes shall precede specific notes and shall be identified by capital letters (A, B, and so forth). Specific notes shall be identified by arabic numerals (1, 2, and so forth).

50.12.1 General notes. General notes shall apply to the entire diagram and shall appear only on the first sheet of multisheet diagrams. No reference shall be made to general notes from the diagram or from specific notes. Examples of general notes are: a warning that high voltage exists throughout the entire equipment, the general instructions for positioning switches, and a list of the test equipment needed to take measurements.

50.12.2 Specific notes. Specific notes shall apply only to a specific item on the diagram. Specific notes shall be repeated on each sheet of a multiple sheet diagram to which they apply and it shall not be required to refer to a specific note on another sheet of a diagram.

50.12.3 Apron notes. Apron notes for foldout diagrams should be placed in a final size image area of 7 by 10 inches with a minimum letter height of 0.060 inch. Notes shall be arranged to make best use of the available space. When notes for a given diagram foldout sheet require more than the 7 by 10 inch apron, the notes shall be extended with additional columns on the diagram image area if the space permits. If the space does not permit, single pages shall precede and shall contain the additional notes. When additional note sheets are required, the notes shall start on the first additional sheet and be printed as a right-hand page; note pages may be printed on both sides. Foldout sheets shall not be used for running text. Each sheet of the diagram, including the note sheets, shall contain the figure number, title, and sheet number.

50.12.3.1 Multiple page notes. For multiple page note pages, applicable to illustrations, each note page if used, shall be consecutively numbered front and back. Multiple note pages shall not be delineated as being part of (or sheet of \_\_\_ ) an overall notes page, but illustrations shall be delineated as being sheet \_\_\_ of \_\_\_ an overall illustration, as applicable. Notes shall precede the illustration or appear on the illustration apron, as applicable. Notes pages shall be of the single sheet type.



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50.13 Foldout page and multisheet illustration limitations.

50.13.1 Foldout pages. Foldout pages shall be developed only when approved by the Government. Multisheet illustrations should be used where possible, in lieu of foldouts, when usability will not be effected. Foldout-foldup pages are not permitted. If approved by the Government, foldout pages may be prepared for the 4 by 8, 5 1/2 by 7, 5 by 8 and 8 1/2 by 11 inch manuals. Foldout pages shall not be used in the 4 by 5 1/2, 4 1/2 by 7 or 17 by 11 inch manuals. Foldouts shall meet the following requirements:

- (a) All foldout pages shall be prepared for printing on one side only.
- (b) Full blank aprons shall be used.
- (c) Foldout pages shall not be spliced.
- (d) Foldout pages shall fall at the end of the manual. When specified, foldout pages shall fall at the end of chapters or be interspersed within text pages. When foldout pages fall at the end of the manual, such pages shall follow the last chapter, appendix or index, whichever forms the last portion.
- (e) Maximum foldout page sizes and maximum printable area for foldout pages shall be as follows (unless otherwise specified in the contract):

<u>Manual Size</u>	<u>Foldout Maximum Page Size (including blank apron)(inches)</u>	<u>Foldout Maximum Printable Area(inches)</u>
4 by 8	12 by 8	7 1/2 by 7 1/2 \a
5 1/2 by 7	16 by 7	10 1/2 by 6 1/2 \b
5 by 8	15 by 8	9 1/2 by 7 1/2 \a
8 1/2 by 11	26 by 11	16 by 10 \c
17 by 11	0	0

- \a Minimum margins: 1/4 inch top, bottom and side opposite binding edge.
- \b Minimum margins: 1/4 inch top, 1/2 inch bottom and side opposite binding edge.
- \c Minimum margins: 1/2 inch top and bottom, 1/4 inch side opposite binding edge.

50.13.2 Multisheet illustrations. Whenever possible, to reduce the number of foldouts to the essential minimum, illustrations shall be divided between facing pages and identified "Figure \_\_\_ sheet 1" and "Figure \_\_\_ sheet 2" respectively. When more than two pages are required, and except for such illustrations as schematic, wiring and logic diagrams where the use of the diagram would be adversely effected, additional sheets may be continued on immediately succeeding pages and similarly identified. Sheet 3, Sheet 4, and so forth, can be planned for succeeding pages when required and if this treatment will not effect the usefulness of the manual.

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50.14 Multisection illustrations. Each section of a multisection illustration shall be identified by a capital letter (see figure 44). Sections may or may not be captioned, but if one section is captioned, all shall be captioned. Each caption, with the identifying letter as its first character, shall be centered with respect to the section to which it applies. Where captions are not used, the identifying letters shall be centered. Identifying letters and captions shall be larger and bolder than any other lettering on the illustration. Sections shall be separated by lines. Separation by shading shall not be used.

50.15 Cartoons. When specified (see 6.2), the use of animated drawings and other visual techniques are permitted. Animated drawings shall not include copyrighted cartoon characters. Such presentations must serve a functional purpose.

50.16 Color in illustrations. The use of color illustrations is discouraged. Shadings, cross-hatchings and patterned lines shall be used instead of color (see figure 78).

50.16.1 Register marks. The key artwork and each overlay shall contain a minimum of three register marks located outside the reproduction area, one centered on each side, and one centered at the top or bottom. The register marks on each overlay shall accurately align with one another and with the key art.

50.16.2 Separation of colors. The black and white, or key, artwork shall be depicted on illustration board or on acetate. Each succeeding color overlay shall be made on acetate, or equivalent, and attached securely to the key artwork. Each color overlay shall be marked with its correct color. A color legend shall be an integral part of an illustration. The legend shall contain an exact duplicate of each solid, tint, or pattern of color and identify the usage in the illustration.

50.17 Other types of illustrations. Depending on the type of information to be shown, a manual may contain illustrations such as frontispiece (assembled view), exploded, operational, procedural, functional, location view, lubrication, waveform, and so forth (see figures 74, 75, 79, and 80).

## 60. PHOTOGRAPHS AND LINE DRAWINGS

60.1 Photographs and line drawings. Line drawings shall be used in lieu of photographs (halftones), when practicable. The use of a photograph instead of a line drawing shall be determined by the practical considerations of the purpose and suitability of the illustration in the publication. Existing illustrations and engineering drawings shall be used where they meet the requirements of this document. In the early development of equipment, a line drawing may be prepared from the source data if the equipment is not available for photographing. Rendered drawings, either airbrush or wet-wash, are acceptable only if such preparation is the most efficient method available. Line tracings of photographs are also acceptable. The resulting line drawings shall be of high reproduction quality. A suitable material capable of maintaining consistent and permanent high density reproducible values shall be used for preparing the line drawings.



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60.2 Photographic details. When specified for use, photographs shall be detailed and sharp, free of heavy shadows, distorted objects, cluttered foregrounds or backgrounds, and give good contrast from white, middle tones, and black.

60.2.1 Retouching. Photographic retouching shall be held to a minimum. Retouching shall be used only to emphasize detail, exclude unwanted detail, correct slight photographic defects and eliminate undesirable shadows for those portions of the photograph related to the text only. Quality of retouched photographs shall be such that tonal values are held when reproduced.

60.2.2 Prescreened photographs. When approved by the Government, prescreened photographs are acceptable as reproducible copy provided they will not be rescreened and are of proper quality, size, and mounted on the reproducible copy of the text page or margin data. When prescreened photographs are used, artwork will be clearly marked to indicate prescreening. Unscreened continuous tone photographs and original artwork shall be supplied, with reproducible copy, as specified by the contract.

60.3 Line drawing details.

60.3.1 Darkness and sharpness of lines. The darkness and sharpness of lines shall be sufficient to reproduce clearly at required reproduction size without additional treatment (see figures 81 and 82). Parallel lines on wiring and schematic diagrams shall in no case be less than 1/16-inch apart when reduced to printed size (see figure 83). Secondary lines, such as those used to indicate extensions or measurements, shall be lighter but strong enough to reproduce clearly at reproduction size. Shading may be used to give substance and form to the item depicted, to sharpen the contrast between the subject and its background or to increase effectiveness. Shadows shall be used only when necessary to provide a clear understanding of form, shape or depth. Shading effects shall not be used for decorative purposes. Accented lines may be used to emphasize detail. Lines, cross-hatching, or mechanical patterns used for coding shall remain clearly defined when reduced to reproduction size (see figure 78).

60.3.2 Designations, diagrams and symbols. Designations, diagrams, graphic symbols and letter symbols shall be in accordance with MIL-STD-100, OP 1700, ANSI Y10.20, ANSI Y32.10, IEEE Std 200-75 and IEEE Std 315A-86, as appropriate. New designations, diagrams and symbols not covered by the aforementioned documents may be used if they are explained in the manual's foreword, preface, or introduction. Government approval is required before any new designations, diagrams or symbols are used.

70. ARTWORK

70.1 Continuous tone artwork. When specified for use, such artwork, whether photograph or drawing, shall be clear in detail, sharp in contrast of tones and with light and shadow in proper relation to a consistent light source. The background shall be an intense white. It shall extend the full width and depth of the artwork.

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70.2 Combination artwork. When specified (see 6.2), presentation of a subject by combining photographs or continuous tone artwork with line drawings, shall be limited to where this presents the subject more accurately or more clearly.

70.3 Mounting of artwork. Drawings, diagrams, and illustrations, needing to be incorporated in a text page manually, shall be securely fastened to a mounting board by a process that will protect the artwork, will not discolor or distort the illustration, and will ensure its being free of wrinkles and blisters. The size of the mounting board shall allow for a minimum border of 1-1/2 inches on all four sides of the image area of each illustration to accommodate required external identification markings. Security classification, if applicable, shall be placed at the top and bottom center of the reverse side of the mounting board and similarly placed outside the image area on the front (see figure 84).

70.4 Identifying artwork. Artwork not affixed to the completed final reproducible copy shall bear the technical manual identification number and figure number outside of the reproduction area. The security classification, if applicable, shall be placed at the top and bottom center, also outside the reproduction area. To eliminate the possibility of printing illustrations in incorrect positions, the top of the artwork shall be identified (see figure 84).

70.5 Covering of artwork. All board mounted artwork shall be protected by an inner flap of non-oil tissue or vellum, and an outer flap of heavy paper. The tissue overlay and protective flap shall be cemented or securely taped to the back of the mounting board at the top of the illustration and folded over the face of the illustration. The figure number, page number and technical manual identification number shall appear in the outside upper right corner of the outer flap (see figure 84). The security classification, if applicable, shall also be placed at the top and bottom center of the outer flap. Computer generated artwork does not require an inner flap of nonoil tissue or vellum.

## 80. CHANGES TO ILLUSTRATIONS

80.1 Illustration changes. When changes are made to illustrations, the original artwork shall be used unless the development of new artwork is less expensive. Sheets added to a set of multisheet illustrations which fall between existing sheets shall be assigned the preceding number plus a decimal number. For example: if a sheet is added between sheets 2 and 3, the added sheet becomes 2.1. If possible, the new sheet shall be added after the last sheet and be assigned the next consecutive number. If a callout is deleted from an illustration, the word "(Deleted)" in parentheses shall be placed after the appropriate number in the legend.

80.1.1 Change symbols for illustrations. Changes to line drawings, charts prepared as illustrations, graphs, diagrams and schematics shall be indicated by shading and screening to highlight the area containing the changed information (see figure 85). Extensively changed presentations shall be indicated by a screen border around the effected area. For minor changes not suitable for shading or screening, a miniature pointing hand shall be used.

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80.1.2 Index number changes. Where a change to an illustration adds index numbers between existing numbers, the added numbers shall be the same as the preceding index number with an added decimal number, for example, 22.1, 22.2, and so forth.

90. REVIEW

90.1 Review of illustrations. Illustrations shall not be furnished separately for review. If a publication is reviewed, illustrations forming a part of the publication shall be included in the review. Each illustration copy shall be approximately the same size as a page of text, except for those of foldout size which shall not exceed maximum foldout dimensions.

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NUMBERING:  
PARAGRAPHS, PROCEDURES, PAGES, DIVISIONS,  
ISSUES, CHANGES, AND PUBLICATIONS

## 10. SCOPE

10.1 Scope. This appendix documents the methodologies for numbering paragraphs, procedures, pages, divisions, issues, changes and the technical manual. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

## 20. APPLICABLE DOCUMENTS (This section is not applicable to this appendix.)

## 30. PARAGRAPHS

30.1 Decimal paragraph numbering. Format for the decimal numbering method shall be as outlined below and on figure 86. Paragraphs shall be numbered consecutively within the chapter. All paragraph numbers shall be preceded by the chapter number and a period.

- (a) Primary sideheads shall be numbered consecutively within the chapter. The paragraph number shall be preceded by the chapter number and a period, for example, the first primary paragraph of Chapter 3 would be 3.1, the second primary paragraph would be 3.2, and so forth.
- (b) All subordinate sideheads shall begin two spaces below the preceding paragraph at the left margin.
- (c) Procedural steps shall begin two spaces below the preceding text and indented two spaces from the left margin. Substeps shall begin two spaces below the preceding step and indented an additional two spaces.

## 40. PROCEDURES

40.1 Procedural steps. Procedural steps shall be used to provide step-by-step instructions, such as disassembly, assembly and alignment procedures. Steps may be further divided into substeps. Procedural steps and checklist items shall be numbered. The text shall begin on the same line as the step number and be separated by two spaces. Carry over lines shall not return to the left margin but shall start under the first letter of the preceding line (blocked).

## 50. PAGES, TABLES, AND ILLUSTRATIONS

50.1 Pages, tables, and illustrations. Pages, tables, and illustrations shall be numbered consecutively within each chapter. Manuals divided into chapters and in turn into sections, shall contain consecutively numbered pages, tables and illustrations for the entire chapter. Page, table, and illustration numbers shall consist of two part Arabic numerals separated by a hyphen. The first part shall be the chapter number with the second part being the order within the chapter. When specified, the volume number shall be included with the page number. For example:

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<u>Number</u>	<u>Meaning</u>
2-17	Chapter 2, page 17
3-12-10	Volume 3, Chapter 12, page 10
Table 2-17. (Title)	Chapter 2, table 17
Figure 2-17. (Title)	Chapter 2, figure 17
Figure 2-17. (Title) (Sheet 1 of 3)	Chapter 2, figure 17 is a multisheet (3 total) illustration. Remaining sheets shall be numbered in consecutive order; (Sheet 2), (Sheet 3), and so forth.

Note that a manual may contain both a table and a figure, that is, 2-17. Only the first sheet of a multiple sheet illustration shall contain the total number of sheets, that is, Sheet 1 of 3. If a chapter is so short that the chapter can be completed on one page, permitting another chapter to start on the same page, both chapter numbers shall be indicated by the page number. For example: "3-1/4-1."

50.2 Cover and title pages. Cover and title page shall not be numbered; however, the first page of a brief manual that uses an abbreviated title, below which the beginning text is placed, shall be assigned an Arabic numeral 1.

50.3 Front matter. Lower case Roman numerals (in sequence i, ii, iii, and so forth) shall be used in numbering front matter pages following the list of effective pages and precede Chapter 1.

50.4 List of effective pages. The list of effective pages shall be numbered using the letter "A" in the lower left-hand corner. When the list of effective pages otherwise begins as a right-hand page, the letter "A" shall be in the lower right-hand corner. When additional pages are required, they shall be identified as "B", "C", and so forth.

50.5 Blank pages. A blank page shall be assigned a number but it shall appear on the preceding or following page. For example: if page 10 of Chapter 1 is blank, page 9 shall bear the number 1-9/(1-10 blank); if page 9 of Chapter 1 is blank, page 10 shall bear the number (1-9 blank)/1-10. When applicable, an added page, such as 1-10.1, shall show that 1-10.2 is blank.

50.6 Foldout figure numbers. The figure numbers for foldouts which fall at the end of the manual shall be "FO-1", "FO-2", and so forth, and shall be placed preceding the figure title under the illustration. The figure numbers for foldouts which fall at the end of a chapter or are interspersed with the text shall follow normal figure numbering sequencing. When a foldout consists of several sheets, the sheets shall be numbered in consecutive order following the figure title.

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APPENDIX G

50.7 Foldout page numbers. The page numbers for foldout pages which fall at the end of the manual shall be FP-1/(FP-2 blank), FP-3/(FP-4 blank), and so forth. The page numbers for foldout pages which fall at the end of a chapter or are interspersed with the text shall follow normal page numbering sequence.

50.8 Glossary pages. The page numbers for an independent glossary shall be consecutively numbered in Arabic numerals with the word "Glossary" preceding the page number. For example: "Glossary 1."

50.9 Index pages. Unless otherwise specified, page numbers for indexes shall be consecutively numbered in Arabic numerals with the word "Index" preceding the page number. For example: "Index 1."

## 60. FOOTNOTES

60.1 Footnotes. Numbering of footnotes to tables shall be independent of that of footnotes to the text. Consecutive superior numbers beginning with "1" shall be used (in tables, superior lowercase letters, asterisks or other designation may be used where numbers would cause confusion). Footnote numbers and text shall be separated by two spaces. The numbering system shall be per chapter or table, as applicable. Footnotes to the text shall be placed at the bottom of the page on which they appear.

## 70. DIVISIONS

70.1 Volumes. Unless otherwise specified, volumes shall be used and numbered consecutively in Arabic numerals. Two or more volumes shall be identified sequentially by volume numbers and subtitles indicative of volume content and have a unique Technical Manual Identification Number assigned as provided by the Government.

70.2 Chapters. Arabic numerals shall be used to number chapters consecutively throughout all volumes of the publication. Chapters shall begin on a right-hand page. Format shall be as shown on figure 87.

70.3 Sections. Roman numerals shall be used to number sections consecutively within each chapter.

70.4 Appendix. Appendixes shall be identified by capital letters, for example, APPENDIX A, APPENDIX B and so forth. Pages, paragraphs, illustrations and tables for appendixes shall be consecutively numbered in Arabic numerals preceded by the capital letter of the appendix. For example:

<u>Number</u>	<u>Meaning</u>
A-17	Appendix A, page 17
Figure B-17	Appendix B, figure 17
Table C-17	Appendix C, table 17



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80. ISSUES AND CHANGES

80.1 Review draft copy. Page numbering techniques shall approximate that to be used in the final reproducible copy. These page numbers are used only to establish the continuity of the RDC and have no bearing on page numbers which will appear later in the final reproducible copy.

80.2 Preliminary technical manual and final reproducible copy. The page number shall be placed as specified in this specification. However, when all the information for a 4 by 5 1/2, 4 1/2 by 7, 5 1/2 by 7, 4 by 8 or 5 by 8 inch manual is placed horizontally on all pages, and all pages are arranged head to foot, the page number shall be placed in the lower right corner of all pages.

80.3 Numbering of changes. Each change package to a manual shall be lettered, as specified by the Government, in sequence and dated (see MIL-M-24784/1). Identification of changes after each revision of a manual shall begin over again with letter A as applicable. The change date shall be the date at which the material to be included was received (copy freeze date).

90. PUBLICATIONS

90.1 Technical manual identification number. The technical manual identification number assigned by the Government shall be located on each page. However, when all the information for a 4 by 5 1/2, 4 by 8, 4 1/2 by 7 or 5 by 8 inch manual is placed horizontally on all pages and all pages are arranged head to foot, the technical manual identification number shall be placed in the upper right corner of all pages. If the publication is jointly used, each Service's number shall be prefixed with the word Army, Navy (NAVSEA) (NAVAIR), (SPAWAR), Marine Corps or Air Force as applicable. The Government's technical manual identification number shall be placed above the using activity's technical manual identification number. The using activity's numbers shall be in alphabetic sequence following the Government's number. For example:

ARMY	TM 11-1510-204-34
AIR FORCE	TO 21M-LGM30G-12
MARINE CORPS	TM-12345/1
NAVY (NAVAIR)	AI-F18AA-WRM-070
NAVY (NAVSEA)	SE211-FA-MMA-010/SPS-10A
NAVY	EE211-FA-MMA-010/SPS-40



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TECHNICAL MANUAL VERIFICATION INCORPORATION CERTIFICATE	
TECHNICAL MANUAL TITLE	
NAVSEA TECHNICAL MANUAL NUMBER	DATE
CONTRACT/TMCR NO.	
<b>I - VERIFICATION INCORPORATION</b>	
<p>All the discrepancies and deficiencies recorded during verification of the technical manual identified above have been corrected or resolved in accordance with the disposition column of the Verification Discrepancy/Disposition Record and incorporated into the Final Reproducible Copy (FRC). The technical manual is approved by:</p> <p style="text-align: center;">_____ Cognizant Government Maintenance Management Activity</p> <p style="text-align: center;">_____ Letter/Message                      _____ Date</p>	
<b>II - REMARKS</b>	
SIGNATURE OF CONTRACTOR'S PUBLICATIONS QUALITY ASSURANCE OFFICER	DATE

NAVSEA 4160/6 (REV. 5 - 89)

FIGURE 2. Technical manual verification incorporation certificate.

## MIL-M-24784 (SH)

USE	TYPE STYLE	CAPITALIZATION	LEADING	VERTICAL SPACING
Publication Number	Sans Serif Bold 10	Upper Case	-	30-Points from Top of Page
Page Number	Sans Serif Bold 10	--	-	30-Points from Bottom of Page
Change Number	Sans Serif Bold 10	Upper and Lower Case	-	30-Points from Bottom of Page
Page Content/Equipment Identification	Sans Serif Bold 10	Upper and Lower Case	2	30-Points from Top of Page
Security Classification	Sans Serif Bold 14	Upper Case	-	30-Points from Top and Bottom of Page
Deleted Page Notation	Serif Bold 8	Upper and Lower Case	2	30-Points from Top and Bottom of Page
Part Number, Chapter Number and Title	San Serif 14	Upper Case	6	48-Points Below Publication No.; 18-Points Above Text, Table, or Illustration
Section Number and Title	San Serif 14	Upper Case	6	28-Points Below Publication No. or 24-Points Below Chapter Title; 18-Points Above Text, Table, or Illustration
Table of Contents, List of Illustrations, List of Tables, Forward/Preface/Introduction, Safety Summary, Index, Glossary and Appendix Headings	San Serif 14	Upper Case	-	48-Points Below Publication Number; 18-Points Above Text
Text	Serif 10	Upper and Lower Case	1	18-Points Below Publication No., Chapter/Section Title; 12-Points Above/Below Table or Illustration; 6-Points Above Page No.; 6-Points Above/Below Warning, Caution and Note Headings

FIGURE 4. Style, capitalization, leading and vertical spacing. (Sheet 1 of 3)



## MIL-M-24784(SH)

USE	TYPE STYLE	CAPITALIZATION	LEADING	VERTICAL SPACING
Emphasis	Italic Bold 10	Upper and Lower Case	1	--
Formulas and Equations	Math 10	Upper and Lower Case	1	12-Points Above/Below Text, Table or Illustration
Primary Sideheads	Sans Serif 10	Upper Case	2	18-Points Below Publication No., Chapter/Section Title; 12-Points Above/Below Text, Table or Illustration; 6-Points Above/Below Warning, Caution and Note Headings
Subordinate Sideheads	Sans Serif 10	Upper and Lower Case	2	18-Points Below Publication No., Chapter/Section Title; 12-Points Below Table or Illustration; 6-Points Below Warning, Caution and Note Headings
Figure Number and Title	Serif or Italic Bold 10	Upper Case for First Letter of Each Principal Word	2	18-Points Below Illustration
Legend Text	San Serif 8	Upper Case for First Letter of First Word	1	28-Points Above Illustration
Legend on Artwork	San Serif 8	Upper Case	1	As Required
Table No. and Title	Serif or Italic Bold 10	Upper Case for First Letter of Each Principal Word	2	18-Points Above Table
Boxhead Titles	Serif 10	Upper Case for First Letter of Each Principal Word	1	--
Table Text	Serif 10	Upper and Lower Case	2	--

FIGURE 4. Style, capitalization, leading and vertical spacing. (Sheet 2 of 3)



## MIL-M-24784 (SH)

USE	TYPE STYLE	CAPITALIZATION	LEADING	VERTICAL SPACING
Rules	3/4 Point Width	--	-	--
Footnotes	Serif 8	Upper and Lower Case	1	18-Points Below Text or Table
Warnings and Cautions (Headings)	Sans Serif Extra Bold 10 (Boxed)	Upper Case	-	6-Points Above and Below Text
Notes (Headings)	Sans Serif Extra Bold 10	Upper Case	-	6-Points Above and Below Text
Maintenance Parts List, Numerical Index and Reference Designation Index Column Heads	Sans Serif 8	Upper Case	1	--
Maintenance Parts List Text	Sans Serif 8 or 10	Upper and Lower Case	1	--
Numerical Index and Reference Designation Index Text	Sans Serif 8	Upper and Lower Case	1	6-Points Space After Every Tenth Entry
<p>All type sizes may be plus-or-minus one point.</p> <p>Slight variations in spacing and leading are permitted.</p> <p>Final reproducible copy shall use above type sizes.</p>				
<p>IT IS NOT THE INTENT OF THIS SPECIFICATION TO SPECIFY THE METHODS OR COMPOSING EQUIPMENT TO BE USED, BUT ONLY TO SPECIFY REQUIRED RESULTS</p>				

FIGURE 4. Style, capitalization, leading and vertical spacing. (Sheet 3 of 3)

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T.O. ATS-1F-4E-2-14SS-1

# SAFETY SUPPLEMENT

## TECHNICAL MANUAL

### MAINTENANCE INSTRUCTIONS

#### INTEGRATED ELECTRONIC CENTRAL

#### TARGET IDENTIFICATION SYSTEM ELECTRO-OPTICAL (TISEO)

#### USAF SERIES F-4E AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. ATS-1F-4E-2-14 DATED 15 JULY 1977. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL

**DISTRIBUTION STATEMENT:** Distribution authorized to U.S. Government agencies only, administrative and operational use, 20 June 1990. Other requests for this document shall be referred to OO-ALC/MMDO, HRL AFB, Utah 84056-5609.

**WARNING:** This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U.S.C., Sec 2751 et seq) or the Export Administration Act of 1979, as amended (Title 50, U.S.C., App 2401 et seq). Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of AFR 80-34.

**HANDLING AND DESTRUCTION NOTICE:** Comply with distribution statement and destroy by any method that will prevent disclosure of contents or reconstruction of the document.

Published under authority of the Secretary of the Air Force

1 JULY 1990

- Page 2-34, subparagraph 2-49.g. of basic manual is amended to read:
  - ATS TRAINING SAMPLE.** The **PO** and **PI** tag may be followed by a paragraph title. This title is ended, and the actual text of the paragraph begun, with a backslash character. If there is no title for the paragraph, the tag should be followed immediately with a backslash.
- Page 12-83 of basic manual is amended to add Warning preceding subparagraph 12-158.b. to read:
 

**WARNING**

After TCTO 1F-4-9876 the mount's antenna cable connector must be wrapped with silicone tape and cable stowed to mount with a retaining strap prior to installing mount in aircraft.
- Page 14-78 of basic manual is amended to add Warning preceding subparagraph 14-161.b. to read:
 

**WARNING**

After TCTO 1F-4-9876 the mount's antenna cable connector must be wrapped with silicone tape and cable stowed to mount with a retaining strap prior to installing mount in aircraft.

FIGURE 5. Safety supplement. (Example)

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O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>
											T.O. ATS-11P3-2-9-7S-5		
OPERATIONAL SUPPLEMENT													
TECHNICAL MANUAL													
STORAGE AND MAINTENANCE PROCEDURES													
BAROSTAT LOCK INITIATOR													
F-111 SERIES AIRCRAFT													
PART NO. 90166-5													
<p>THIS PUBLICATION SUPPLEMENTS T.O. ATS-11P3-2-9-7 DATED 5 FEBRUARY 1979 AND FORMALIZES INTERIM OPERATIONAL SUPPLEMENT T.O. ATS-11P3-2-9-7S-5 DATED 9 JULY 1987. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.</p>													
<p>COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL</p>													
<p>DISTRIBUTION STATEMENT: Distribution authorized to U.S. Government agencies only, administrative or operational use, 15 April 1987. Other requests for this document shall be referred to OO-ALC/MMDO, Hqs AFB, Utah 84056-5609.</p>													
<p>WARNING: This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U.S.C., Sec 2751 et seq) or the Export Administration Act of 1979, as amended (Title 50, U.S.C., App 2401 et seq). Violators of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of AFR 80-34.</p>													
<p>HANDLING AND DESTRUCTION NOTICE: Comply with distribution statement and destroy by any method that will prevent disclosure of contents or reconstruction of the document.</p>													
Published under authority of the Secretary of the Air Force													
											1 JULY 1990		
<ol style="list-style-type: none"> <li>1. Page 3-59, figure 3-13 (sheet 1 of 3), NOTES of basic manual is amended to add NOTE 3 to read: <ol style="list-style-type: none"> <li>3. CLEARANCE BETWEEN FORWARD AND AFT VARI RAMP AND INTAKE STRUCTURE, TOP AND BOTTOM, SHALL BE 0.060 MINIMUM OPERATING CLEARANCE.</li> </ol> </li> <li>2. Page 4-2, table 4-1 of basic manual is amended to change LIFE (MONTHS) SHELF and SERVICE columns from 102 to read 120.</li> <li>3. Page 4-28, paragraph 4-15 of basic manual is amended to renumber existing subparagraph j through o. to read i. through n. and renumber existing subparagraph i. to read o. and insert in proper sequence.</li> <li>4. Page 6-12, paragraph 6-32, reference to PPP-T-620 (4 places) of basic manual is amended to read T-T-620 (4 places).</li> </ol>													
THE END													
											1/(2 blank)		
O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>	O <sub>S</sub>

FIGURE 6. Operational supplement. (Example)

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## ENGINEERING JUDGEMENT RECORD

TRS TITLE: \_\_\_\_\_

TMIN \_\_\_\_\_ APL(S) \_\_\_\_\_

TMCR/TMSR/BOA \_\_\_\_\_

PREPARING ACTIVITY \_\_\_\_\_

PARAGRAPH	JUSTIFICATION	REFERENCE SOURCE

**GENERAL REMARKS:**

FIGURE 7. Engineering judgement record.

MIL-M-24784(SH)

# SECURITY CLASSIFICATION 1

## PUBLICATION NUMBER 2

VOLUME NO./PART NO. 4

REVISION NO. 5

TECHNICAL MANUAL 7  
TYPE OF PUBLICATION 8  
MAINTENANCE LEVELS 9

## NOMENCLATURE OF EQUIPMENT -

Title Block

TYPE, MODEL, PART NUMBER,

NATIONAL STOCK NUMBER

OR

SUBJECT

SUBTITLE 11

Manufacturer of Equipment 12  
Contract Number 13

Navy Seal 14  
Supersedure Notice 15  
Supplement Notice 16  
Volume Notice 17  
Disclosure Notice 18  
Distribution Statement 19  
Export Control Notice 20  
Destruction Notice 21

Authority Notice 22

0910LP0023800



SE211F0H8K020

DATE 23

CHANGE - DATE 24

## SECURITY CLASSIFICATION 25

NOTE: Vertical spacing  
compressed to fit  
specification border.

FIGURE 8. Cover/title page. (Example) (Sheet 1 of 5)

MIL-M-24784(SH)

<u>NOTES</u>	<u>TYPE POINT SIZE</u>
1. The security classification assigned by the acquiring activity shall be as specified in DOD Manual 5200.1-R, Chapter IV or DOD 5220.22-M, Section II-19, when the manual itself is classified.	24
2. The acquiring activity shall furnish the TM identification number(s). If the manual will be jointly used by more than one Service, the acquiring Service's number shall appear at the top with the other Service's number immediately below it. Each Service's number shall be prefixed with the word Army, Navy, Marine Corps, or Air Force as appropriate. All numbers shall appear above the ruled line, near the right margin, except for Naval Sea Systems Command numbers, which shall be on the left margin.	24
3. Not used.	
4. Required for multivolume/multipart sets only, located below TM identification number.	14
5. (N) Required when it is advisable to indicate status for publications subject to frequent revisions. Especially significant when the same TM identification numbers are maintained for superseding revisions identified by a change of the publication date.	14
6. The title is required to provide all information necessary to relate the manual to its subject and content, such that readers can discern the applicability of the manuals and can discriminate between manuals of similar applicability. The	

FIGURE 8. Cover/title page. (Example) (Sheet 2 of 5)

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<u>NOTES</u>	<u>TYPE POINT SIZE</u>
title consists of a heading, the type of manual, the level of maintenance, the prime title, and subtitle as applicable.	
7. The words TECHNICAL MANUAL shall appear in the upper center portion of the page, aircraft flight manuals excepted. When applicable, the word PRELIMINARY shall be centered above the words TECHNICAL MANUAL. For flight manuals, the appropriate term shall be used. Not required for Space and Naval Warfare Systems Command and Naval Sea Systems Command technical manuals.	14
8. Required to define the specific type of technical manual (e.g. Maintenance Manual, IPB, RPSTL, etc.)	14
9. Required to define the specific intended level of maintenance, when the manual is restricted for use at a specified level.	14
10. The prime title: nomenclature of the equipment, type, model, part number, (blocks, serial numbers, registration numbers, if appropriate), or subject shall be positioned below the words identifying the manual type. Also, the classification of the equipment nomenclature shall be indicated as specified in DOD Manual 5200.1-R, Chapter IV or DOD 5220.22-M, Section II-19, when the manual itself is classified.	18 to 24
11. Indicates the content covered. Required on multivolume/multipart publications to differentiate between the coverage among volumes.	14
12. Identification of the manufacturer of the equipment shall appear below the equipment nomenclature.	8
13. The original contract number shall be placed on all new issues and carried forward on all subsequent title pages. If the contract number for a change or revision is different from the	8

FIGURE 8. Cover/title page. (Example) (Sheet 3 of 5)



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<u>NOTES</u>	<u>TYPE POINT SIZE</u>
original number, the number applicable to the change or revision shall be indicated on any new title pages, in addition to the original number. No more than two contract numbers, the original and the latest, need appear.	
14. (N) The Department of the Navy seal, with Command identifier, is used.	1½ to 1½ inches
15. When a manual supersedes a previous issue, or another manual, a supersedure notice shall be placed in the space indicated.	8
16. When a manual supplements, or is supplemented by, another manual, a supplement notice shall be placed in the space indicated.	8
17. When a manual is one volume of a multivolume set, a volume notice shall be placed in the space indicated.	8
18. A disclosure notice shall be placed in the space indicated on all manuals except those with Distribution Statement A.	8
19. The distribution statement shall be placed in the space indicated.	8
20. When required, the export control notice shall be placed in the space indicated.	8
21. When required, the destruction notice shall be placed in the space indicated.	8
22. Indicates the authority under which the manual is acquired and issued. It shall be placed on the cover/title page (not T-2). This statement will be furnished by the acquiring activity.	8
23. The publication date; normally the copy freeze date.	18

FIGURE 8. Cover/title page. (Example) (Sheet 4 of 5)

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<u>NOTES</u>	<u>TYPE POINT SIZE</u>
24. Changed title pages shall show a change number and date.	14
25. Same as 1.	24

Spacing between the necessary information shall be such as to result in an attractive well balanced title page. Horizontal lines 1 point high shall be placed across the page, one just below the TM identification number and the second just above the date.

When an abbreviated title followed by text on the same page is used instead of a cover/title page, the abbreviated title shall be confined to a 7 by 5 1/2 inch area. Type size shall be such that all the information can be included within the prescribed area. Abbreviated title pages shall be used only when specified by the acquiring activity.

FIGURE 8. Cover/title page. (Example) (Sheet 5 of 5)

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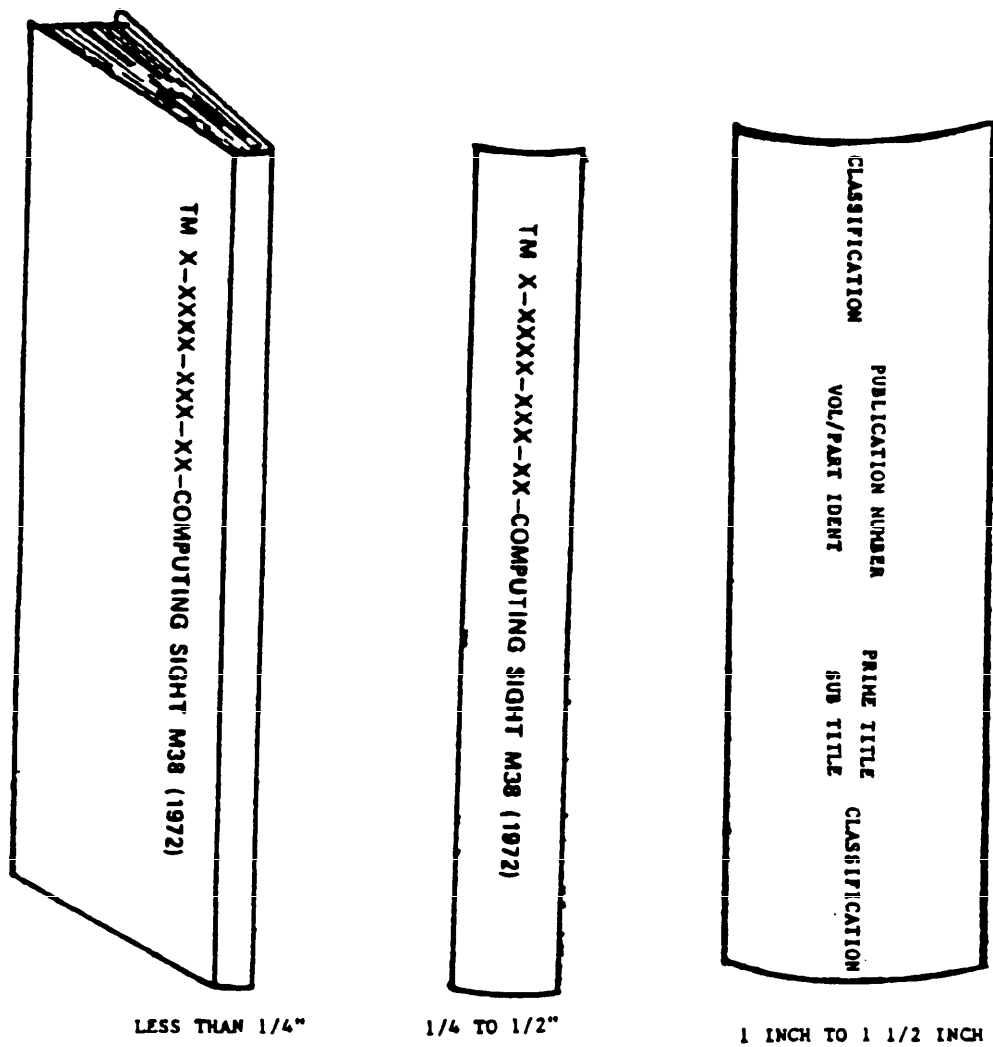


FIGURE 9. Backbone for binder or cover. (Example)

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## LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES DESTROY SUPERSEDED PAGES

NOTE: The portion of the list affected by the changes is indicated by a vertical bar in the right margin of the page. Changes to illustrations are indicated by measure pointing lines. Changes in writing assignments are indicated by dotted lines.

## Dates of issue for original and changed pages are:

Original	0	1 January 1988	Change	4	6 July 1989
Change	1	19 September 1988	Change	5	25 September 1989
Change	2	29 December 1988	Change	6	27 December 1989
Change	3	21 February 1989	Change	7	29 March 1990

## TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 376, CONSISTING OF THE FOLLOWING:

Page No.	*Change No.	Page No.	*Change No.	Page No.	*Change No.
Title	7	3-41	0	4-48	0
T-2	7	3-42 Blank	0	4-49 - 4-51	6
A - B	7	3-43	0	4-52 - 4-54	0
VS-1 - VS-4	7	3-44	6	4-55	2
i - ii	2	3-45	0	4-56 Blank	0
iii	7	3-46	2	4-57	2
iv - viii	2	3-47 - 3-54	7	4-58 - 4-59	0
ix - x	0	4-1 - 4-2	0	4-60	7
1-1 - 1-2	0	4-3	5	4-61 - 4-64	0
1-3	3	4-4	0	4-65	2
1-4 Blank	0	4-5	7	4-66	0
2-1 - 2-2	0	4-6	0	4-67	3
2-3	2	4-7	5	4-68	2
2-4 - 2-8	0	4-8 - 4-9	0	5-1/6-1 - 6-4	0
3-1	5	4-10	2	A-1 - A-4	0
3-2 Blank	0	4-11	0	Glossary 1 - Glossary 3	7
3-3 - 3-4	7	4-12 - 4-13	3	Glossary 4 Blank	0
3-5	2	4-14 - 4-15	0	Index 1 - Index 2	0
3-6	4	4-16	3	Index 3	2
3-7	0	4-17	0	index 4 - index 5 Added	7
3-8	4	4-18 - 4-19	3	Index 6 Blank	7
3-9 - 3-10	0	4-20	0		
3-11	4	4-21 - 4-22	6		
3-12 - 3-18	0	4-23 - 4-29	0		
3-19	2	4-30 Blank	0		
3-20 Blank	2	4-31	2		
3-21	0	4-32 - 4-33	0		
3-22 - 3-23	5	4-34	2		
3-24 Blank	0	4-35 - 4-37	0		
3-25	2	4-38	2		
3-26 Blank	0	4-39	0		
3-27	4	4-40	3		
3-28 Blank	0	4-41	2		
3-29 - 3-30	0	4-42 - 4-43	0		
3-31 - 3-32	2	4-44	3		
3-32.1 Added	7	4-45	0		
3-32.2 Blank	7	4-46	2		
3-33	5	4-46.1 Added	7		
3-34 - 3-35	5	4-46.2 Blank	7		
3-36 - 3-38	0	4-46.3 - 4-46.4 Deleted	2		
3-39 - 3-40	5	4-47	1		

\*Zero in this column indicates an original page

A Change A

USAF

FIGURE 10. List of effective pages. (Example)

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PUBLICATION NUMBER

RECORD OF CHANGES

CHANGE NO.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY

FIGURE 11. Change record page. (Example)

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T.O. 1C-1308-2-1

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LIST OF TABLES .....	iv	5.1 General .....	3-1
FOREWORD .....	v	5.6 Engine Installation .....	3-3
1 GENERAL INFORMATION .....	1-1	5.12 Engine Control System .....	3-3
1.1 General Description .....	1-1	5.16 Engine Fuel System .....	3-4
1.12 General Arrangement .....	1-3	5.20 Engine Starter System .....	3-5
1.34 Principal Dimensions .....	1-9	5.25 Engine Oil System .....	3-5
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1.44 Torque Values .....	1-11	5.37 Air Turbine Motor (ATM) .....	3-6
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## "FORWARD"

The purpose of the Operational Stations Book (OSB) is to describe the operational relationships and procedures employed within the shipboard operational spaces and stations during the ship's maximum tactical environment and/or major evolutions which take into account the design philosophy utilized in space allocations and equipment arrangements within the ship. The book provides operational personnel with space orientation within the hull, space and station functional requirements, management philosophy, station manning requirements, responsibilities and operational procedures. The operational relationships and procedures described in the OSB are the product of both the design philosophy employed by the designer and verification by experienced Fleet personnel.

The basic organization and procedures for departmental and divisional spaces may be based on this book. The format has been prepared in such a manner that this book may be promulgated as doctrine for the spaces included.

This book is written to be used by all personnel concerned with personnel training, planning and operation of spaces included. It is intended to be used by ship's personnel for instruction, orientation, information, and ready reference for the operations described herein.

Operational concepts rather than technical descriptions have been emphasized. This book is not intended to duplicate technical information covered by equipment manuals or similar publications, nor is it intended as a substitute for individual operator training requirements. It is not intended that this book duplicate information which may be presented in the Combat System Technical Operations Manual (CSTOM) (if applicable), except to the extent required for continuity and thoroughness of understanding. Other guidance information can be obtained by referring to the Ship Information Booklet, Booklet of General Plans, Shipyard Plans, Technical and System Manuals, Naval Warfare Publications (NWP), and so forth.

Appendices (if included) are used to summarize or amplify such areas as the external or internal communications facilities employed in operating the spaces described in this book.

User Activity Comment Sheets (affixed at the rear of this book) are provided to report any possible deficiencies in this book or in the concepts presented. It is not desired that typographical errors be reported. Additional sheets may be reproduced locally. Comments should be forwarded directly to Commander, Naval Sea Systems Command, Manning and Controls Integration Branch, 2531 Jefferson Davis Hwy., Arlington, VA 22242-5160.

FIGURE 15. Foreword, standard. (Example)

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**SAMPLE SAFETY SUMMARY**

This publication describes physical and chemical processes which may require the use of chemicals, solvents, paints, or other commercially available material. The user of this publication should obtain the material safety data sheets (Occupational Safety and Health Act (OSHA) Form 20 or equivalent) from the manufacturers or suppliers of materials to be used. The user must become completely familiar with the manufacturer/supplier information and adhere to the procedures, recommendations, warnings, and cautions of the manufacturer/supplier for the safe use, handling, storage, and disposal of these materials. The following are general safety precautions and instructions that people must understand and apply during many phases of operation and maintenance to ensure personal safety and health and the protection of DOD property. Portions of this may be repeated elsewhere in this publication for emphasis.

**WARNING AND CAUTION STATEMENTS**

WARNING and CAUTION statements have been strategically placed throughout this text prior to operating or maintenance procedures, practices or conditions considered essential to the protection of personnel (WARNING) or equipment and property (CAUTION). A WARNING or CAUTION will apply each time the related step is repeated. Prior to starting any task, the WARNINGS or CAUTIONS included in the text for that task will be reviewed and understood. Refer to the materials list figure at the beginning of the appropriate manual section for material used during maintenance of this equipment. The detailed warnings for hazardous material only are listed separately in the safety summary as the "Hazardous Materials Warnings" section.

**HAZARDOUS MATERIALS WARNINGS**

Warnings for hazardous material in this manual are designed to warn personnel of hazards associated with such items when they come in contact with them during actual use. Additional information related to hazardous material is provided in (insert applicable references for Service(s) using the manual). For each hazardous material used, a material safety data sheet is required

FIGURE 16. Safety summary. (Example) (Sheet 1 of 2)

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to be provided and available for review by users. Consult your local safety and health staff concerning any questions on hazardous chemicals, MSDSs, personal protective equipment requirements, and appropriate handling and emergency procedures.

This Hazardous Materials Warnings section gives the complete warnings for hazardous material used in this manual. To help the user understand the potential hazards of these materials, a more detailed warning for these materials and an explanation of the hazard symbols follow. The number after the word WARNING is the same number for the warning used in the procedures of this manual.

#### EXPLANATION OF HAZARD SYMBOLS



The abstract symbol bug shows that a material may contain bacterial or viruses that present a danger to your life or health.



The symbol of drops of a liquid onto a hand shows that the material will cause burns or irritation of human skin or tissue.



The rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition, or high pressure.



The symbol of a person wearing goggles shows that the material will injure your eyes.



The symbol of a flame shows that a material can ignite and burn you.



The symbol of a skull and crossbones shows that a material is poisonous or is a danger to life.



The symbol of a three circular wedges shows that the material emits radioactive energy and can injure human tissue or organs.



The symbol of a human figure in a cloud shows that vapors of a material present a danger to your life or health.

FIGURE 16. Safety summary. (Example) (Sheet 2 of 2)



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<p style="text-align: center;">SK225-77 IRS-011/PM 10 PMP NOTE</p> <p>The inner face of the gear housing (6, Figure 1-4) are originally electrochemically coated with chromium. In this type plating, microcracking is intentionally introduced to assist in retention of lubricants.</p> <p>3-4.2.2 <b>Gear Housing Examination.</b> Measure the inside diameter of the gear housing (6) at the driver and idler gear bores; required diameter is 2.400 to 2.402 inches. Replace the housing if worn beyond limits. Record the final readings and/or corrective action taken (readings A &amp; B) in the attached E.O. pump examination, Test and Repair Action Record (ETRAR) Volume SK225-77-IRS-012/PM 10 PMP, page 1-16.</p> <p>3-4.2.3 <b>Replacement Bushing Examination.</b> Measure the inside diameter of bushings (17, 18, 19, 20 and 21). Record final readings and/or corrective action taken in ETRAR, page C-15 as readings C, D, E, F and G respectively. Allowable limits are:</p> <table border="1" style="margin-left: 20px;"> <tr><td>Bushing 17</td><td>0.999 - 0.999</td></tr> <tr><td>Bushing 18</td><td>0.810 - 0.811</td></tr> <tr><td>Bushing 19</td><td>0.748 - 0.749</td></tr> <tr><td>Bushing 20</td><td>0.748 - 0.749</td></tr> <tr><td>Bushing 21</td><td>0.748 - 0.749</td></tr> </table> <p>3-4.2.4 <b>Gear Housing Bore and Gear Length Comparisons.</b></p> <ol style="list-style-type: none"> <li>a. Measure depth of gear bores at point B (see page C-16). Record final reading for part 6; as item H, in the ETRAR matrix.</li> <li>b. Measure the length of both the idler gear (part 7) and the driver gear (part 8). Subtract the results of this measurement from the diameter recorded in step a to find the gear mesh clearance. End clearance should not exceed 0.005 inch. Replace gears if worn to point of allowing too much end clearance. Record final end clearance readings in Figure 3-8 as readings I and J respectively.</li> </ol> <p>3-4.3 <b>Attached L.O. Pump Assembly.</b> Use figure 3-6 to reference part numbers. Reassemble in reverse order of disassembly (step 3-4.1).</p> <p>3-4.3.1 <b>Install New Bearing Bushings.</b> Press bearing bushing (17) into retainer (16), bearing bushing (18 and 19) into bearing plate (12), and bearing bushing (20 and 21) into inner cover.</p> <p>3-4.3.2 <b>Fit Bushings.</b> Assure diametrical clearance measurements are taken at points above in figure 3-8. Diametrical clearance of bushings (17, 18, 19, 20 and 21) is 0.001 inch minimum to 0.002 inch maximum with shafts (8 and 10). Ream bushings if necessary to meet minimum diametrical clearance requirements.</p> <p>3-4.3.3 <b>Record Diametrical Clearance Readings.</b> Record final readings in figure 3-8 for letters K, L, M, N and O respectively. Signify that bushings were replaced with a mark in the appropriate column.</p> <p>3-4.3.4 <b>Attach Idler Gear (7) to Idler Shaft (8).</b></p> <ol style="list-style-type: none"> <li>a. Press fit.</li> <li>b. Ensure idler gear (7) is centered on idler shaft (8).</li> <li>c. Ensure oil passage in idler shaft (8) is clear.</li> </ol>	Bushing 17	0.999 - 0.999	Bushing 18	0.810 - 0.811	Bushing 19	0.748 - 0.749	Bushing 20	0.748 - 0.749	Bushing 21	0.748 - 0.749	<p style="text-align: center;">3-16 Change B</p>
Bushing 17	0.999 - 0.999										
Bushing 18	0.810 - 0.811										
Bushing 19	0.748 - 0.749										
Bushing 20	0.748 - 0.749										
Bushing 21	0.748 - 0.749										

**PRIME  
FUNCTION  
(SINGLE LEVEL  
BULLET)  
PRESENTATION**

**INFORMATION  
PARAGRAPH  
PRESENTATION**

<p style="text-align: center;">SK225-77 IRS-011/PM 10 PMP SECTION III</p> <p>3-4 ATTACHED LUBE OIL PMP</p> <p>3-4.1 <b>DISASSEMBLY OF ATTACHED L.O. PMP.</b> Item numbers below refer to figure 3-6.</p> <ol style="list-style-type: none"> <li>a. Remove nuts (1) from tapered pins (6).</li> <li>b. Remove nuts (2) and lock washers (3) from pump housing studs (23).</li> <li>c. Remove both tapered pins (6).</li> <li>d. Remove inner cover (5).       <ol style="list-style-type: none"> <li>(1) Slowly.</li> <li>(2) Ensure that both bearing bushings (20 and 21) are in place, within cover recesses.</li> </ol> </li> <li>e. Remove gear housing (6). Slide it off over the gears (7 and 9) and pump housing studs (23).</li> <li>f. Slide the idler gear (7) attached to the idler shaft (8) out of bearing (18) in upper bearing plate (12).</li> <li>g. Press idler gear (7) from idler shaft (8).</li> <li>h. Pull driver gear (9) from drive shaft (10) and remove key (11).</li> <li>i. Remove bearing plate (12) from shaft housing (26).</li> <li>j. Withdraw drive shaft (10) by lifting it through the bearing bushing (17) located in the retainer (16)/shaft housing (26) assembly.</li> <li>k. Remove oil pump coupling half (13) and key (14) from drive shaft (10).</li> <li>l. Remove screen (15) and lift the retainer (16) with bearing bushing (17) from shaft housing (26).</li> <li>m. Remove bearing bushings (17, 18, 19, 20 and 21) from inner cover (5), bearing plate (12) and retainer (16) by either pressing or machining, as applicable.</li> </ol> <p>3-4.2 <b>DETAILED L.O. PMP INSPECTION AND REPAIR.</b> Item numbers below refer to figures 3-6.</p> <p>3-4.2.1 <b>Part Examination.</b> The following shall be examined for: corrosion, pitting, scoring, wear, cracks and damage to machine surfaces. Replace if cracked. Repair other defects by hands or replace.</p> <table border="1" style="margin-left: 20px;"> <tr><td>Lower Cover (5)</td><td>Drive Shaft (10)</td></tr> <tr><td>Gear Housing (6)</td><td>Bearing Plate (12)</td></tr> <tr><td>Idler Shaft (7)</td><td>Retainer (16)</td></tr> <tr><td>Idler Gear (8)</td><td>Shaft Housing (26)</td></tr> <tr><td>Inner Gear (9)</td><td></td></tr> </table>	Lower Cover (5)	Drive Shaft (10)	Gear Housing (6)	Bearing Plate (12)	Idler Shaft (7)	Retainer (16)	Idler Gear (8)	Shaft Housing (26)	Inner Gear (9)		<p style="text-align: center;">3-15 Original</p>
Lower Cover (5)	Drive Shaft (10)										
Gear Housing (6)	Bearing Plate (12)										
Idler Shaft (7)	Retainer (16)										
Idler Gear (8)	Shaft Housing (26)										
Inner Gear (9)											

FIGURE 18. Step by step procedural styles. (Sample) (Sheet 1 of 2)

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56225-ZZ-TR5-031/MS FD PMP

3-4.3.5 Unit Assembly Steps:

- a. Install retainer (16, Figure 3-6) with fitted bearing bushing (17).
  - (1) In shaft housing (24).
  - (2) Ensure dowels (22) enter assigned holes.
  - (3) Attach with screws (15).
  - (4) Torque to 2 to 4 ft.-lbs.
- b. Insert key (16) in drive shaft (10).
- c. Install oil pump coupling half (13).
  - (1) On drive shaft (10).
  - (2) Ensure keyways match correctly.
  - (3) Ensure oil passages in end of drive shaft (10) are clear.
- d. Replace drive shaft (10).
  - (1) Insert through bearing bushing (17) into shaft housing (24).
  - (2) Ensure bearing surfaces are aligned.
- e. Install plate (12).
  - (1) Over pump housing studs (23).
  - (2) Drive shaft (10) passes through bearing bushing (17).
  - (3) Ensure tapered pin holes are aligned with matching holes in shaft housing (24).
- f. Insert key (11) in drive shaft (10).
- g. Attach driver gear (9) to drive shaft (10).
  - (1) Ensure keyways match correctly.
  - (2) Press driver gear (9) against shoulder on drive shaft (10).
- h. Install idler gear (7) and idler shaft (8).
  - (1) Engage gear teeth (7 and 9).
  - (2) Twist-tilde idler shaft (8) into bearing bushing (19).
- i. Replace gear housing (6).
  - (1) Slide it over gears (7 and 9), pump housing studs (23).
  - (2) Ensure tapered pin holes are aligned with matching holes in bearing plate (12).
- j.
  - (1) Fit over studs and exposed shafting.
  - (2) Shafts (8 and 10) fit into bearing bushings (20 and 21).

Original 3-17

### DUAL LEVEL PRESENTATION

56225-ZZ-TR5-031/MS FD PMP

- a. Install tapered pins (4, Figure 3-6).
  - (1) Insert tapered pins (4) through lower cover (3), gear housing (6), bearing plate (12) and shaft housing (24).

**CAUTION**

The following steps must be taken in the order presented without deviation. Improper alignment of the pump housing assembly may result if the steps of procedure are reversed.

  - (2) Replace tapered pin nuts (1). Tighten to 2 to 4 ft.-lbs.
  - (3) Install lock washers (1) over studs (23).
  - (4) Replace nuts (2) on studs (23). Tighten nuts (2) to 14 to 30 ft.-lbs.

3-4.4.6 L.O. Pump Assembly Testing Requirement.

- a. Hand rotate coupling (13).
- b. Test to ensure free rotation of shafts (and gears) in the housing assembly.
- c. Ensure that no binding can be detected.

3-18 Change A

FIGURE 18. Step by step procedural styles. (Sample) (Sheet 2 of 2)



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T.O. 21M-LGM30G-2-7-7

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Repair .....	5-388
<b>Air Conditioner Fan Assembly S-3</b>	
Installation .....	5-297
Removal .....	5-296
<b>Air Conditioner Fan Assembly S-3 DC Brush</b>	
Installation .....	5-297C
Removal .....	5-297B
<b>Alarm Subsystem</b>	
Description .....	1-67
<b>B</b>	
<b>Brine Cooler BC-102</b>	
Repair .....	5-391
<b>Brine Pump P-102</b>	
Installation .....	5-177
Removal .....	5-176
Repair .....	5-394
<b>Brine Strainer STR-104</b>	
Installation .....	5-312
Removal .....	5-311
<b>Brine Subsystem</b>	
Description .....	1-59
Servicing .....	5-366
<b>Brush Lifting Solenoid K-16</b>	
Installation .....	5-133
Removal .....	5-132

Change 6 Index 1

FIGURE 19. Alphabetical index. (Example)

MIL-M-24784 (SH)

(Insert Classif. of TMDER Here and At Bottom of Page) CLASSIFICATION:

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER) (NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3A)					
INSTRUCTION: Continue on 8-1/2" x 11" paper if additional space is needed.					
1. USE THIS REPORT TO INDICATE DEFICIENCIES, PROBLEMS, AND RECOMMENDATIONS RELATING TO PUBLICATION.					
2. BLOCKS MARKED WITH *** ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.					
3. FOR UNCLASSIFIED TMDERS, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1H FOR MAILING CLASSIFIED TMDERS.)					
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 551-2976/2968 OR COMMERCIAL 805-982-2976/2968.					
1. NAVSEA TECHNICAL MANUAL NO.*		2. VOL. PART*	3. TITLE*		
4. REV. NO./DATE OR TM CH. NO./DATE		5. SYSTEM/EQUIPMENT NOMENCLATURE		6. SYSTEM/EQUIPMENT IDENTIFICATION/(MK/MOD/AN/PART NO.)	
7. USER'S EVALUATION OF MANUAL (Check Appropriate Blocks)					
A. EXCELLENT	B. GOOD	C. FAIR	D. POOR	E. COMPLETE	F. INCOMPLETE
8. GENERAL COMMENTS					
9. RECOMMENDED CHANGES TO PUBLICATION					
PAGE NO. A.	PARA-GRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS TYPE OF PROBLEM (INDICATE SAFETY (S), MAJOR (M), OR MINOR (P))
10. ORIGINATOR'S NAME AND WORK CENTER (Please Print)		11. SIGNATURE OF 3-M COORDINATOR		12. DATE SIGNED	13. AUTOVON/COMM. NO.
14. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)					
15. THIS SPACE ONLY FOR NSDSA					
A. CONTROL NO.	B. COG ISEA	C. DATE		D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE	

NAVSEA 4160/1 (Rev. 10-89) (FRONT) (REPLACES NAVSEA 9086/10, DESTROY STOCK)

FIGURE 20. NAVSEA (USER) technical manual deficiency/evaluation report (TMDER).  
(Sheet 1 of 2)

MIL-M-24784(SH)

PLEASE CLOSE WITH TAPE DO NOT STAPLE THANK YOU

-----  
DEPARTMENT OF THE NAVY

=====  
Official Business  
PENALTY FOR PRIVATE USE, \$300

PLACE  
POSTAGE  
HERE

FIRST CLASS MAIL

COMMANDING OFFICER  
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION  
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)  
PORT HUENEME, CA 93043-5007

-----  
FOLD HERE

NAVSEA 41801 (5-89) (BACK)

FIGURE 20. NAVSEA (USER) technical manual deficiency/evaluation report (TMDER).  
(Sheet 2 of 2)

MIL-M-24784 (SH)

SPAWAR 4160/1A (10-85)

USER ACTIVITY TECHNICAL MANUAL COMMENT SHEET (UATMCS)						
1. UATMCS SEQUENCE NUMBER (SITE)			2. DATE			
3. PUBLICATION NUMBER		4. VOLUME NO.	5. TITLE/NOMENCLATURE			
6. ORIGINAL PUBLICATION DATE		7. CHANGES				
8. CLASSIFICATION OF UATMCS. <input type="checkbox"/> UNCLASSIFIED <input type="checkbox"/> CLASSIFIED _____						
9. THIS COMMENT IMPACTS: <input type="checkbox"/> SAFETY <input type="checkbox"/> EQUIPMENT OPERATION <input type="checkbox"/> PREVENT MAINT <input type="checkbox"/> CORRECT MAINT <input type="checkbox"/> TRAINING <input type="checkbox"/> PARTS LIST <input type="checkbox"/> OTHER						
10. UATMCS TYPE: <input type="checkbox"/> PROBLEM <input type="checkbox"/> QUESTION <input type="checkbox"/> SUGGESTION <input type="checkbox"/> COMMENT						
11. RECOMMENDED CHANGE TO PUBLICATION						
PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON	
12. ORIGINATOR NAME			13. RANK/RATE/GRADE AND TITLE			
14. WORK CENTER			15. TELEPHONE (AUTOVON/COM'L)			
16. SHIP HULL NO. AND/OR DUTY STATION (DO NOT ABBREVIATE)						
17. FOR SPAWAR USE ONLY						
a. CONTROL NO.	b. COG ISEA	c. DATES			d. PRIORITY	e. TRANSMITTED TO
		REC	FWD	DUK		
INSTRUCTIONS:						
1. USE PLAIN WHITE PAPER FOR CONTINUATION SHEETS						
2. FOR UNCLASSIFIED UATMCS FOLD ON DOTTED LINE ON REVERSE SIDE, STAPLE/SEAL AND MAIL TO COMMANDING OFFICER, NAVELEXEN PORTSMOUTH, P.O. BOX 55, PORTSMOUTH, VIRGINIA 23705-0055. ATTENTION: SPAWAR TECH DATA CENTER. MARK AND MAIL CLASSIFIED UATMCS IN ACCORDANCE WITH OPNAVINST 5510.1 (CURRENT VERSION)						
3. FOR USE WITH NAVELEX/SPAWAR PUBLICATIONS ONLY.						
					PAGE 1 OF _____	

FIGURE 21. User activity technical manual comment sheet (UATMCS). (Sheet 1 of 2)

MIL-M-24784(SH)

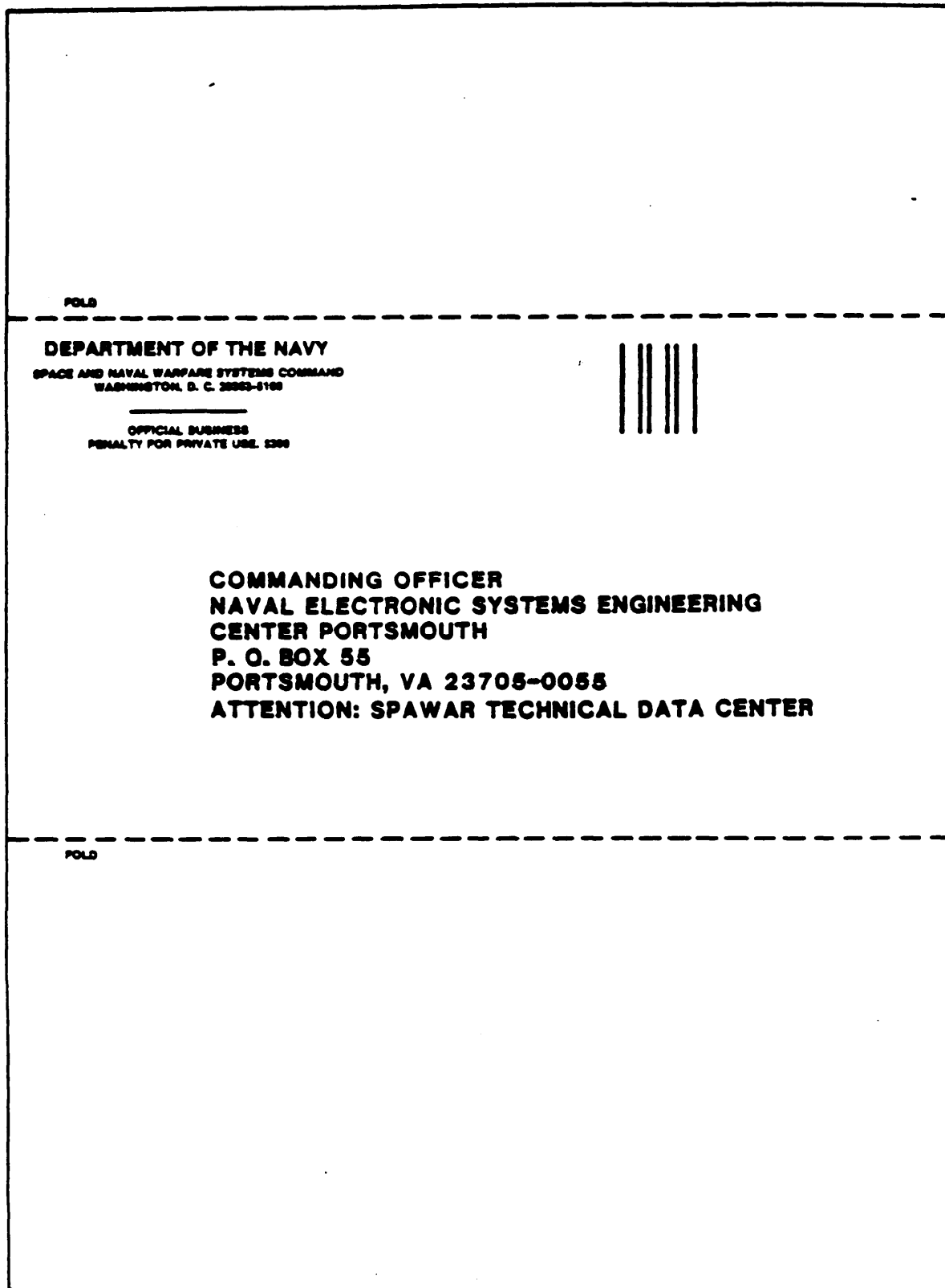


FIGURE 21. User activity technical manual comment sheet (UATMCS). (Sheet 2 of 2)

MIL-M-24784(SH)

WARNINGS, CAUTIONS, AND NOTES. Warnings, cautions, and notes which appear in manuals are defined as follows:

**WARNING**

Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, which, if not strictly observed, could result in injury to or death of personnel.

**CAUTION**

Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness or long term health hazards to personnel.

NOTE

Highlights an essential operating or maintenance procedure, condition or statement.

**WARNING**

Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, which, if not strictly observed, could result in injury to or death of personnel.

**CAUTION**

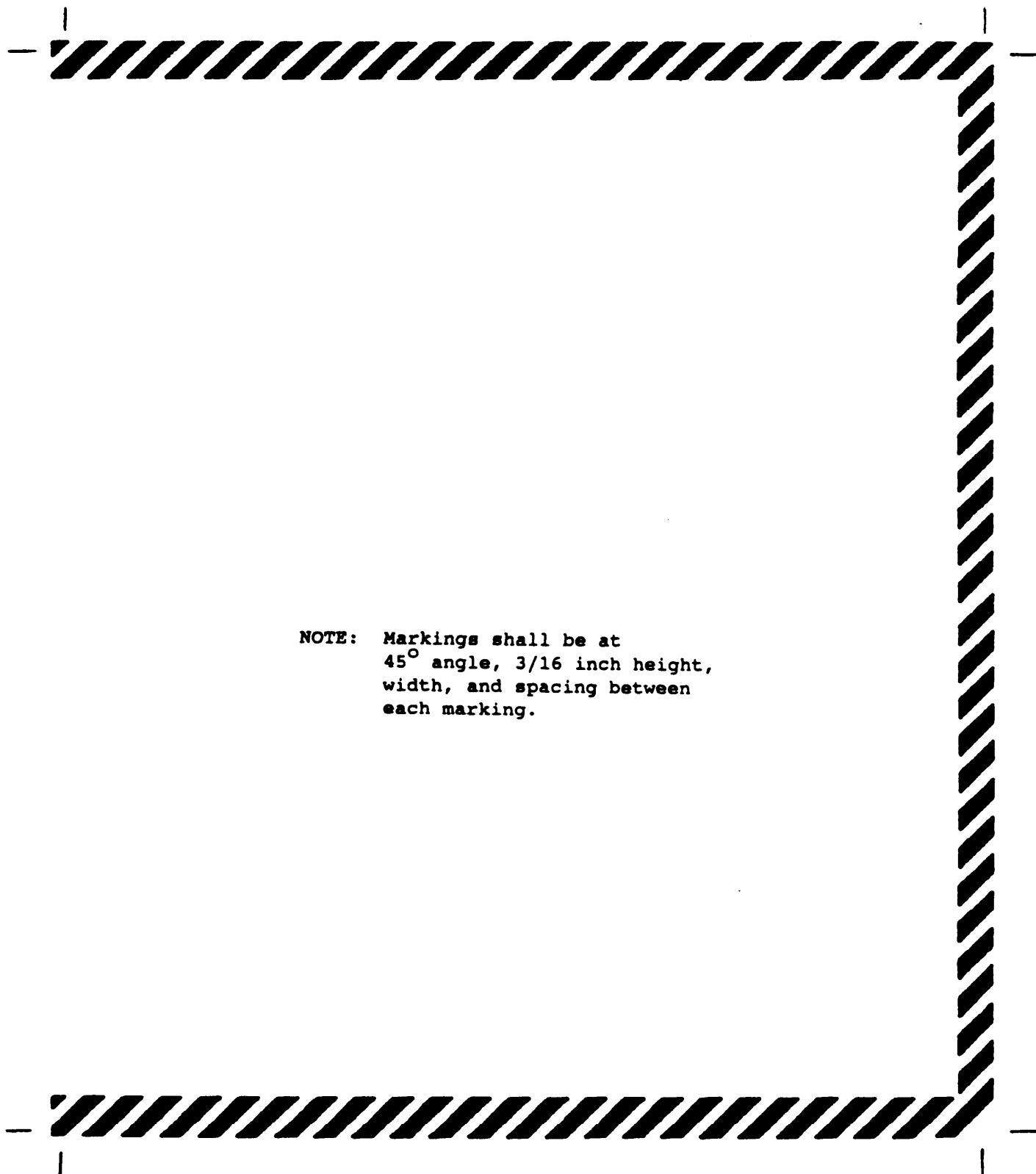
Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness or long term health hazards to personnel.

NOTE

Highlights an essential operating or maintenance procedure, condition or statement.

FIGURE 22. Warnings, cautions and notes. (Example)

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**NOTE:** Markings shall be at  
45° angle, 3/16 inch height,  
width, and spacing between  
each marking.

FIGURE 23. Emergency page markings. (Example)



MIL-M-24784(SH)

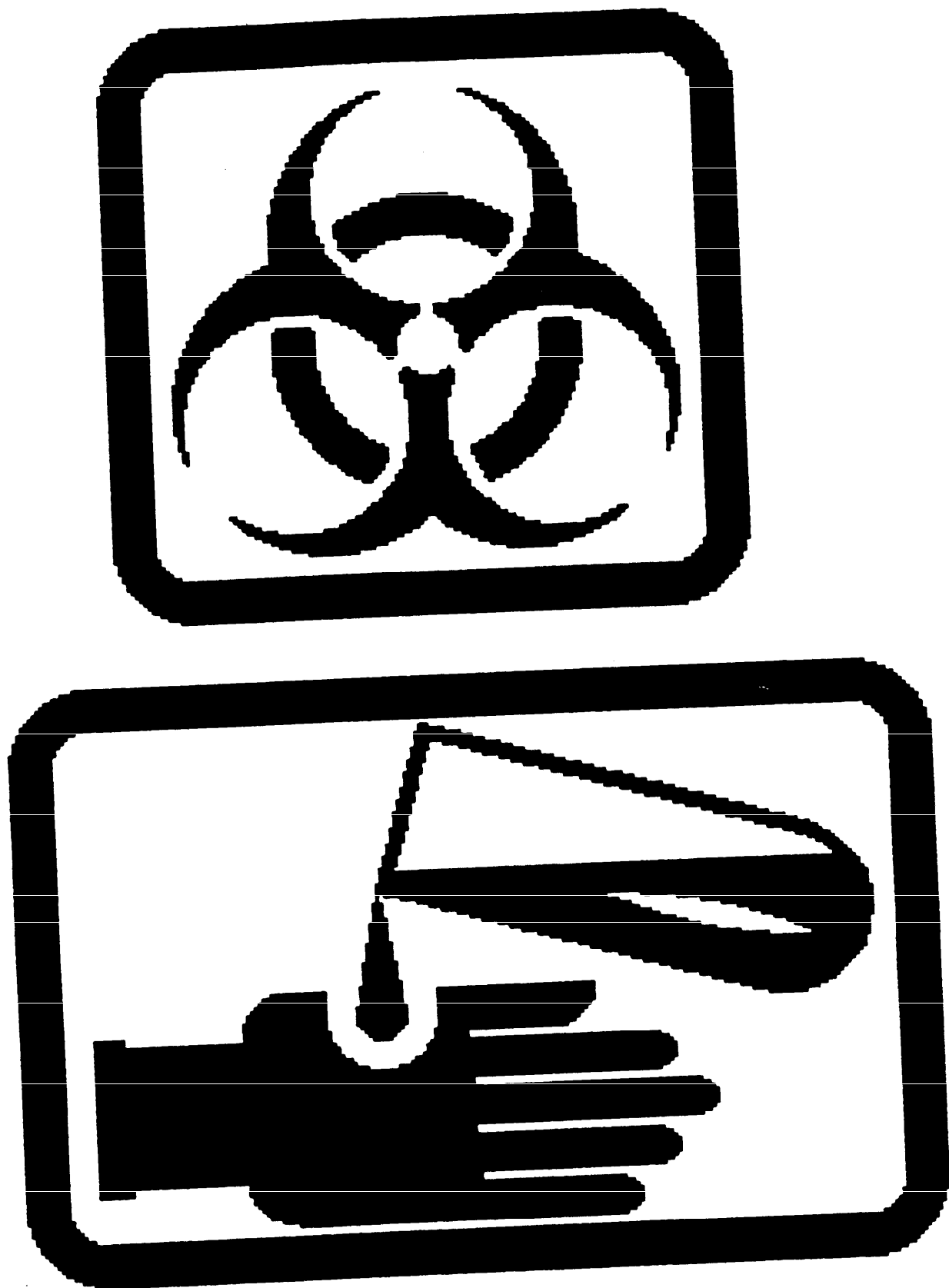


FIGURE 24. Biological and chemical icon.

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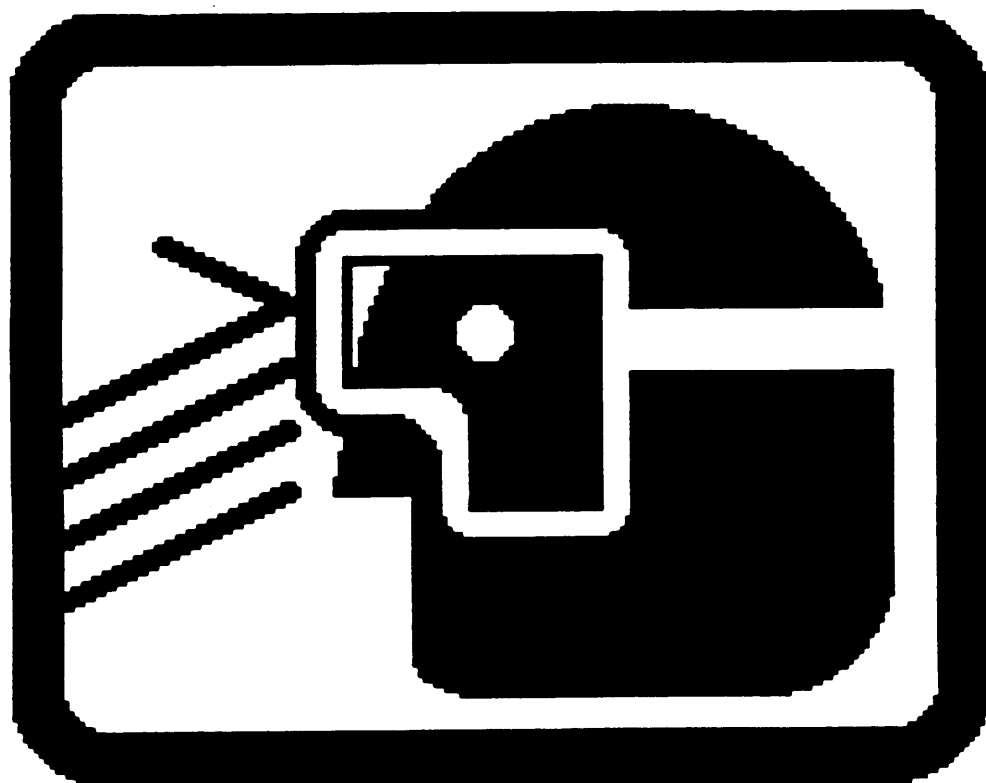


FIGURE 25. Explosion and eye protection icon.



FIGURE 26. Fire and poison icon.

MIL-M-24784 (SH)

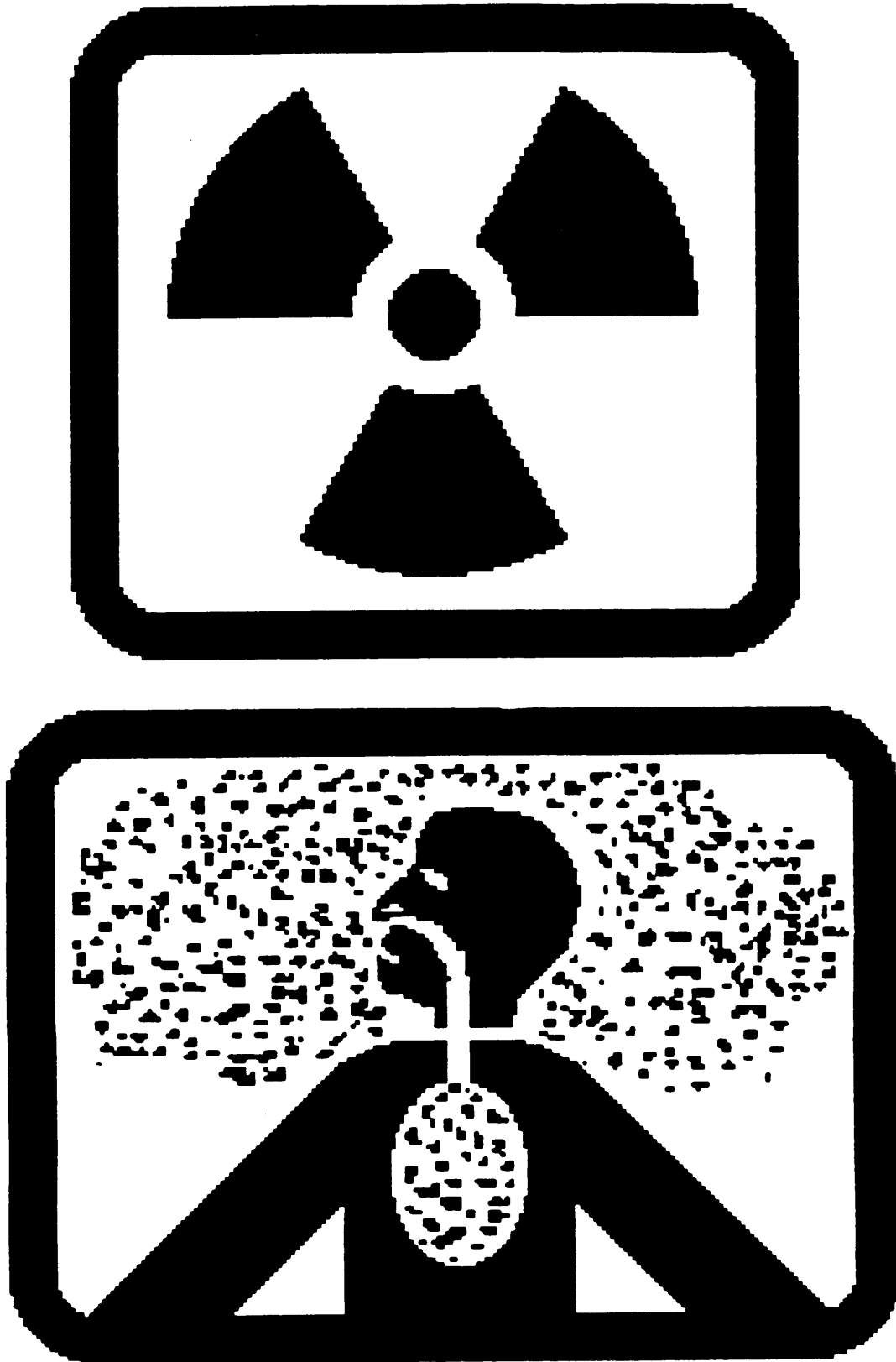


FIGURE 27. Radiation and vapor icon.





## MIL-M-24784(SH)

Figure and index Number	Description	Qty.	Fed. Mfg. Code	Mfg. Part No.
6-1	Bearing - Inner	1	80648	B2212
-2	Ring, Retainer MS 9013	1	80756	RS-216
-3	Plug, Drain MS 9015	1	45681	8P5N-S
-4	Hydraulic Motor - ASD	1	16954	M15-17998
-5	"O" Ring MS-28775-234	4		
-6	Hex Hd Capscrew (Special) 1-8Nc x 3-3/4, Grade 5, MS 90725-237	4		
-7	Spring, Heavy Duty, 1-1/2 O.D. x 3/4 I.D. x 12" LG	1	15340	9-2448-26

FIGURE 30. Parts list table, HM&E Equipment. (Example)



MIL-M-24784(SH)

TABLE ZZ. RADAR SET AN/SPS-XX, PARTS LIST

## Amplifier-Oscillator Group OA-2815/SPS-XX (Unit 2)

REFERENCE DESIGNATION	NOTES	NAME AND DESCRIPTION	FIGURE NUMBER (ITEM)
2		AMPLIFIER - OSCILLATOR GROUP OA-2815/SPS-XX: Provides drive power for AN/SPS-XX final stage, made in three cabinets which can be separated; mfr 89661, part no. 478D-800G02.	1-1
2AT1	1	ATTENUATOR, FIXED: 50 ohms, 1 watt, bnc type connector; mfr 91578, type RT3-M-51. (Attaching Parts) B(1), T(4)	6-119(17)
2B1		FAN, CENTRIFUGAL: Cw rotation, 3 o'clock blast, aluminum case, 6-13/32 in. long, 6-7/17 in. w; mfr 82877, type DRFPKS406, 89661, dwg 331C158H03. (Attaching Parts) L(8), T(8), X(8)	6-119(42)
2C1 thru 2C8		CAPACITOR, FIXED, PAPER DIELECTRIC: 0.01 F±10%, 600 Vdc working; mfr 56289, part no. 102P15, 89661, dwg 54B7098H07.	6-119

FIGURE 31. Parts list table, electronic Equipment. (Example)

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TABLE ZZ. RELAY INDEX

REFERENCE DESIGNATION	FUNCTIONAL NAME	ENERGIZING VOLTAGE	TROUBLE-SHOOTING DIAGRAM (FIG.NO.)
6A4K9 6A4K10 6A4K11	HV Door Interlock Cabinet Interlock Buzzer Relay	115 Vac 28 Vdc 28 Vdc	5-21 5-22 5-22

TABLE ZZ. INDICATOR LAMP INDEX

REFERENCE DESIGNATION	FUNCTIONAL NAME	ENERGIZING VOLTAGE	TROUBLE-SHOOTING DIAGRAM (FIG.NO.)
9A8DS15	HV INTERLOCK CONFIDENCE-VSWR TRIP-OUT	28 Vdc	5-22
9A8DS16	HV INTERLOCK CONFIDENCE-HVPS	28 Vdc	5-22

TABLE ZZ. CIRCUIT BREAKER AND FUSE INDEX

REFERENCE DESIGNATION	FRONT PANEL MARKING	RATING		CIRCUIT PROTECTED	TROUBLE-SHOOTING DIAGRAM (FIG.NO.)
		VOLTS	AMPS		
9A8F1	KLYSTRON FILAMENT FUSE ALARM 5 AMP	250	5	Klystron filament control circuit and filament transformer 9A1T106	5-32
14A2F1	CONTROL	125	3	Voltage sensor bridge power supply consisting diodes 13A2CR1 through CR4.	5-2

FIGURE 32. Protective device index.

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TABLE 0-0. RELAY LADDER INDEX

Relay Number	Function Bus	Coil Supply	Figure	Sheet	Zone
K(405)25	ANGLE COAST	80 VDC (48B), 28 VDC (48A)	5-71	34	A-3
K(405)26	TE	28 VDC	5-71	33	B-3
K(405)27	PROBE RELAY	28 VDC	5-71	23	B-3
K(405-A02)01	RANGE RATE SENSE	28 VDC	5-71	33	A-1
K(3806)01	CW FOCUS COIL OPERATE	80 VDC-ST	5-33	22	B-3
K(3825)01	ARC SIGNAL	+80 VDC	5-33	19	B-3
K(3827)01	RADIATE COMMAND SW	80 VDC	5-71	31	B-1
			5-33	2	B-4
K(3703)01	None	80 VDC	5-33	6	A-5
K(3703)02	BEAM ON	80 VDC	5-33	6	B-3

TABLE 0-0. SWITCH LADDER INDEX

Switch Number	Switched Bus	Switched Voltage	Figure	Sheet	Zone
S(3)01	REFL PWR SPLY INTLK	115 AC 1-RY	5-27	23	A-2
S(4)01	INTLK (7)	115 VDC-ST	5-71	26	A-3
S(4)02	None	80V P-P MIN.	5-27	10	A-4
S(20-01)01	SERVO INTLK	115 AC 1-CV & RY	5-19	8	B-2
S(20-01)15	SERVO INTLK	115 AC 1-CV & RY	5-19	9	B-5
S(20-02)02	TN HTR	115 AC 1-CV	5-71	23	B-2
S(20-02)03	TN HTR	115 AC 1-CV	5-71	23	B-3
S(20-04)05	BTL SHT, INTLK (8), (9)	115 AC 1-ST, 115 VDC-ST	5-71	26	B-4
			5-71	20	A-1
S(20-04)06	BTL SHT, INTLK (8), (10)	115 AC 1-ST, 115 VDC-ST	5-71	26	B-4
			5-71	20	A-1

TABLE 0-0. LAMP LADDER INDEX

Lamp Number	Lamp Name	Energizing Bus Voltage	Figure	Sheet	Zone
D8(13)03	H. V. ON	115 AC 1-RY	5-27	4	A-1
I(20-04)01	INTLK BYPASSED	115 AC 1-ST	5-71	20	A-1
I(20-04)02	INTLK BYPASSED	115 AC 1-ST	5-71	20	A-1
I(28)01	INTLK BYPASSED	115 AC 1-ST	5-71	21	B-3
I(30)01	INTLK BYPASSED	115 AC 1-ST	5-71	21	B-2
I(38)01	SURFACE MODE	28 AC 400	5-71	18	B-2
I(38)02	ALERT	TO FCSWB	5-71	15	B-5

FIGURE 33. Relay, switch, and lamp indexes.

MIL-M-24784 (SH)

"TRAINING SUMMARY FOR THE INGERSOLL-RAND  
MODEL NA 13.5 CFH, 4500 PSI HIGH PRESSURE  
AIR COMPRESSOR (HPAC) LOG FORMS  
FOR USE ON SSBN627, CLASS

The following summary discusses selected values on Air Compressor Log forms which is of concern to an operator. It will be noted on the log forms that some values outside the listed ranges need not be circled. These values are shown in black and may be either the upper or lower value shown for that particular range. The values which are recorded on the log form which fall outside the normal range red values are of concern and must be circled. The red values are the significant values and values circled on the log forms will show that a potential problem area is developing or has already developed.

TEMP CIRC WATER OUT - Values lower than the 95 degree Fahrenheit given for the normal range of the circulating water out temperature need not be circled. This value is dependent on the "circulating water" in temperatures which are recorded elsewhere on the new log form.

PRESSURE 4TH STAGE - The lower value shutdown is given for this stage as it is an indication that back pressure regulating values in the air dryers are not functioning properly (see tech manual for HP Dehydrator and Filter - NAVSEA S6228-AB-MMA-000/NA, paragraphs 1-3-4 and pages 1-5). This value provides the required pressure for proper functioning of the shis air dryers. Operation of the air dryers at pressures lower than 4300 psi can cause saturation of the desiccant with subsequent breakdown desiccant carryover and permit saturation air to be sent to the air banks.

The normal range values for the 4th stage were selected in the following manner:

- (a) Lower range values - 4300 psi - this value is required again for proper operation of the air dryers.
- (b) Higher range value - 4800 psi - values this high may be required to charge the air banks to 4500 psi.

TEMP 1ST STAGE SUCT - Values outside the listed normal range need not be circled as the operator has little or no control over the compartment air temperature. Values outside the normal range will not adversely affect compressor operation.

INTERSTAGE LOWER VALUE TEMP VALUES - Temperature values below the listed lower normal range for the various stages within the compressor need not be circled as these are a function of the circulating water inlet temperature and this value is recorded elsewhere on the log form. In addition these values are not normally an indication of problems developing within the compressor.

Sample arrangement only. Type size does not conform to minimum specification requirements.

FIGURE 34. Log form training summary. (Sample)



MIL-M-24784(SH)

TABLE ZZ. TROUBLESHOOTING INDEX RADIO SETS  
AN/SRC-XX AND AN/SRC-XX

FUNCTIONAL AREA	TROUBLE SHOOTING PARAGRAPH	TROUBLE SHOOTING DIAGRAM	FUNCTIONAL DESCRIPTION PARAGRAPH	ALIGNMENT/ ADJUST PARAGRAPH
AC Power	5-3	5-8	3-9a	6-105,6-106
DC Power	5-4	5-19	3-9b	6-107 through 6-110, 6-127
Keying	5-5	5-24	3-13	6-22
Receive RF	5-8	5-1	3-4	6-112 through 6-115
System Channel and Frequency Selection	5-9	5-16	3-10, 3-12	6-121

FIGURE 36. Troubleshooting index.

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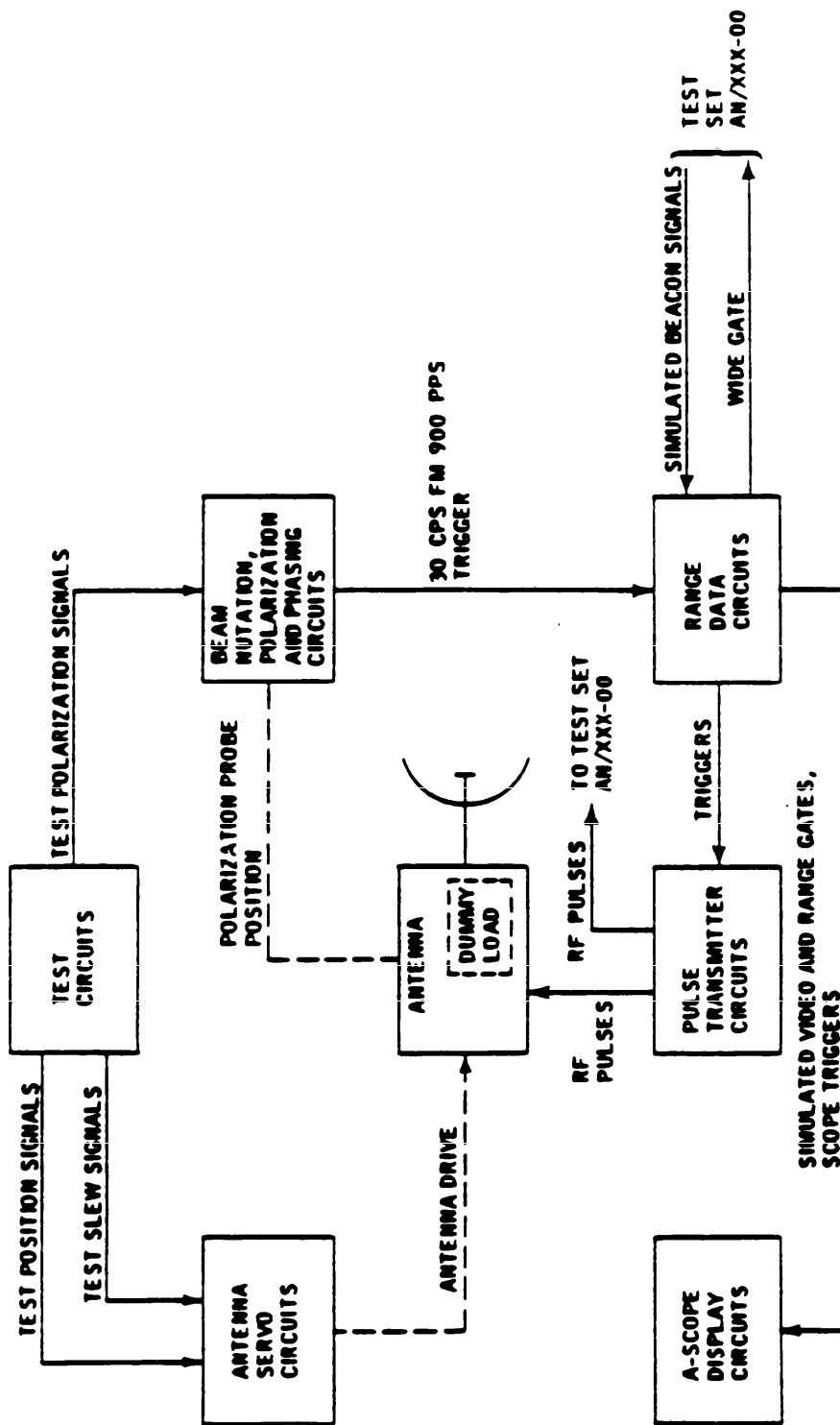


FIGURE 37. Functional block diagram, equipment. (Typical)



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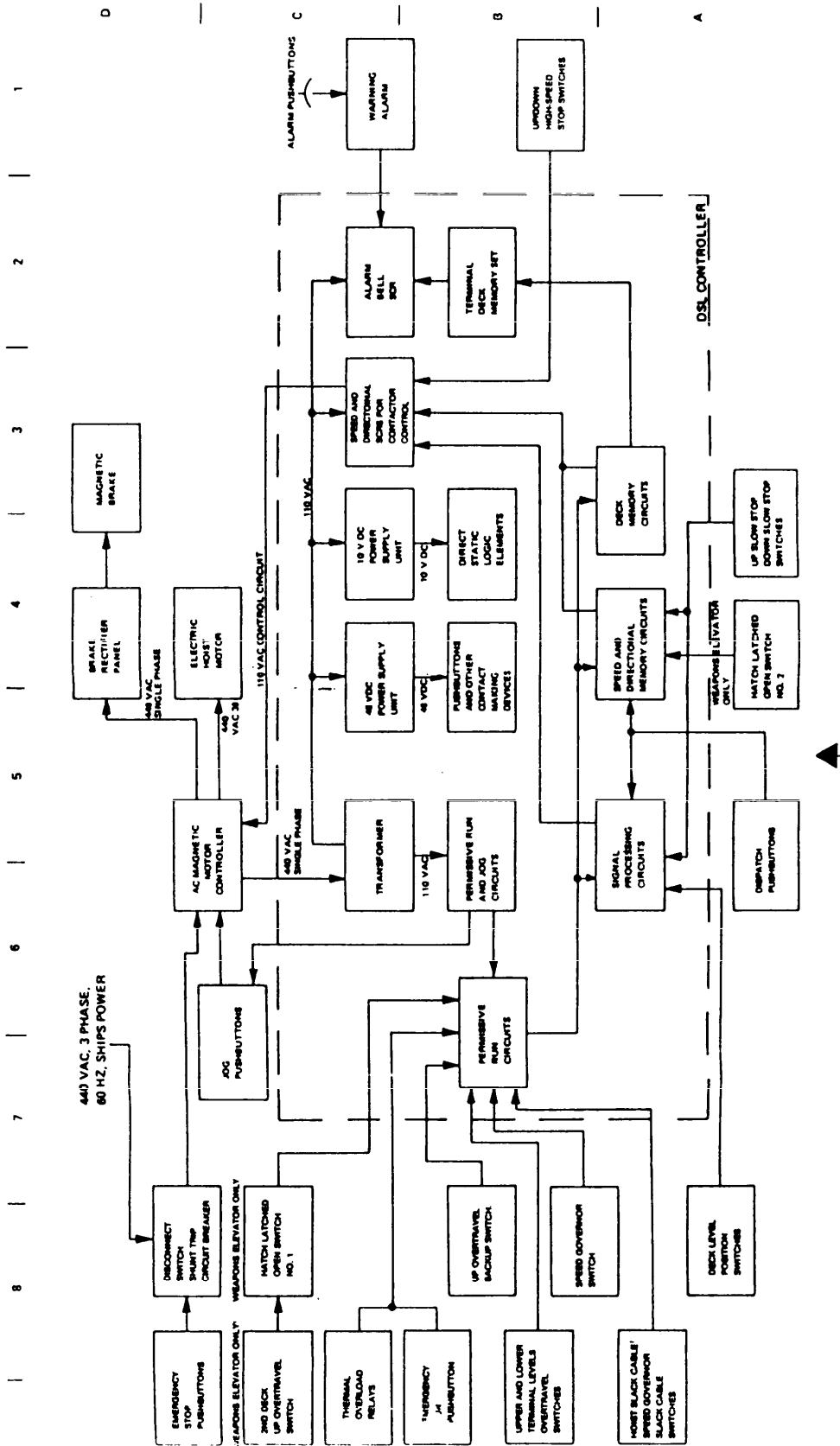


FIGURE 38. Functional block diagram, overall.

MIL-M-24784(SH)

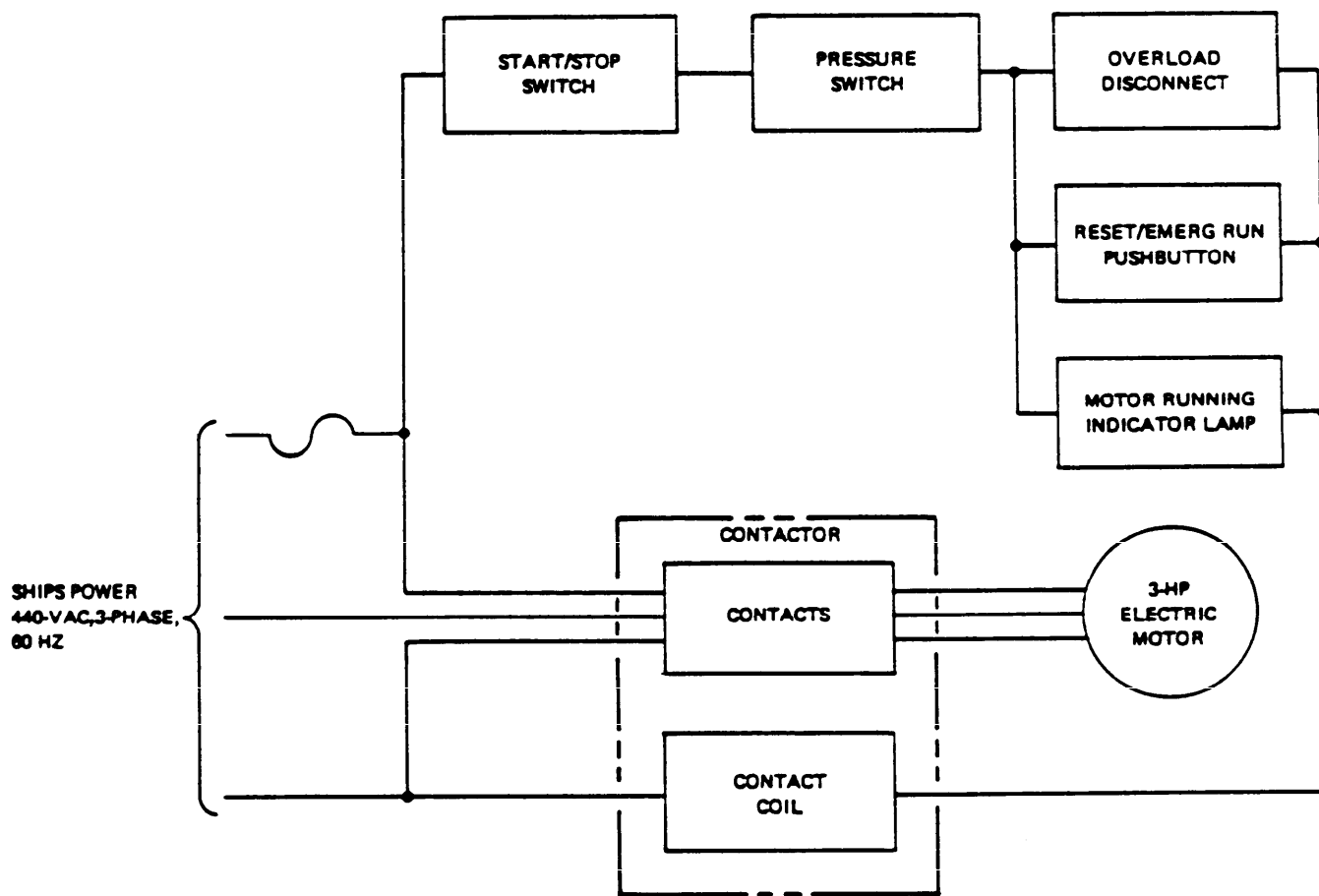


FIGURE 39. Functional block diagram, system.

MIL-M-24784(SH)

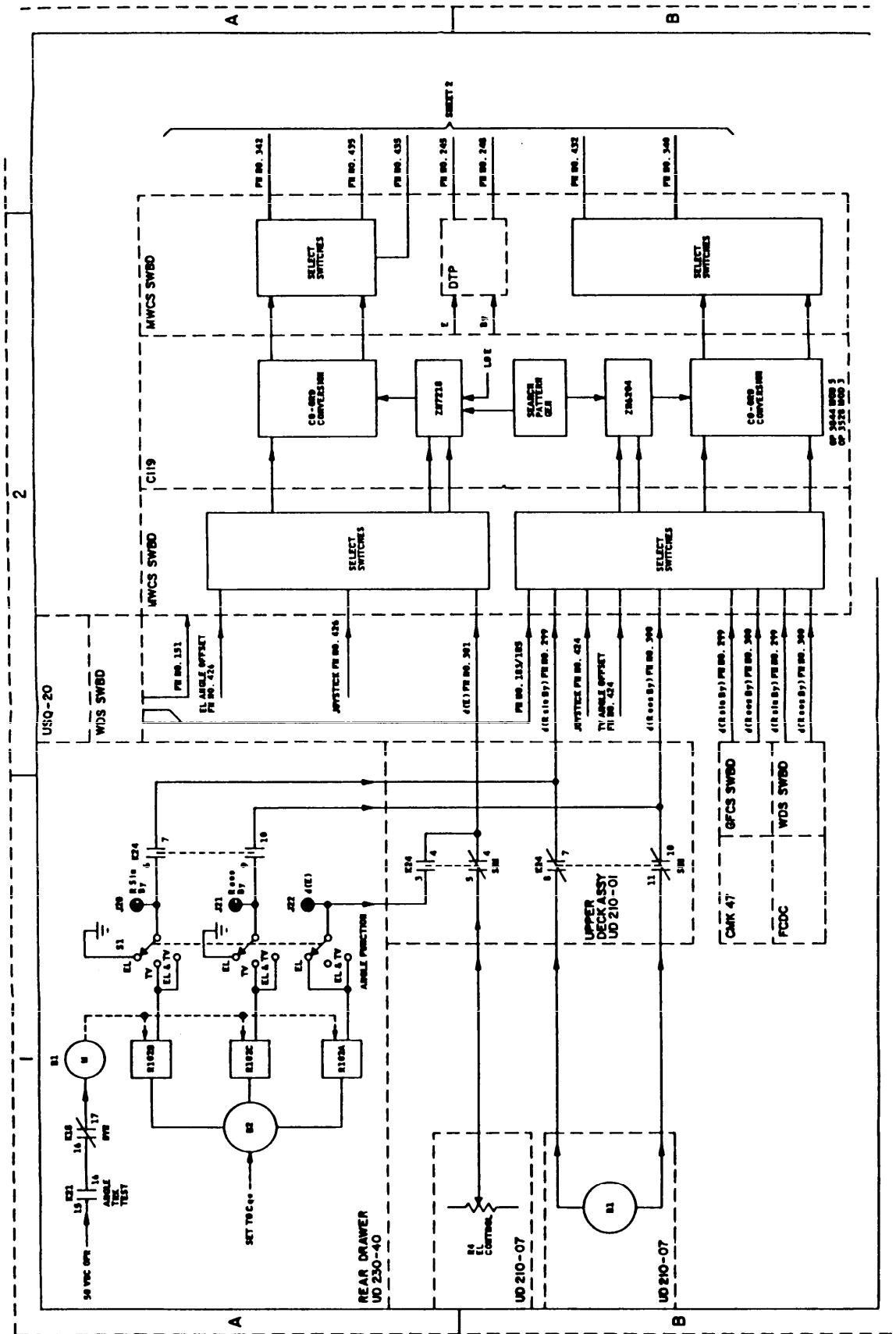
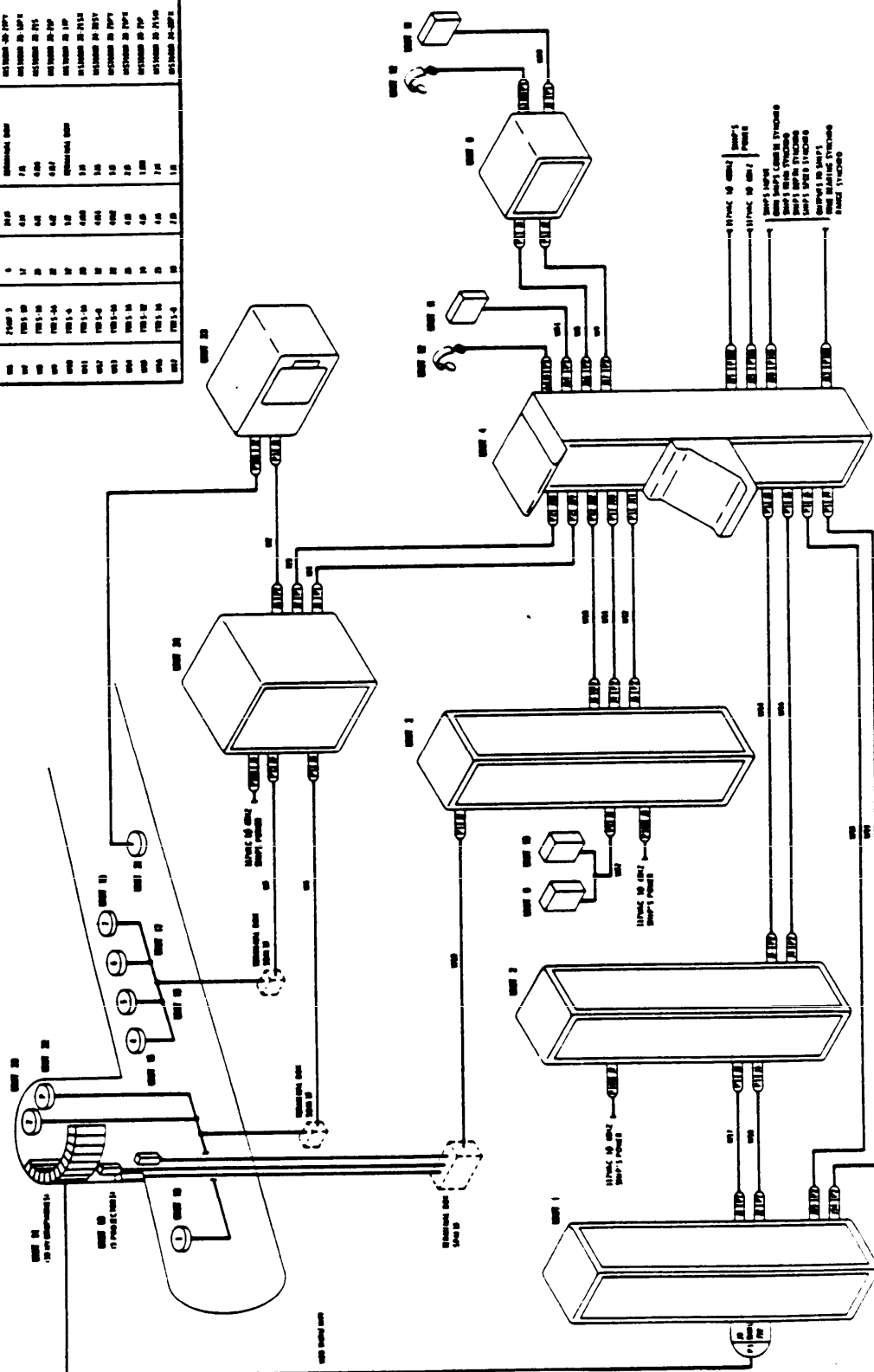


FIGURE 40. Troubleshooting block diagram, summary.

MIL-M-24784 (SH)

LIST OF CABLES			
CABLE	TYPE	ACTIVE CONDUCTORS	PI NUMBER
01	FRS-4	17	FRS-4
02	FRS-10	17	FRS-10
03	FRS-10	17	FRS-10
04	FRS-10	17	FRS-10
05	FRS-10	17	FRS-10
06	FRS-10	17	FRS-10
07	FRS-10	17	FRS-10
08	FRS-10	17	FRS-10
09	FRS-10	17	FRS-10
10	FRS-10	17	FRS-10
11	FRS-10	17	FRS-10
12	FRS-10	17	FRS-10
13	FRS-10	17	FRS-10
14	FRS-10	17	FRS-10
15	FRS-10	17	FRS-10
16	FRS-10	17	FRS-10
17	FRS-10	17	FRS-10
18	FRS-10	17	FRS-10
19	FRS-10	17	FRS-10
20	FRS-10	17	FRS-10
21	FRS-10	17	FRS-10
22	FRS-10	17	FRS-10
23	FRS-10	17	FRS-10
24	FRS-10	17	FRS-10
25	FRS-10	17	FRS-10
26	FRS-10	17	FRS-10
27	FRS-10	17	FRS-10
28	FRS-10	17	FRS-10
29	FRS-10	17	FRS-10
30	FRS-10	17	FRS-10
31	FRS-10	17	FRS-10
32	FRS-10	17	FRS-10
33	FRS-10	17	FRS-10
34	FRS-10	17	FRS-10
35	FRS-10	17	FRS-10
36	FRS-10	17	FRS-10
37	FRS-10	17	FRS-10
38	FRS-10	17	FRS-10
39	FRS-10	17	FRS-10
40	FRS-10	17	FRS-10
41	FRS-10	17	FRS-10
42	FRS-10	17	FRS-10
43	FRS-10	17	FRS-10
44	FRS-10	17	FRS-10
45	FRS-10	17	FRS-10
46	FRS-10	17	FRS-10
47	FRS-10	17	FRS-10
48	FRS-10	17	FRS-10
49	FRS-10	17	FRS-10
50	FRS-10	17	FRS-10
51	FRS-10	17	FRS-10
52	FRS-10	17	FRS-10
53	FRS-10	17	FRS-10
54	FRS-10	17	FRS-10
55	FRS-10	17	FRS-10
56	FRS-10	17	FRS-10
57	FRS-10	17	FRS-10
58	FRS-10	17	FRS-10
59	FRS-10	17	FRS-10
60	FRS-10	17	FRS-10
61	FRS-10	17	FRS-10
62	FRS-10	17	FRS-10
63	FRS-10	17	FRS-10
64	FRS-10	17	FRS-10
65	FRS-10	17	FRS-10
66	FRS-10	17	FRS-10
67	FRS-10	17	FRS-10
68	FRS-10	17	FRS-10
69	FRS-10	17	FRS-10
70	FRS-10	17	FRS-10
71	FRS-10	17	FRS-10
72	FRS-10	17	FRS-10
73	FRS-10	17	FRS-10
74	FRS-10	17	FRS-10
75	FRS-10	17	FRS-10
76	FRS-10	17	FRS-10
77	FRS-10	17	FRS-10
78	FRS-10	17	FRS-10
79	FRS-10	17	FRS-10
80	FRS-10	17	FRS-10
81	FRS-10	17	FRS-10
82	FRS-10	17	FRS-10
83	FRS-10	17	FRS-10
84	FRS-10	17	FRS-10
85	FRS-10	17	FRS-10
86	FRS-10	17	FRS-10
87	FRS-10	17	FRS-10
88	FRS-10	17	FRS-10
89	FRS-10	17	FRS-10
90	FRS-10	17	FRS-10
91	FRS-10	17	FRS-10
92	FRS-10	17	FRS-10
93	FRS-10	17	FRS-10
94	FRS-10	17	FRS-10
95	FRS-10	17	FRS-10
96	FRS-10	17	FRS-10
97	FRS-10	17	FRS-10
98	FRS-10	17	FRS-10
99	FRS-10	17	FRS-10
100	FRS-10	17	FRS-10



Sample arrangement only. Layout does not conform to microfilm requirements.  
Type size does not conform to minimum specification requirements.

FIGURE 41. Interconnecting cable run/piping diagram.

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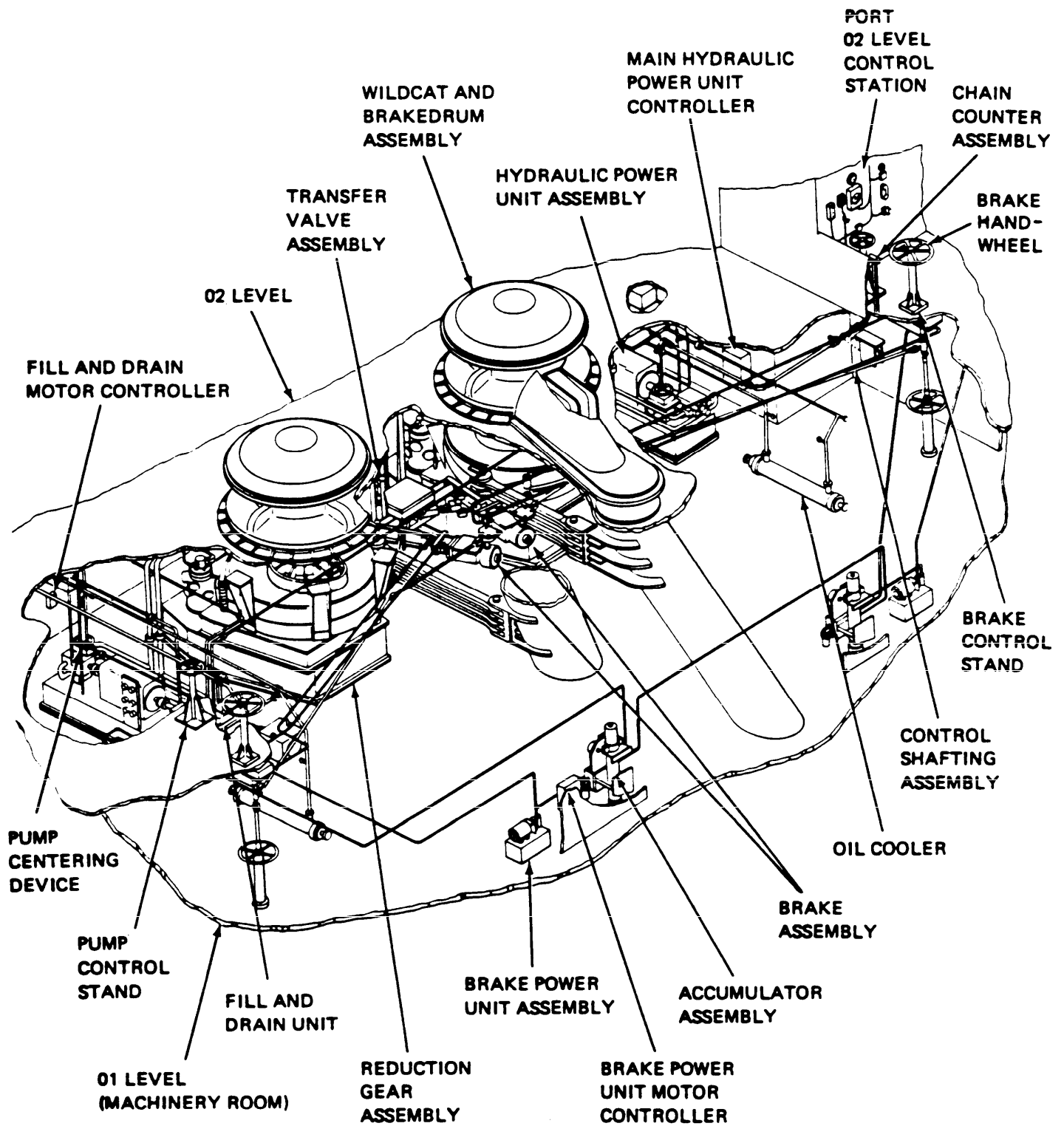


FIGURE 42. Equipment illustration showing relationship of all units.

MIL-M-24784(SH)

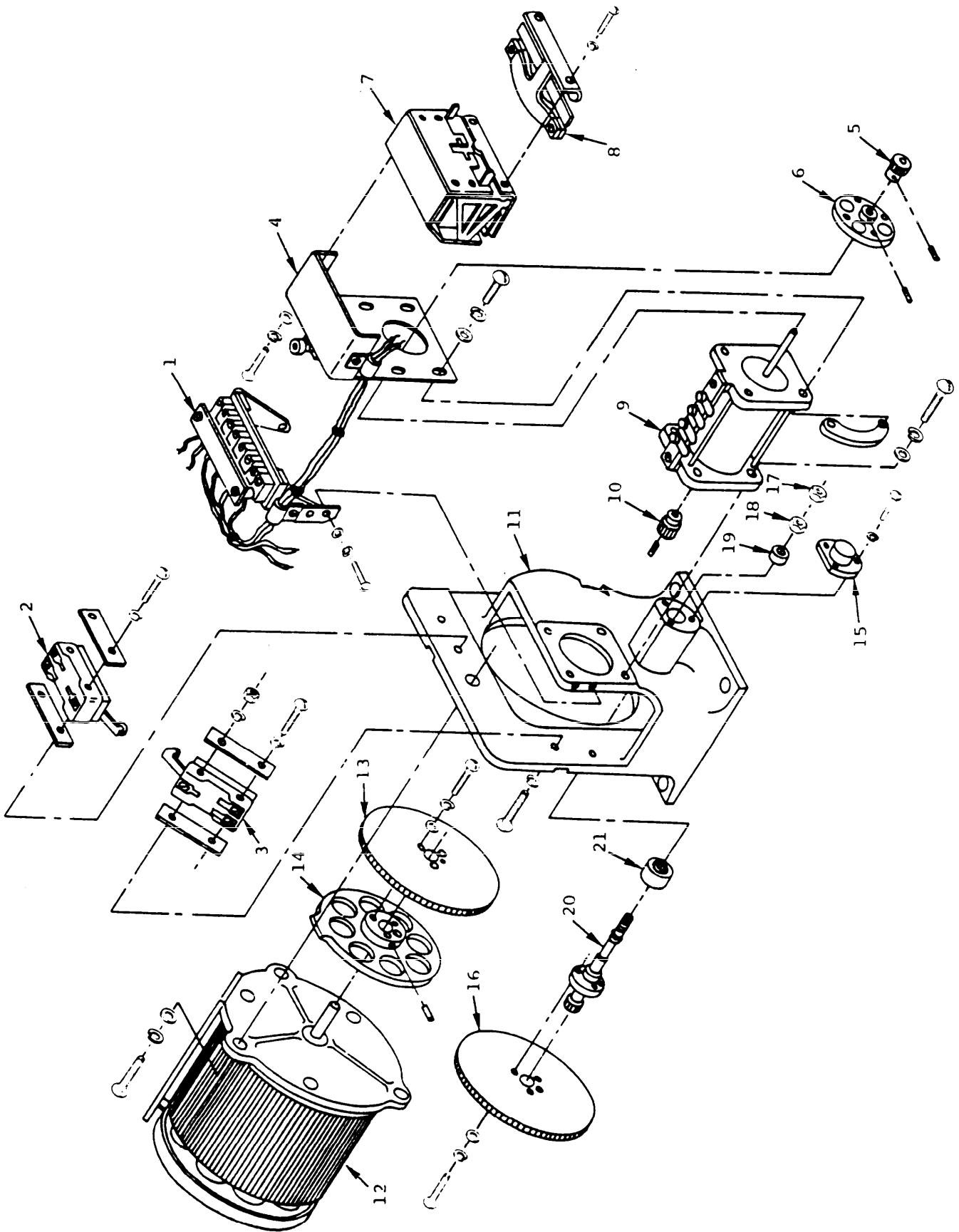


FIGURE 43. Exploded view.

MIL-M-24784(SH)

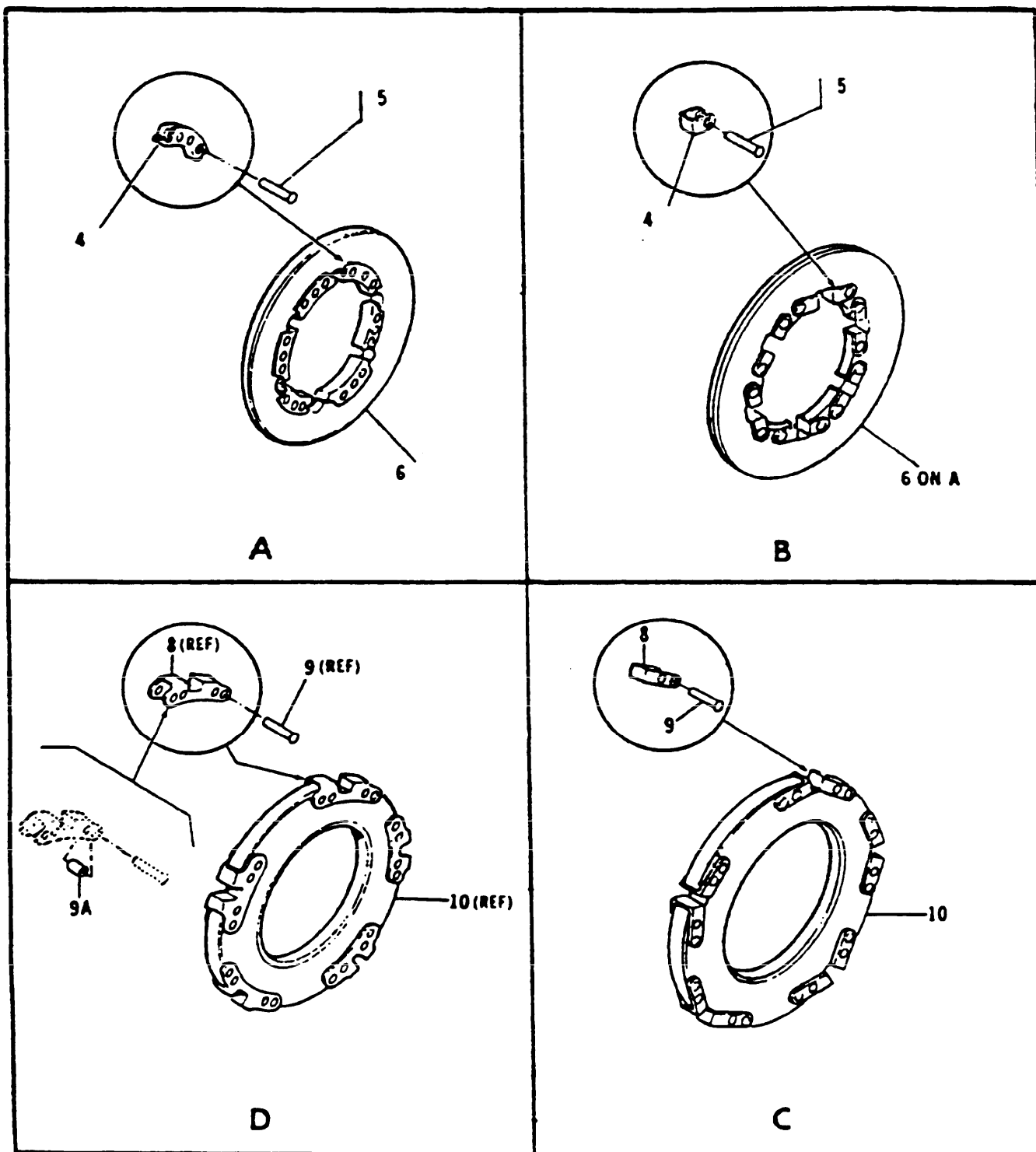


FIGURE 44. Multisection illustration. (Sample)



MIL-M-24784 (SH)

SE211-FO-TRS-010/SPS-10

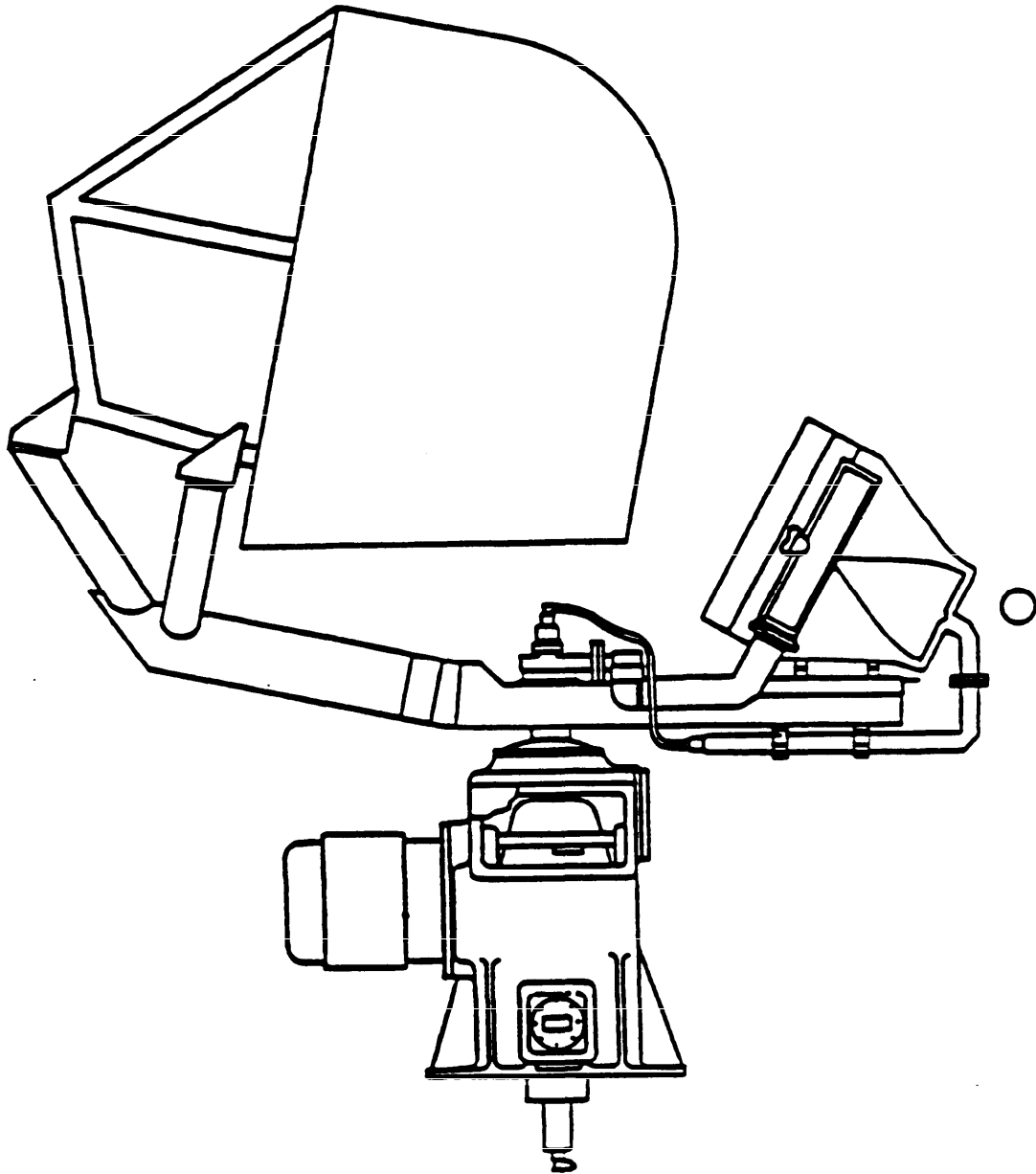


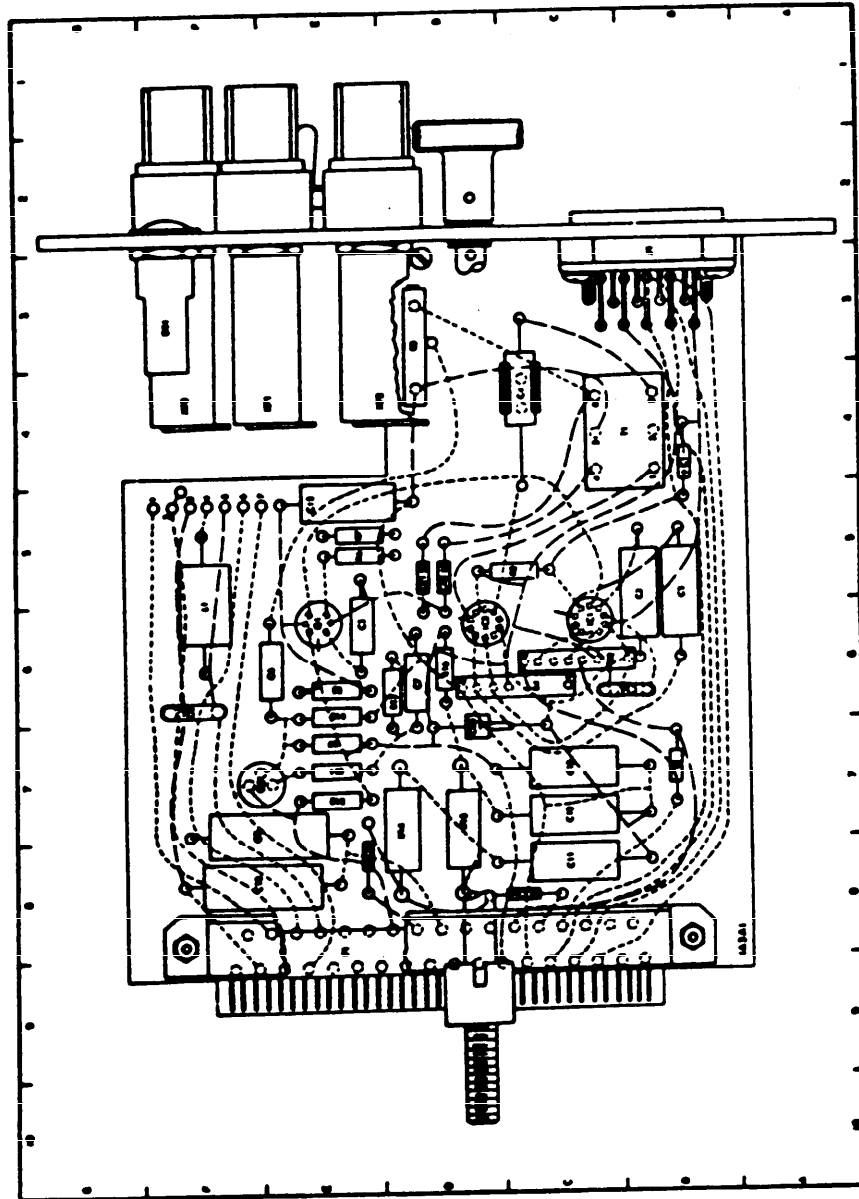
FIGURE 1-0 ANTENNA ASSEMBLY PS-936C/SPS-10

(BLANK/1-0)

ORIGINAL

FIGURE 45. Frontispiece illustration. (Example)





PARTS LOCATION INDEX		ASSEMBLY M13A1	
REFERENCE DESIGNATION	LOCATION	REFERENCE DESIGNATION	LOCATION
C1	4-B	P1	6-E
C2	6-B	Q1	6-E
C3	6-B	Q2	7-F
C4	6-C	R1	7-B
C5	6-E	R2	7-C
C6	6-E	R3	7-C
C7	6-B	R4	6-E
C8	6-F	R5	6-E
C9	6-F	R6	6-E
C10	6-C	R7	6-E
C11	7-C	R8	6-E
C12	7-C	R9	7-E
C13	7-D	R10	6-E
C14	7-E	R11	7-E
C15	6-E	R12	6-D
C16	6-E	R13	7-E
C17	6-D	R14	7-D
C18	6-E	R15	7-D
C19	6-E	R16	6-D
C20	6-E	T1	4-B
CR1	6-D	X71	4-E
CR2	6-D	X72	4-D
CR3	6-E	X73	4-F
CR4	6-C		
CR5	7-D		
BB1	3-F		
BC1	3-C		
BC2	6-D		
J1	3-B		
L1	6-F		

--- COMPONENT SIDE

--- BACK SIDE

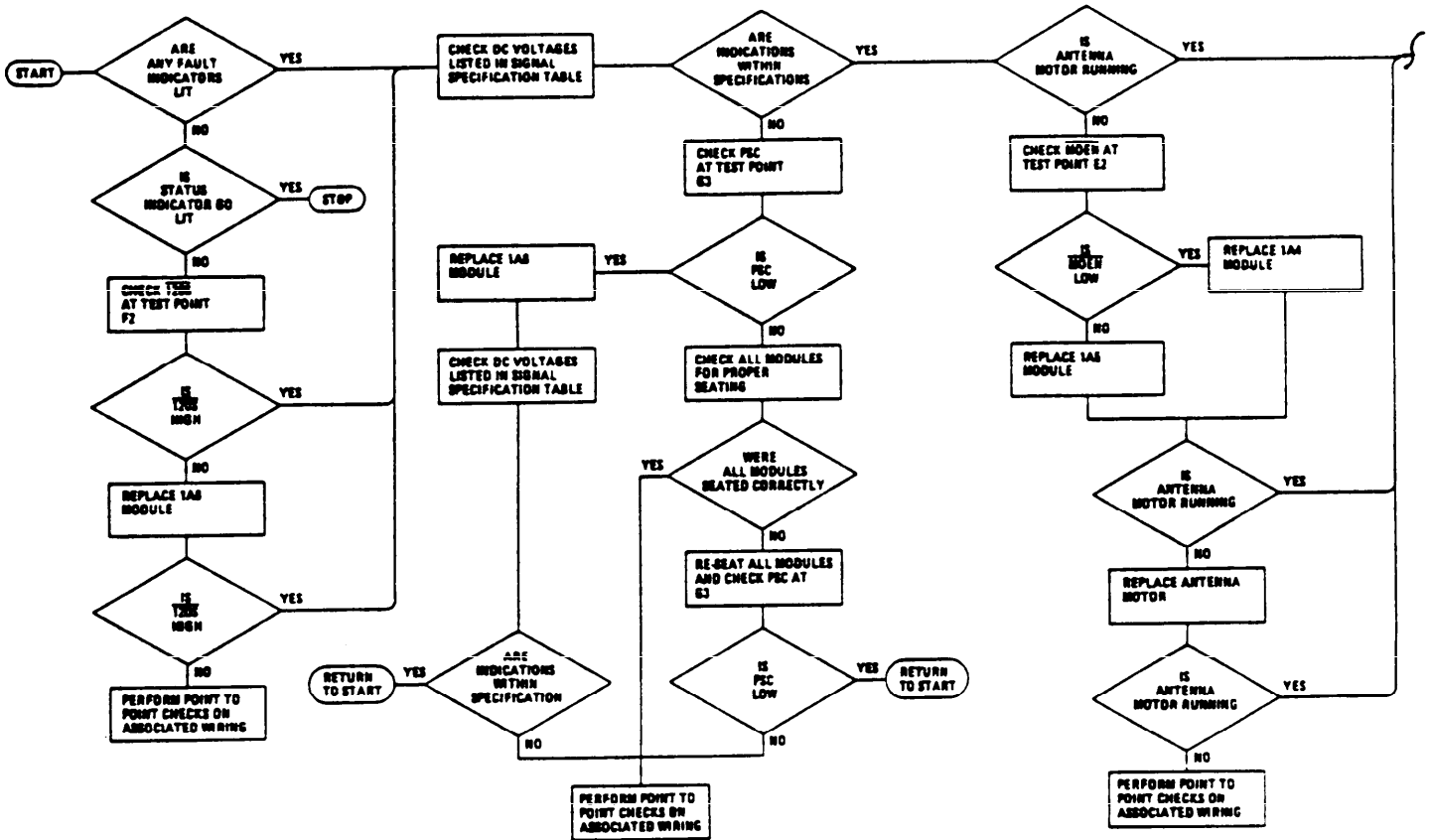
**Note:** Sample arrangement only. Size and legibility do not necessarily conform to minimum specification requirements. Supplementary data appears on an apron.

FIGURE 4.7. Engineering drawing





MIL-M-24784 (SH)



Sample arrangement only. Type size does not conform to minimum specification requirements.

FIGURE 50. Fault logic diagram. (Sheet 1 of 2)







MIL-M-24784 (SH)

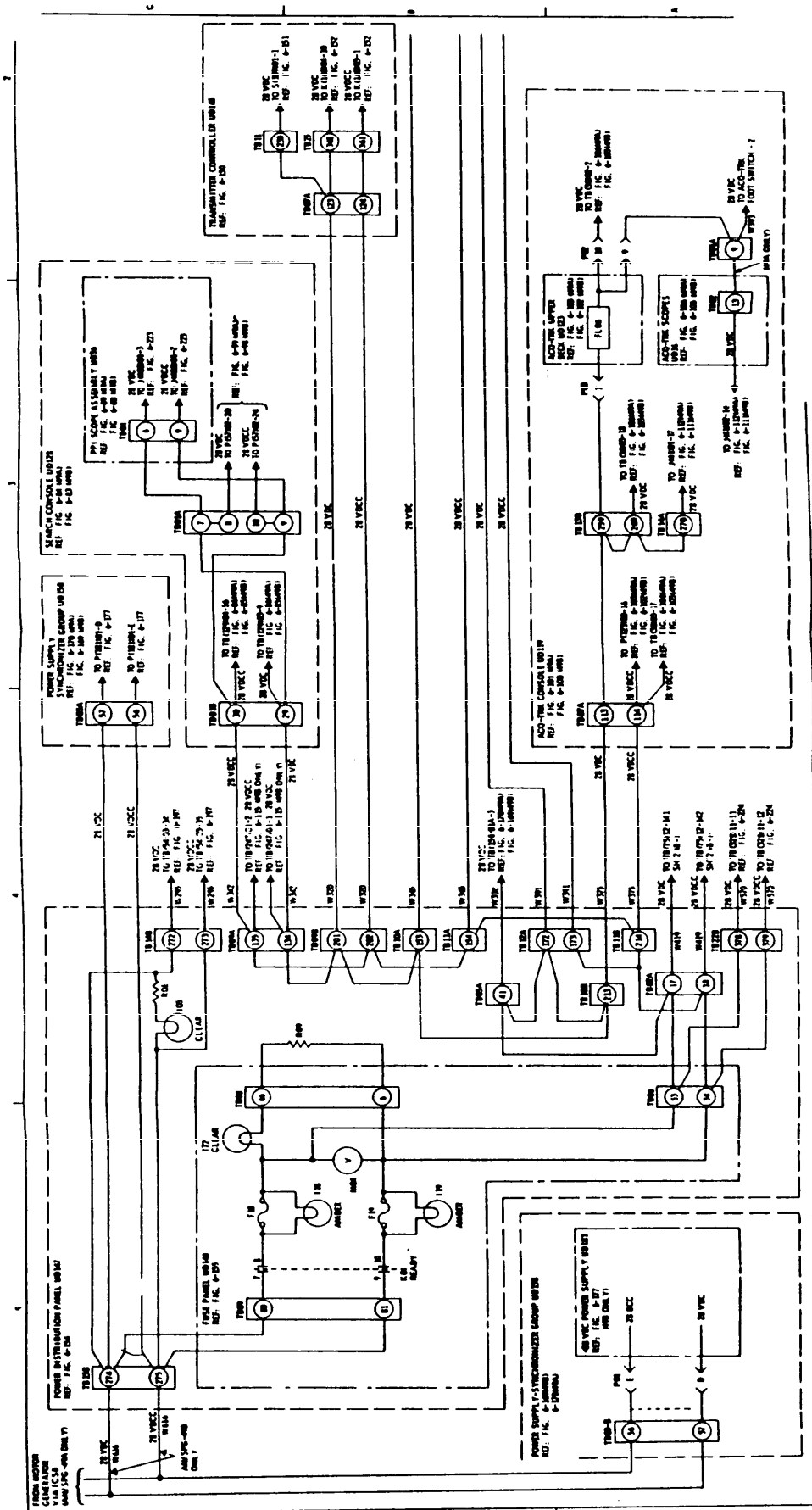
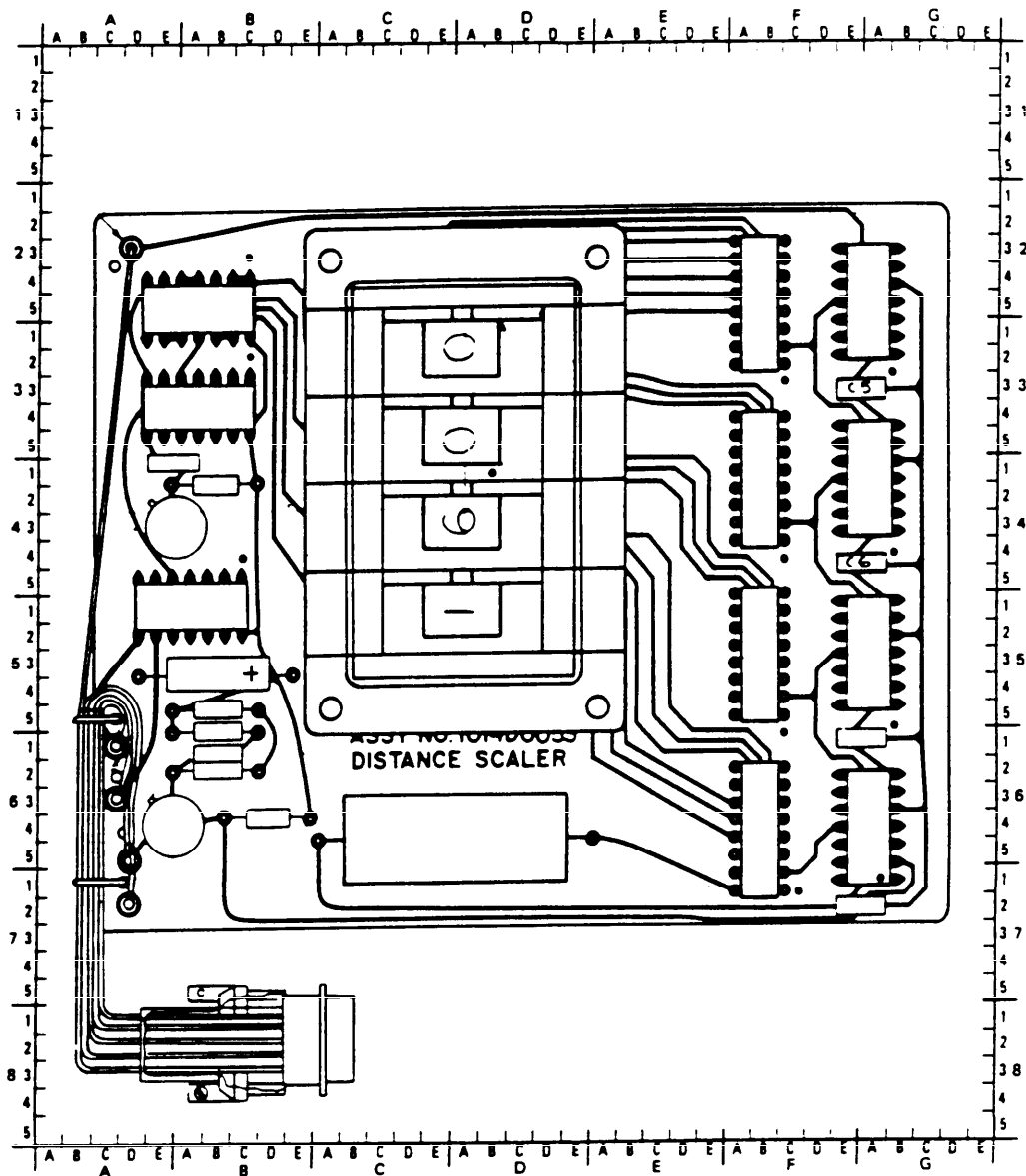


FIGURE 52. Power distribution diagram.

## MIL-M-24784 (SH)



REF DESIG	LOCATING COORD	NAME AND DESCRIPTION
C1	B.B/5.2	CAPACITOR: 15 uf, 20%, 20V; MIL TYPE M39003/01-2050
C2	D.A/5.4	CAPACITOR: 0.1 uf, 10%, 50V; MIL TYPE CH09A1RA104K
C3	B.B/6.1	CAPACITOR: 0.01 uf, 20%, 200V; MIL TYPE CK06CW103M
C4	A.E/4.1	SAME AS C3
C5	F.E/3.3	SAME AS C3
C6	F.E/4.4	SAME AS C3
C7	F.E/6.1	SAME AS C3
C8	F.E/7.2	SAME AS C3
E1	A.C/2.3	TERMINAL: MIL TYPE 55155
E2	A.C/6.1	SAME AS E1
E3	A.C/8.3	SAME AS E1
E4	A.D/6.5	SAME AS E1
E5	A.D/7.2	SAME AS E1
P4	B.E/8.2	CONNECTOR: MIL TYPE MS3106A14S-6P
Q1	A.E/6.4	TRANSISTOR: MIL TYPE JAN2N2222
Q2	A.E/4.3	SAME AS Q1

FIGURE 53. Printed circuit board, typical.

MIL-M-24784(SH)

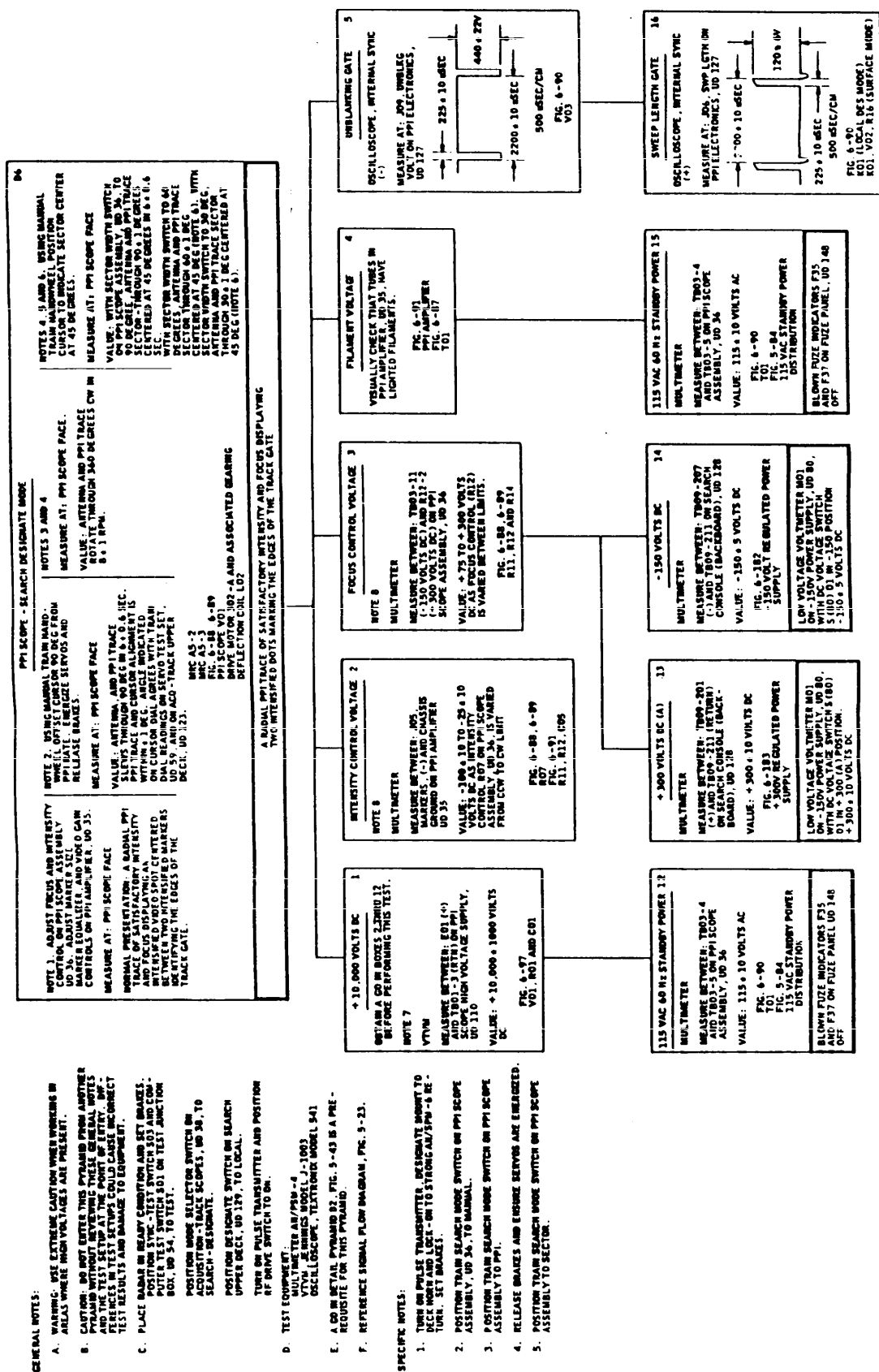


FIGURE 54. Pyramid, detailed, electronic equipment.



## MIL-M-24784 (SH)

Order of Presenting  
Information  
as Applicable

Set topics apart by 1 1/2 spaces

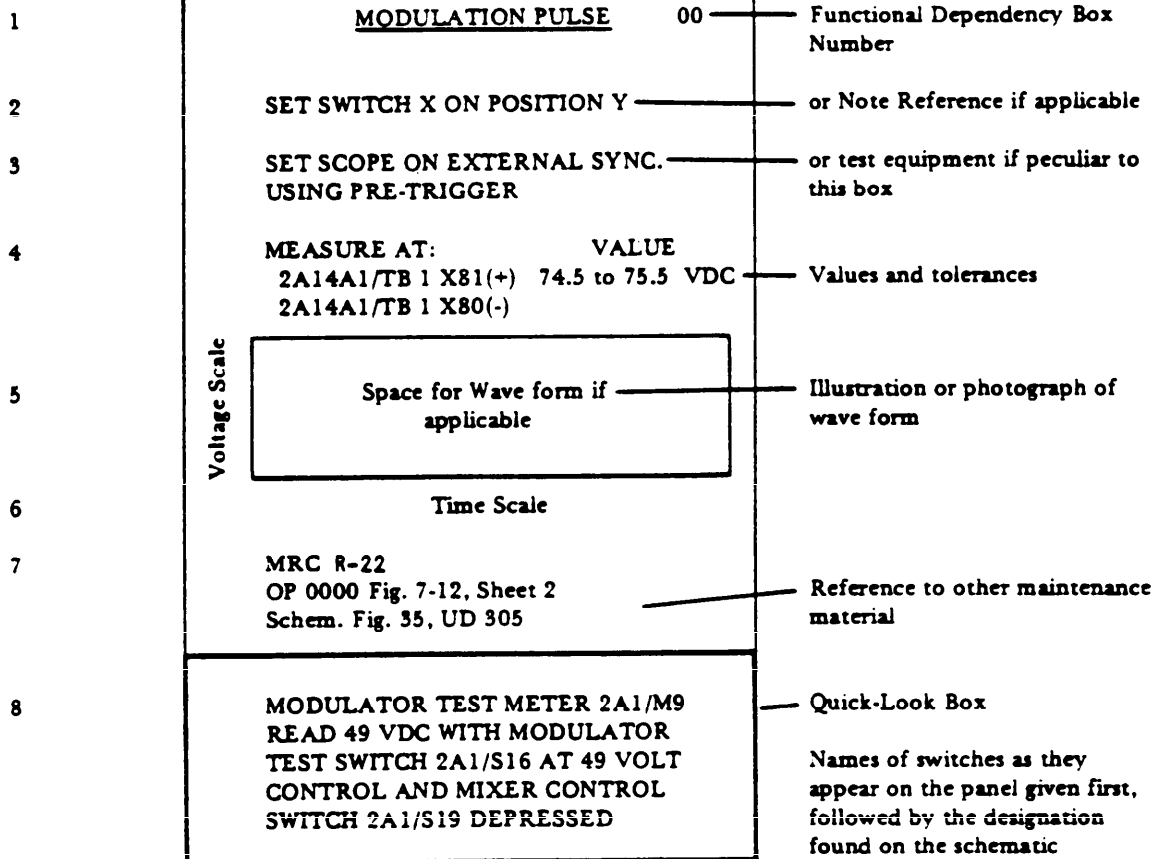


FIGURE 56. Functional dependency box format.

MIL-M-24784(SH)

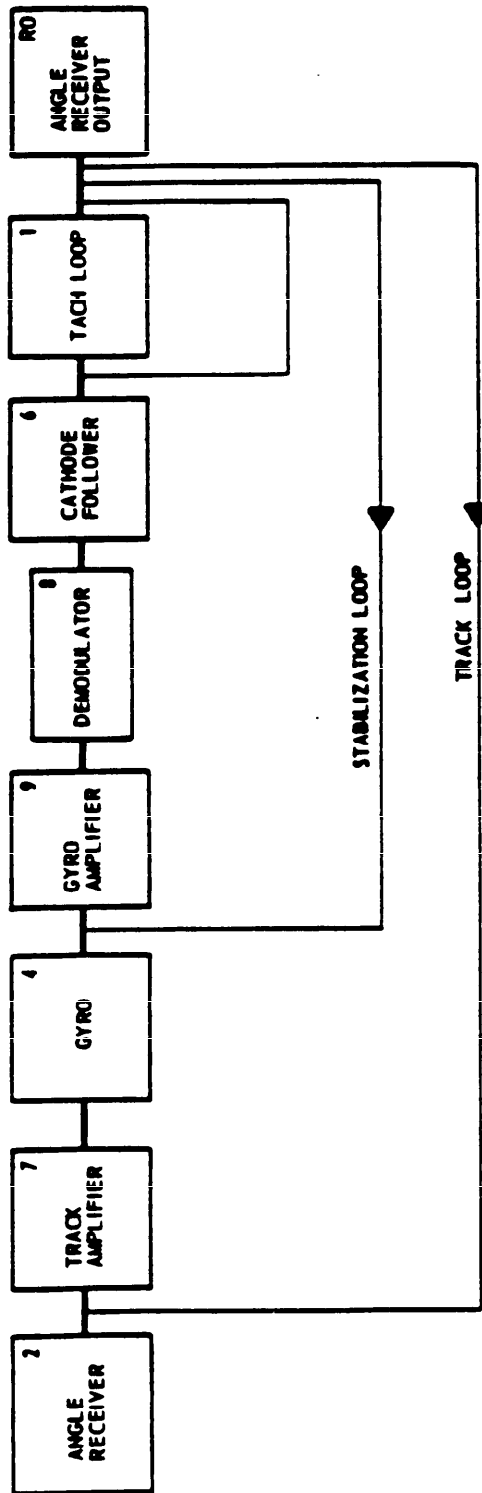


FIGURE 57. Signal flow diagram feedback loop.

MIL-M-24784(SH)

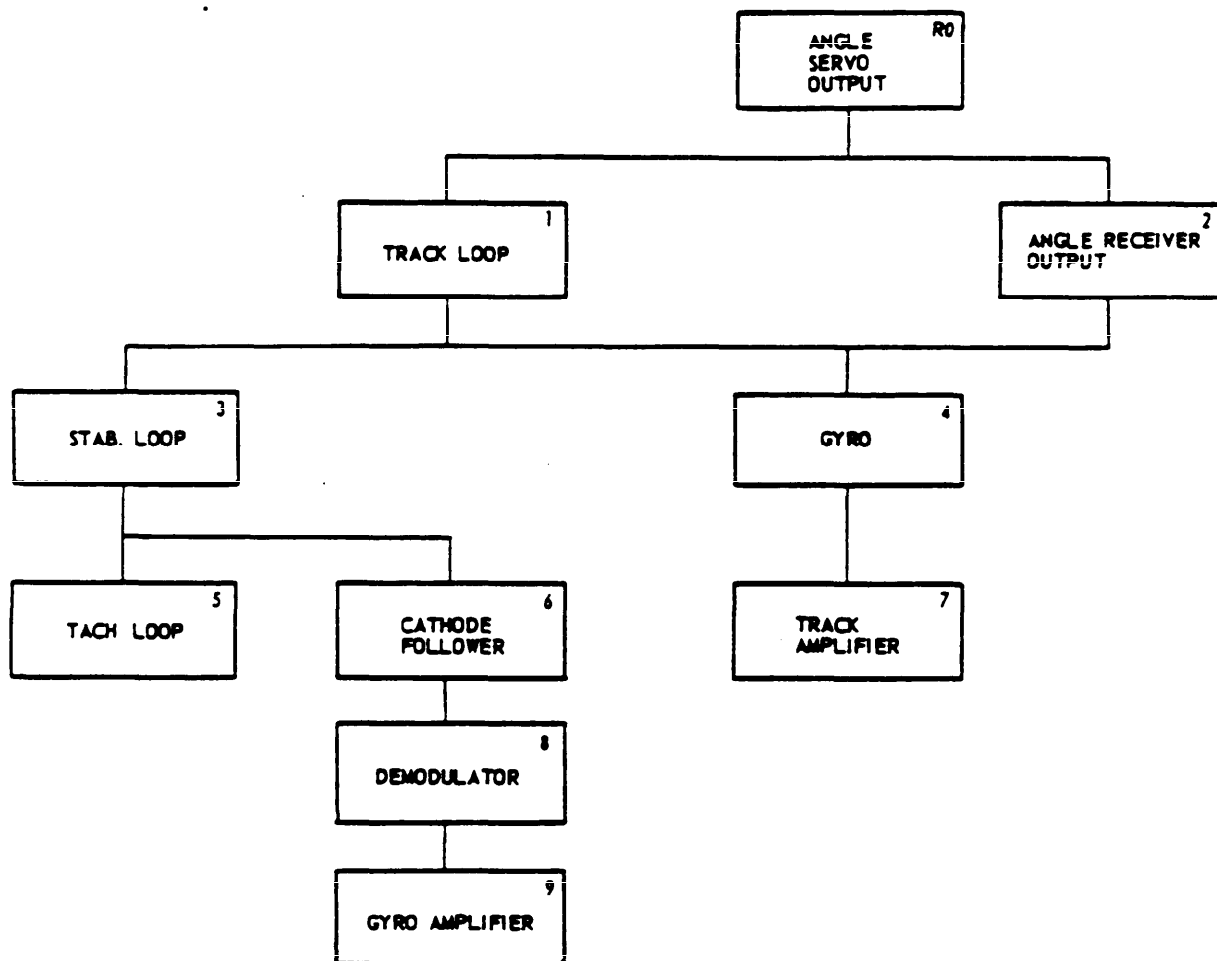
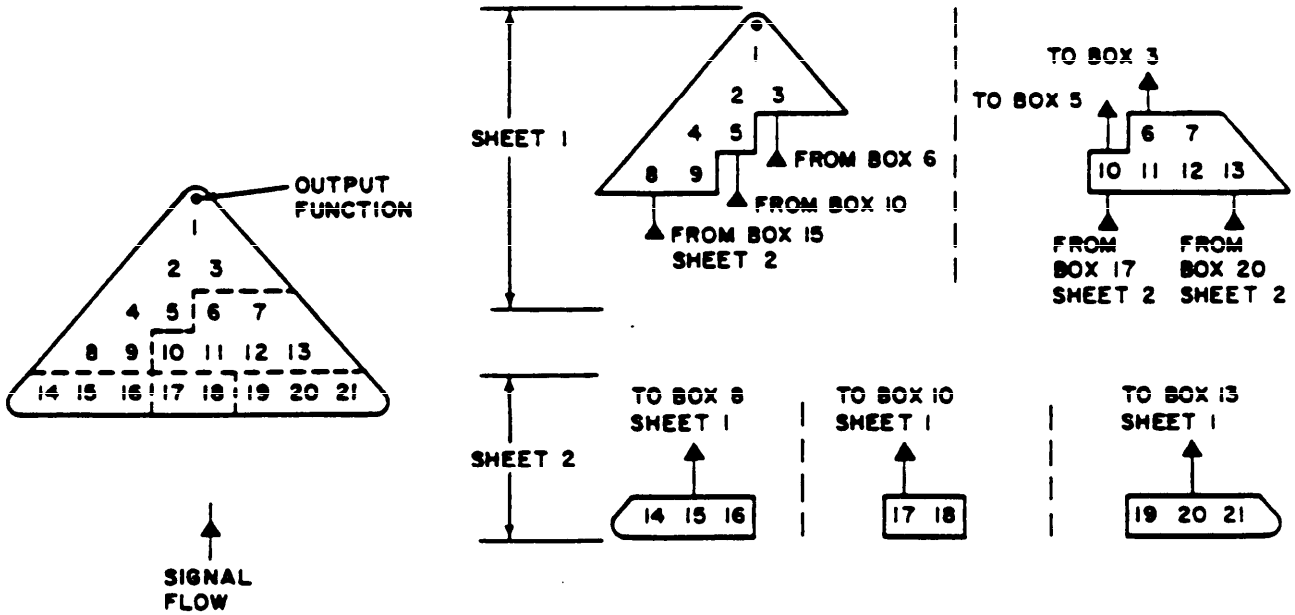


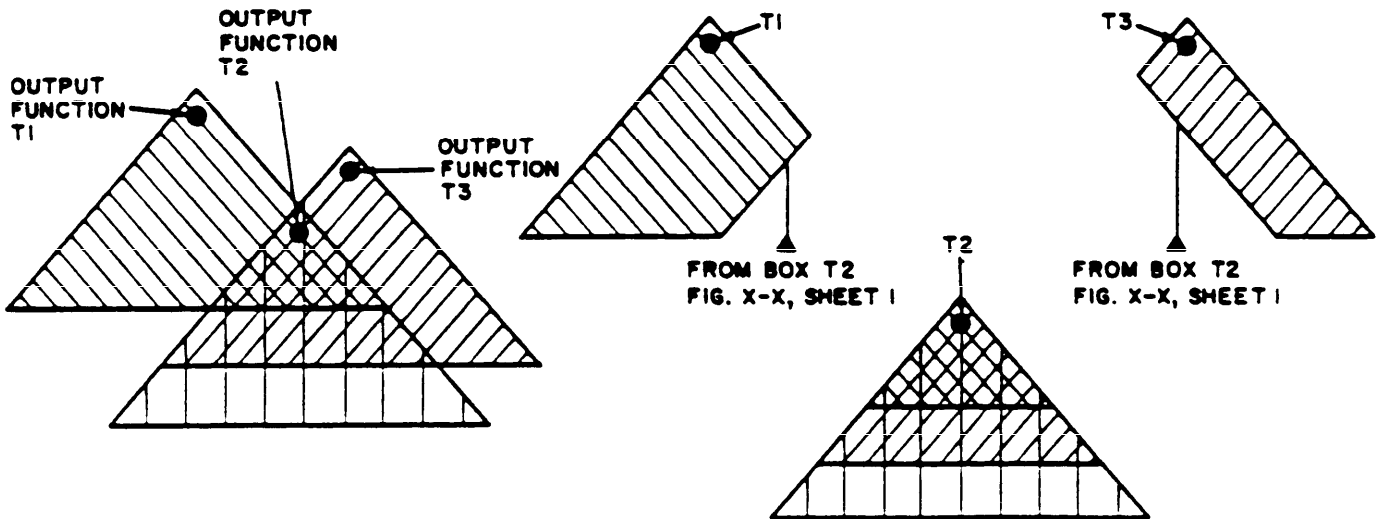
FIGURE 58. Pyramid feedback loop, detailed.



MIL-M-24784 (SH)



CASE A1: SEPARATION OF A SINGLE PYRAMID INTO PORTIONS ON SAME OR SEPARATE SHEETS.



NOTE  
 BOXES WITH IDENTICAL TITLES AND INFORMATION  
 WILL BE REPEATED ON EACH DIAGRAM, BUT THE  
 BOX NUMBERS SHALL CONFORM TO THOSE ON  
 THEIR RESPECTIVE DIAGRAMS.

CASE A2: INTERRELATED OUTPUT FUNCTIONS.

FIGURE 59. Pyramid interrelationship cross-referencing.





MIL-M-24784(SH)

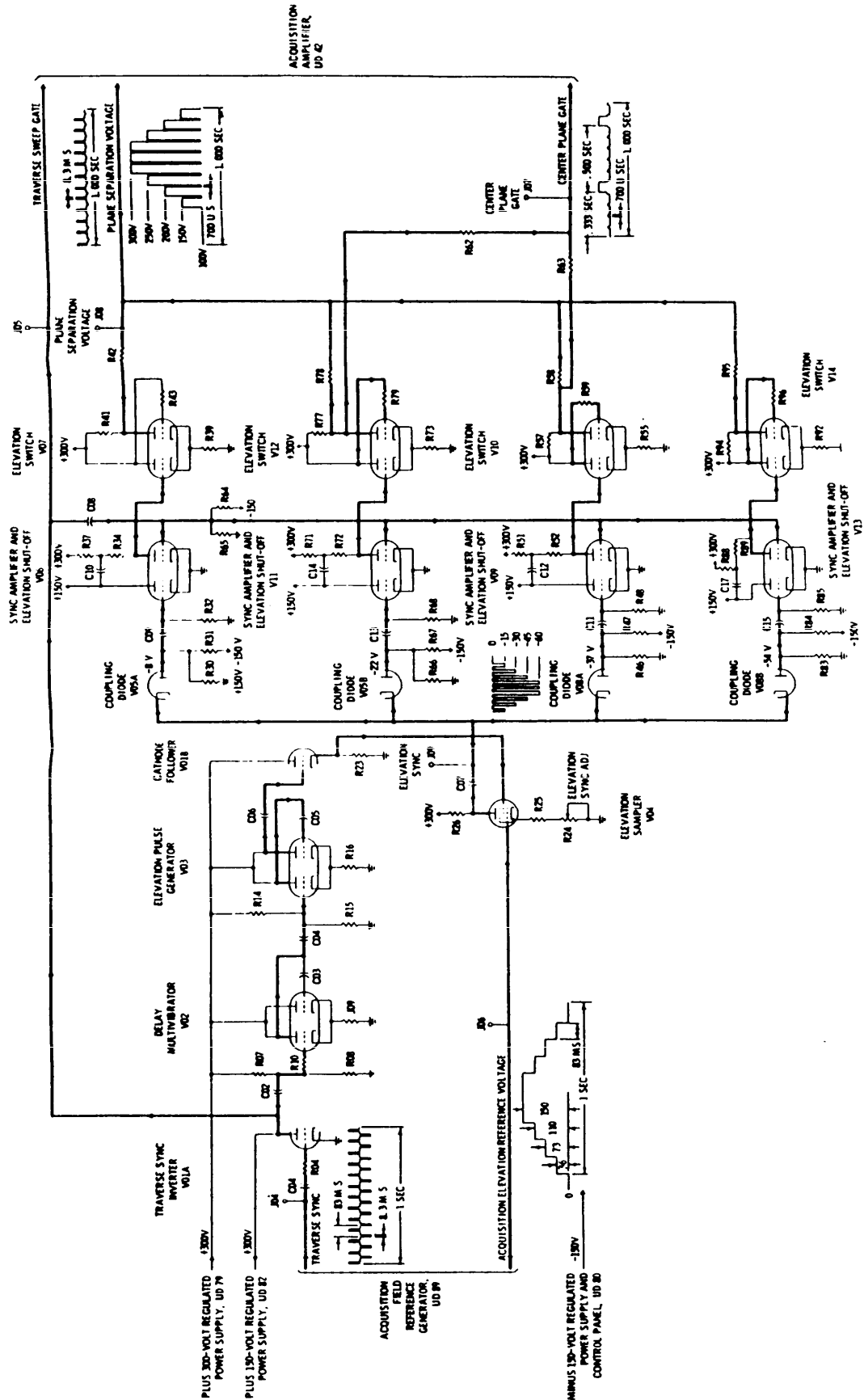


FIGURE 62. Electronic schematic diagram. (Simplified)

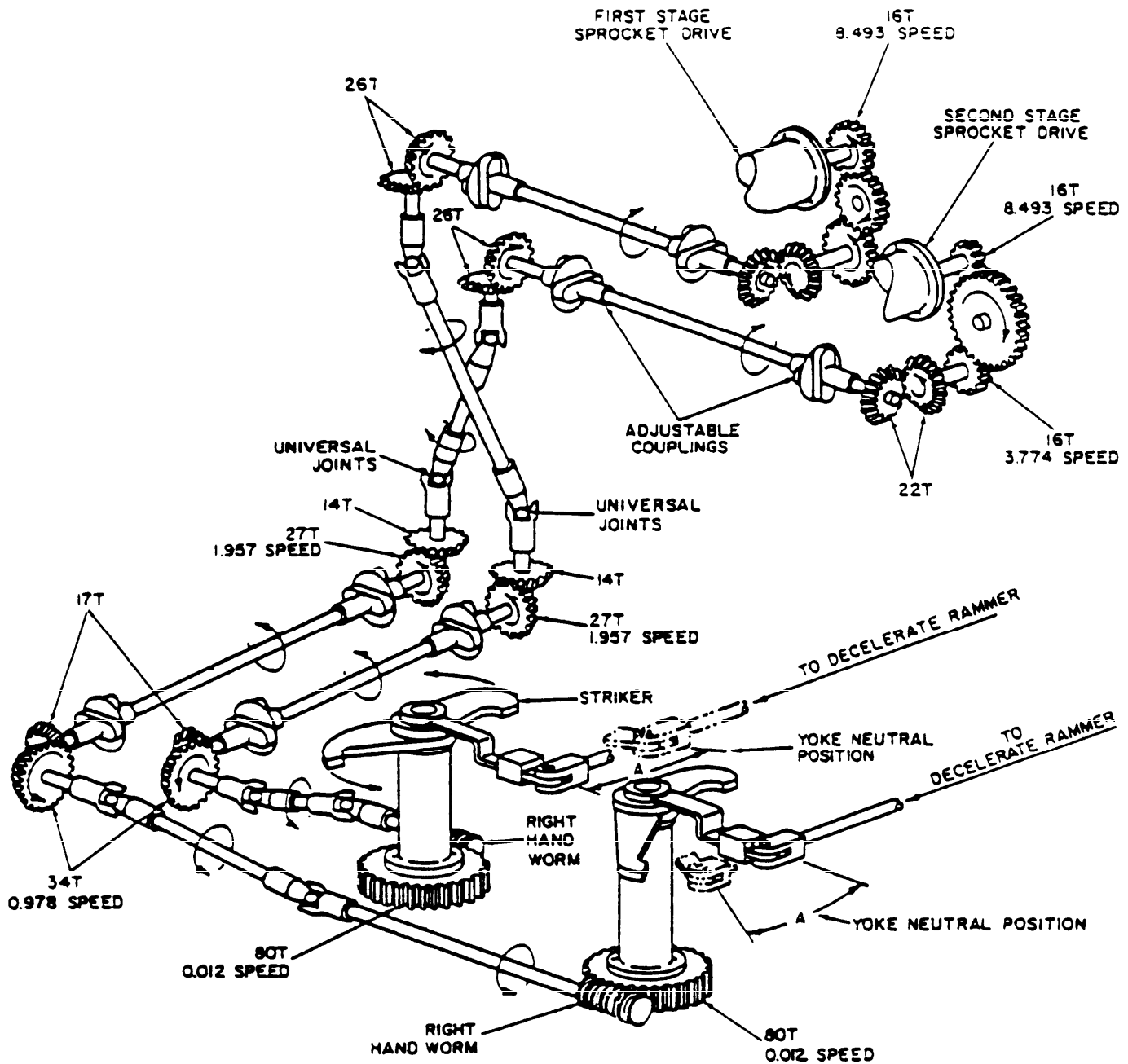


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FIGURE 64.

MIL-M-24784 (SH)



## NOTES:

ARROWS INDICATE DIRECTION OF  
ROTATION FOR RAMMING  
A=15 DEGREES

FIGURE 65. Mechanical schematic diagram.

MIL-M-24784 (SH)

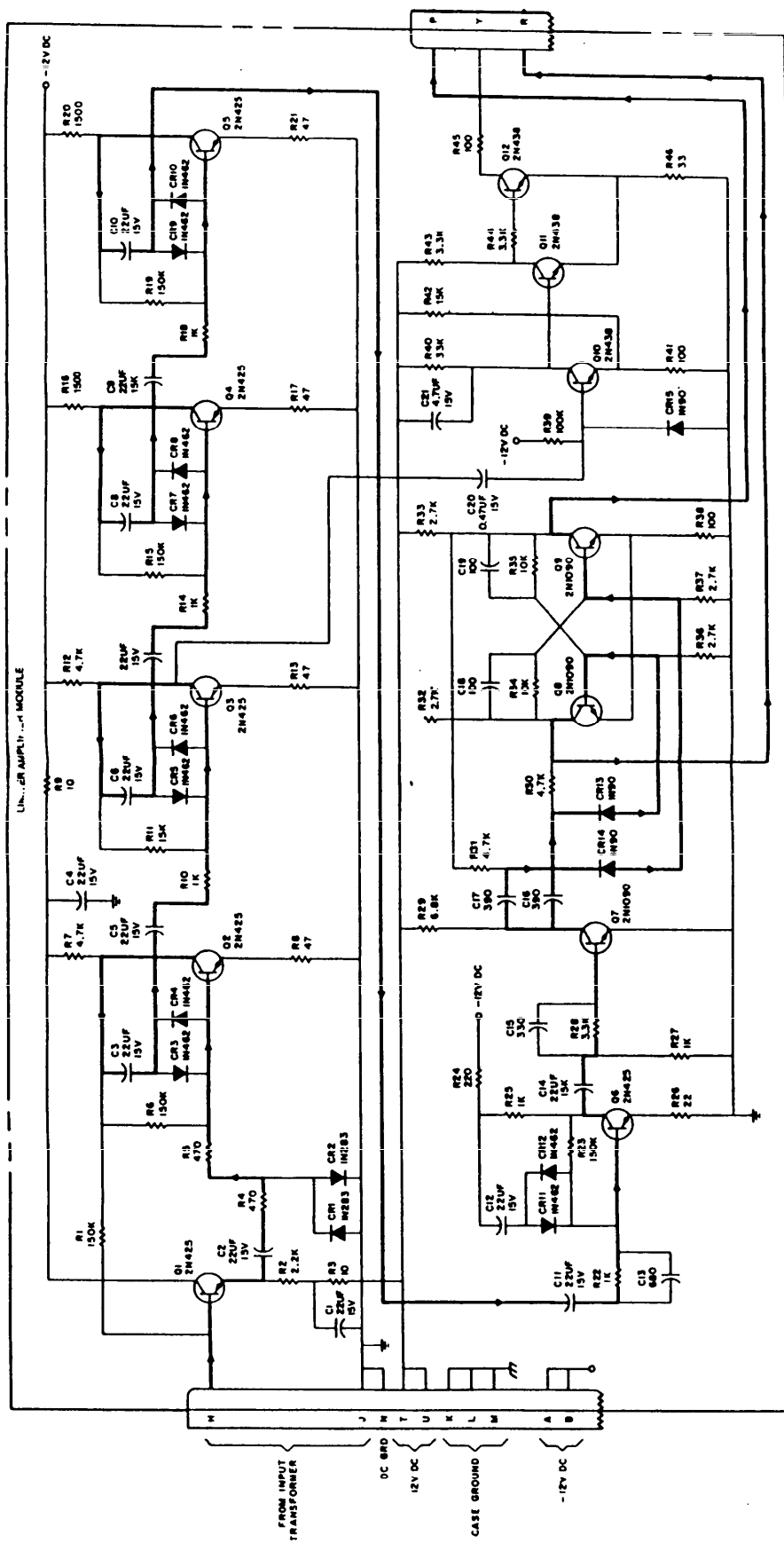


FIGURE 66. Maintenance schematic diagram.





MIL-M-24784 (SH)

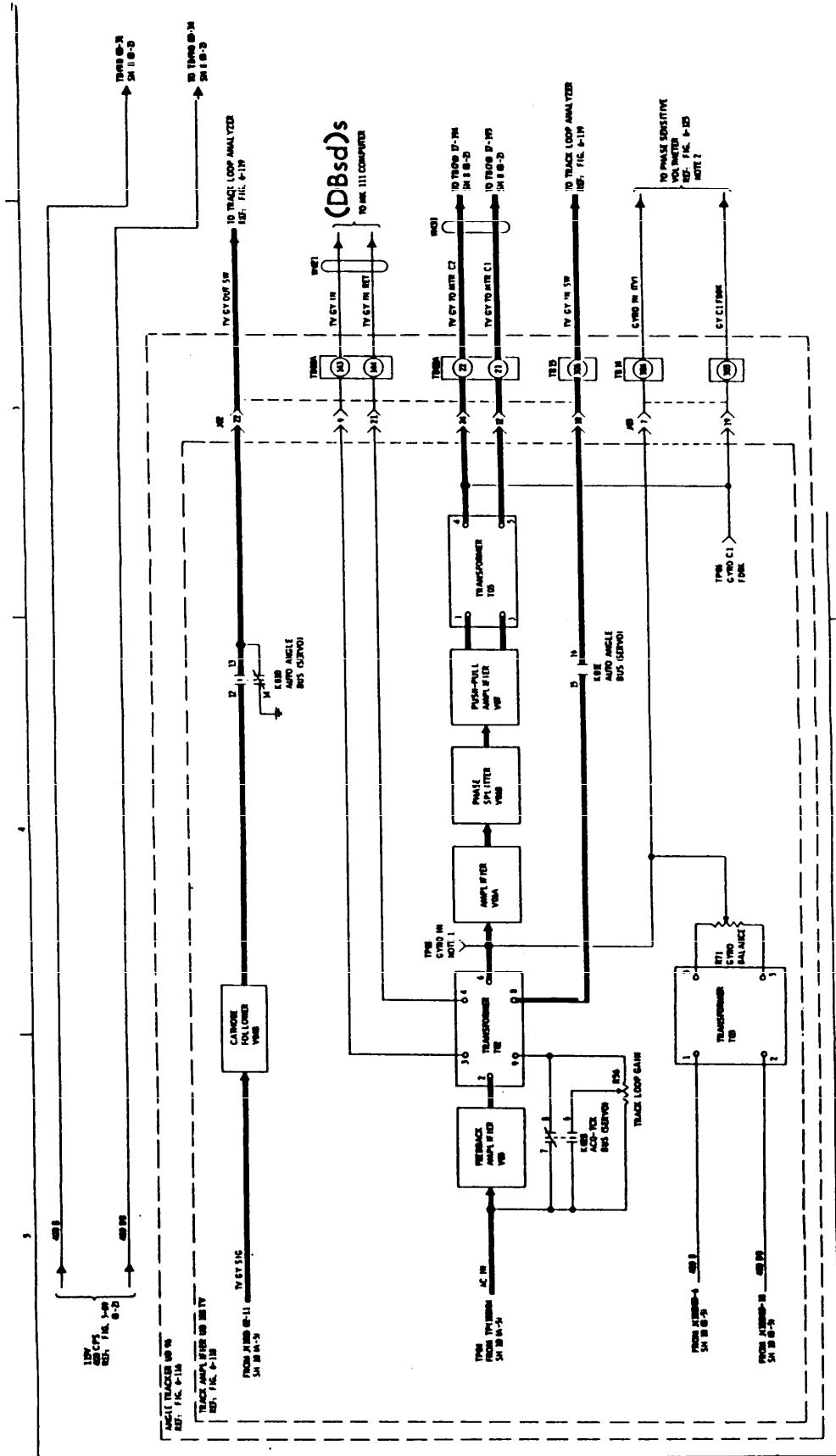


FIGURE 68. Signal flow diagram, physical dependency type.



MIL-M-24784(SH)

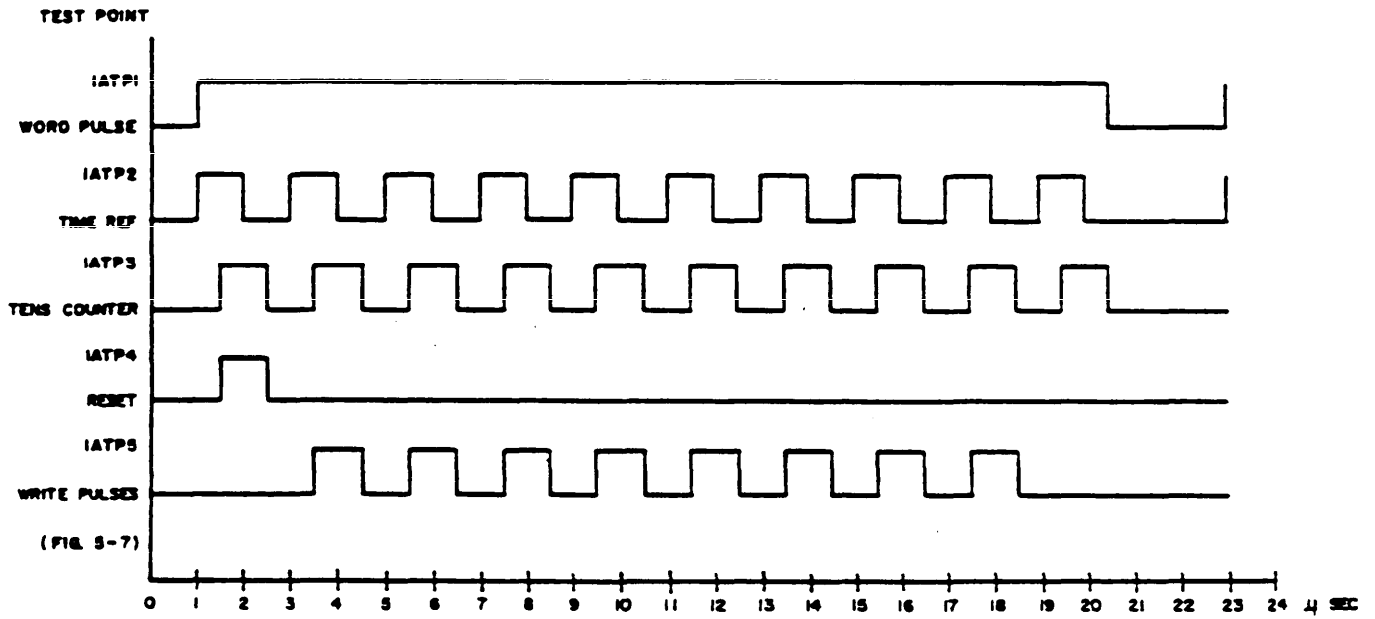
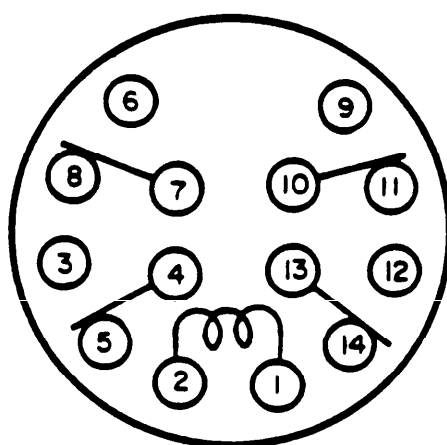


FIGURE 71. Timing circuits diagram.

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K(260-05)3

FIGURE 70. Relay pin identification diagram. (Sample)

MIL-M-24784(SH)

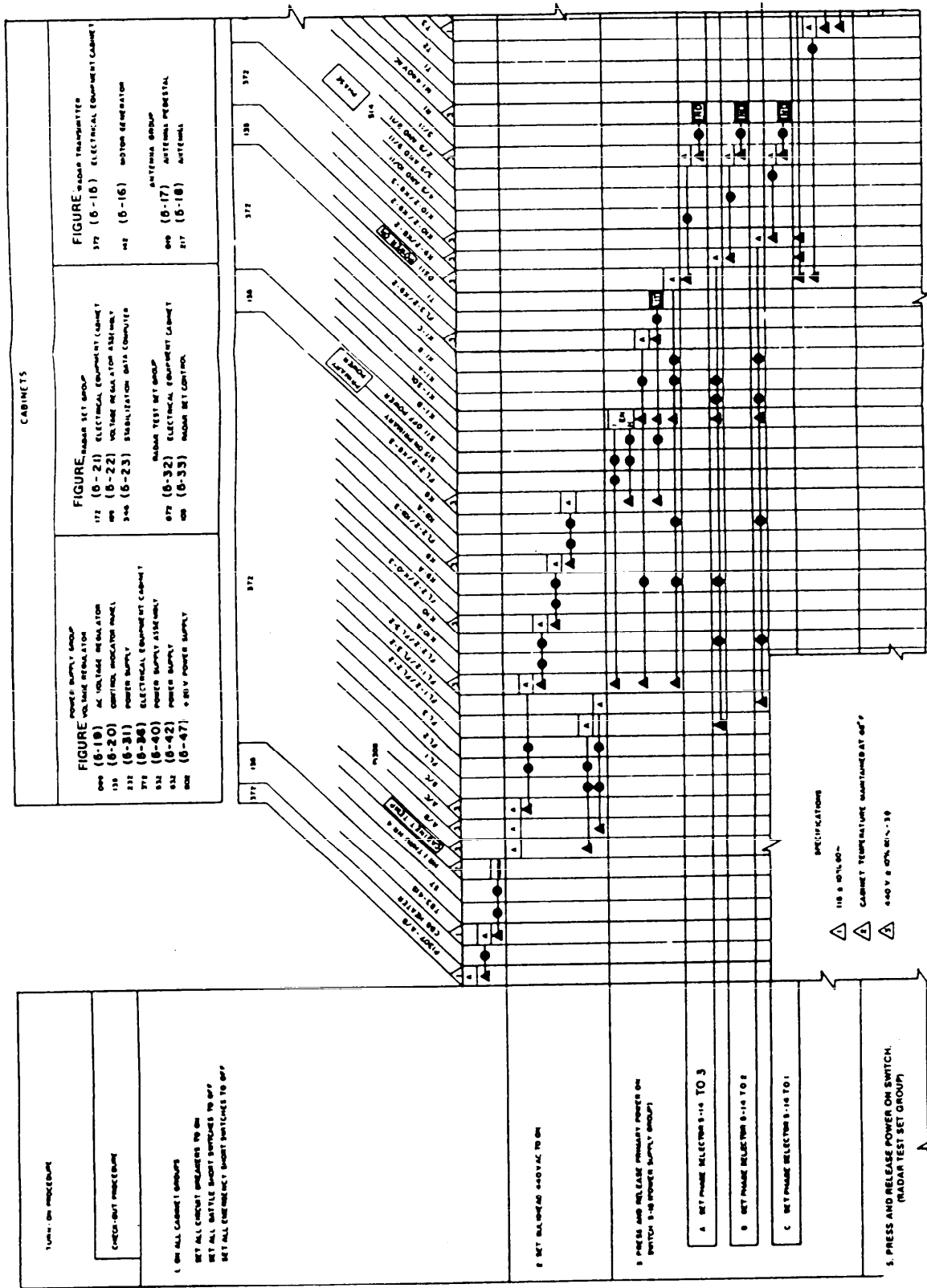


FIGURE 72. Troubleshooting maintenance dependency matrix chart.

MIL-M-24784(SH)

## Legend for figure 1-1:

- |   |                                     |
|---|-------------------------------------|
| 1. Screw, fil-hd, 4-40<br>x 1/2         | 8. Indicator light<br>glass         |
| 2. Plate                                | 9. Maltese cross<br>indicator light |
| 3. Lockwasher, internal<br>star, 1/4 in | 10. Screw                           |
| 4. Trigger guard                        | 11. Battery testing<br>button       |
| 5. Relay                                | 12. Wiring harness                  |
| 6. Connector                            | 13. Screw                           |
| 7. Indicator light shell                |                                     |

Figure 1-1. GCU Wiring Tester-Exploded View (illustration  
identification number)

FIGURE 73. Cutline with legend. (Example)

**INSTALLATION CYCLE--**

**SINGLE ACTION INSTALLATION**



**Step 2.** Head of pin upsets sleeve to form a strong, bulbbed head on blind side.



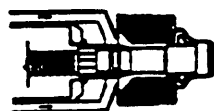
**Step 1.** During initial part of driving operation, the sleeve is squeezed between head of pin and nose of rivet tool.



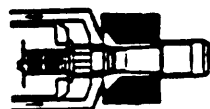
**Step 4.** Pin is broken off in tension at breakneck groove, substantially flush with head of sleeve. There is no projecting pin left to be cut off in a separate operation.

**INSTALLATION CYCLE--**

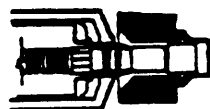
**DOUBLE ACTION INSTALLATION (5/32 and 3/16 diameter only)**



**Step 2.** Head of pin upsets sleeve to form a strong, bulbbed head on blind side.



**Step 1.** During initial part of driving operation, the sleeve is squeezed between head of pin and nose of rivet tool.



**Step 4.** Pin is broken off in tension at breakneck groove, substantially flush with head of sleeve. There is no projecting pin left to be cut off in a separate operation.



**Step 3.** When blind head has been formed, the tool automatically forces locking collar (at primall end of sleeve) into conical space between recess in head and locking groove in pin. This locks parts together permanently.

**TYPICAL NOMINAL INSTALLATION**

FIGURE 74. Procedural illustration. (Sample)



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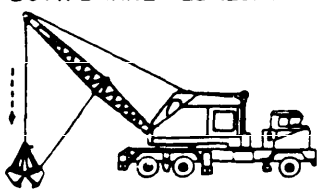
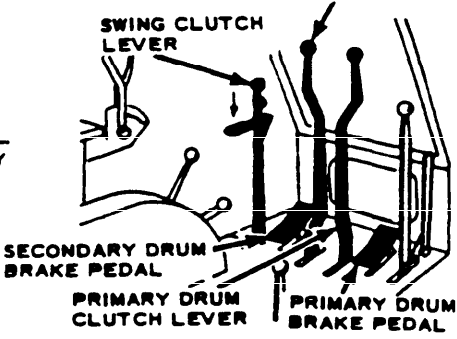
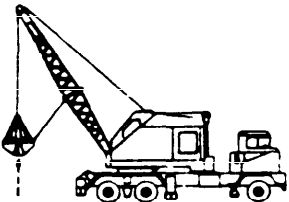
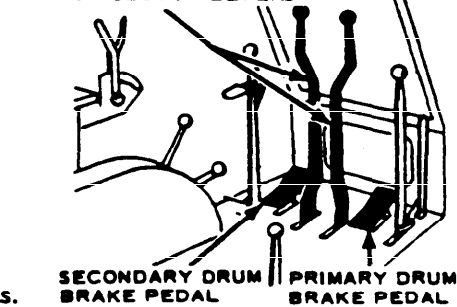
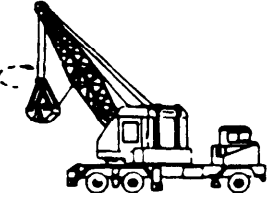
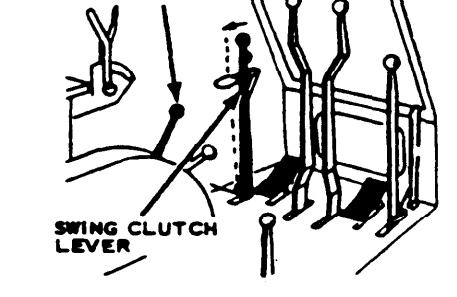
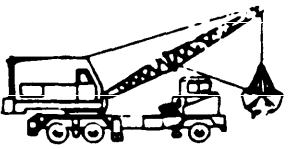
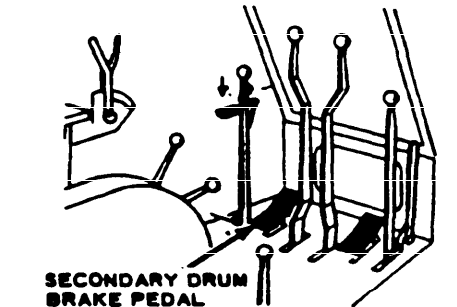
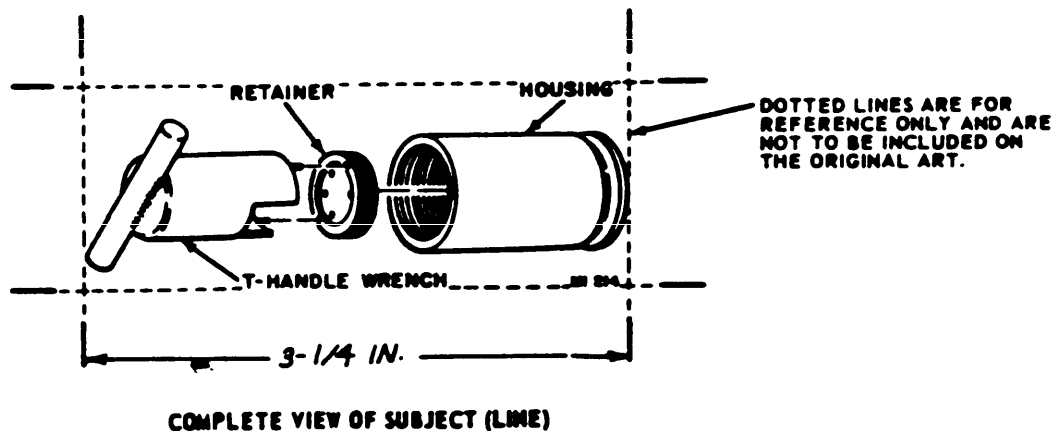
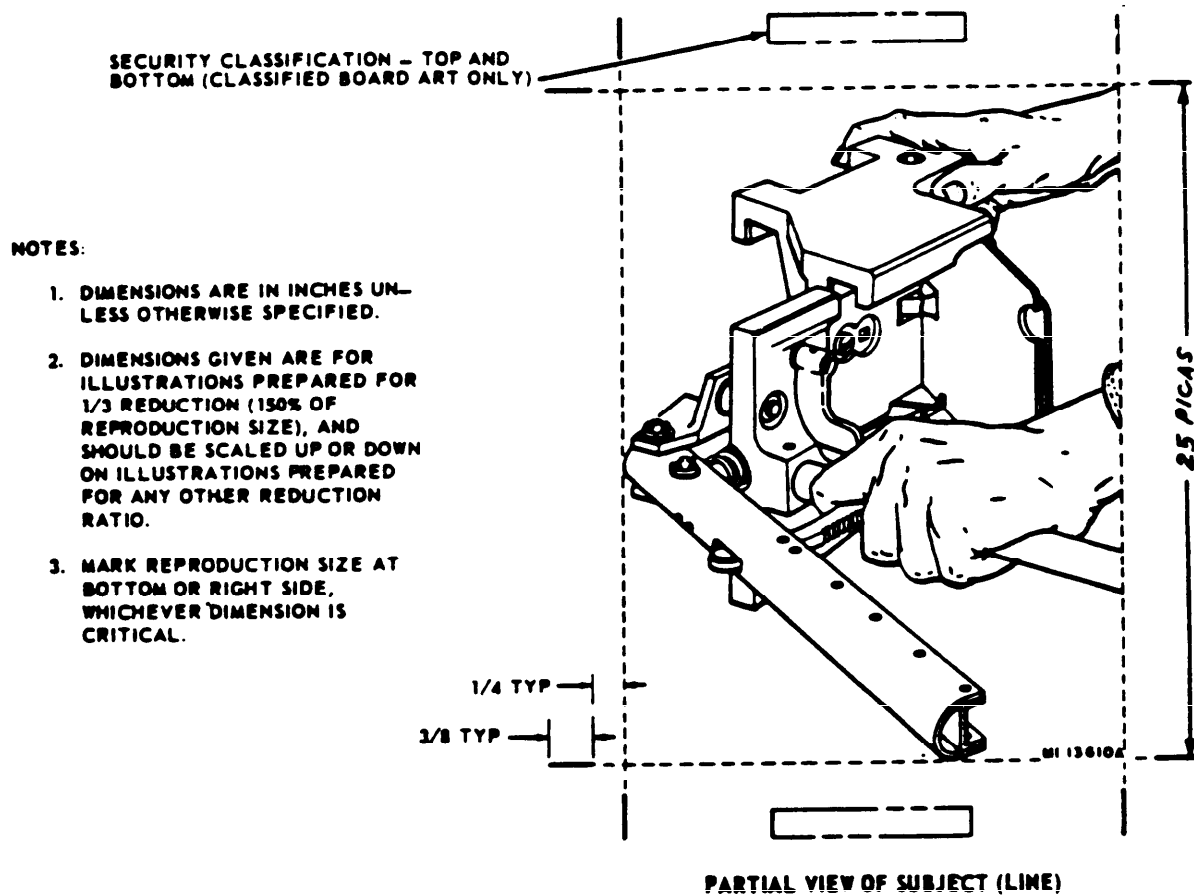
<p><b>FILLING THE CLAMSHELL</b></p>	<p>PULL BACK ON THE DRUM CLUTCH LEVERS UNTIL THE CLAMSHHELL BUCKET IS HIGH ENOUGH TO CLEAR THE MATERIAL BEING MOVED, THEN PUSH THE DRUM CLUTCH LEVERS TO NEUTRAL POSITION, APPLYING BOTH BRAKE PEDALS. SWING CLAMSHHELL OVER MATERIAL.</p>	<p>SECONDARY DRUM CLUTCH LEVER</p>
	<p>RELEASE THE SECONDARY DRUM BRAKE PEDAL TO OPEN CLAMSHHELL BUCKET, THEN RELEASE PRIMARY DRUM BRAKE PEDAL TO LOWER CLAMSHHELL BUCKET ONTO MATERIAL.</p>	 <p>SWING CLUTCH LEVER SECONDARY DRUM BRAKE PEDAL PRIMARY DRUM CLUTCH LEVER PRIMARY DRUM BRAKE PEDAL</p>
<p><b>CLOSING AND HOISTING</b></p>	<p>TO CLOSE THE CLAMSHHELL BUCKET PULL BACK ON THE SECONDARY DRUM CLUTCH LEVER. HOLD THE LEVER UNTIL THE BUCKET IS FILLED WITH MATERIAL AND CLOSED. WHEN THE BUCKET IS CLOSED, RELEASE THE PRIMARY DRUM BRAKE PEDAL AND PULL THE PRIMARY DRUM CLUTCH LEVER BACK. HOLD BOTH LEVERS BACK UNTIL THE LOAD HAS REACHED THE DESIRED HEIGHT.</p>	<p>PRIMARY AND SECONDARY DRUM CLUTCH LEVERS</p>
	<p>RETURN BOTH DRUM CLUTCH LEVERS TO NEUTRAL AND AT THE SAME TIME APPLY BOTH DRUM BRAKE PEDALS.</p>	 <p>SECONDARY DRUM BRAKE PEDAL PRIMARY DRUM BRAKE PEDAL</p>
<p><b>SWINGING</b></p>	<p>PUSH THE SWING CLUTCH LEVER FORWARD TO SWING THE CRANE TO THE LEFT. PULL IT TO THE REAR TO GO TO THE RIGHT. SWING SLOWLY AND EVENLY TO AVOID BUCKET WHIPPING. WHEN HANDLING FINE MATERIALS KEEP LOAD ON SECONDARY LINE BUT COORDINATE PRIMARY DRUM TO AVOID EXCESSIVE SLACK IN PRIMARY LINE.</p>	<p>SWING BRAKE</p>
		 <p>SWING CLUTCH LEVER</p>
<p><b>DUMPING</b></p>	<p>TO DUMP THE BUCKET, RELEASE THE SECONDARY DRUM BRAKE PEDAL.</p>	
		 <p>SECONDARY DRUM BRAKE PEDAL</p>

FIGURE 75. Operational view/illustration. (Sample)

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FIGURE 76. Cropping and sizing of illustrations.

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TO ~~XX-XXXX-XX~~

## CHAPTER 16

## SIGHTING AND FIRE CONTROL EQUIPMENT

## SECTION III. ALIGNMENT

16.1 ORIENTATION.

16.1.1 General. The azimuth oil gear M3 features self-synchronous operation and self-contained hydraulic stops for elevation.

16.1.2 Azimuth Gear. The azimuth oil gear M3 (figure 16-4) shall be oriented as follows:

- a. Level the gun carriage by setting the elevation indicator to 0.

## NOTE

The azimuth boresight clutch may stick in position. Moving the carriage left and right will free the clutch.

- b. Open the azimuth boresighting clutch by moving the boresighting level to the UP position.

Figure/Table 16-4. Azimuth Oil Gear M3.

Cutline

- c. Depress the power synchronizing mechanism to start the oil gear.

16-1

FIGURE 77. Illustration/text cutline. (Example)

MIL-M-24784(SH)

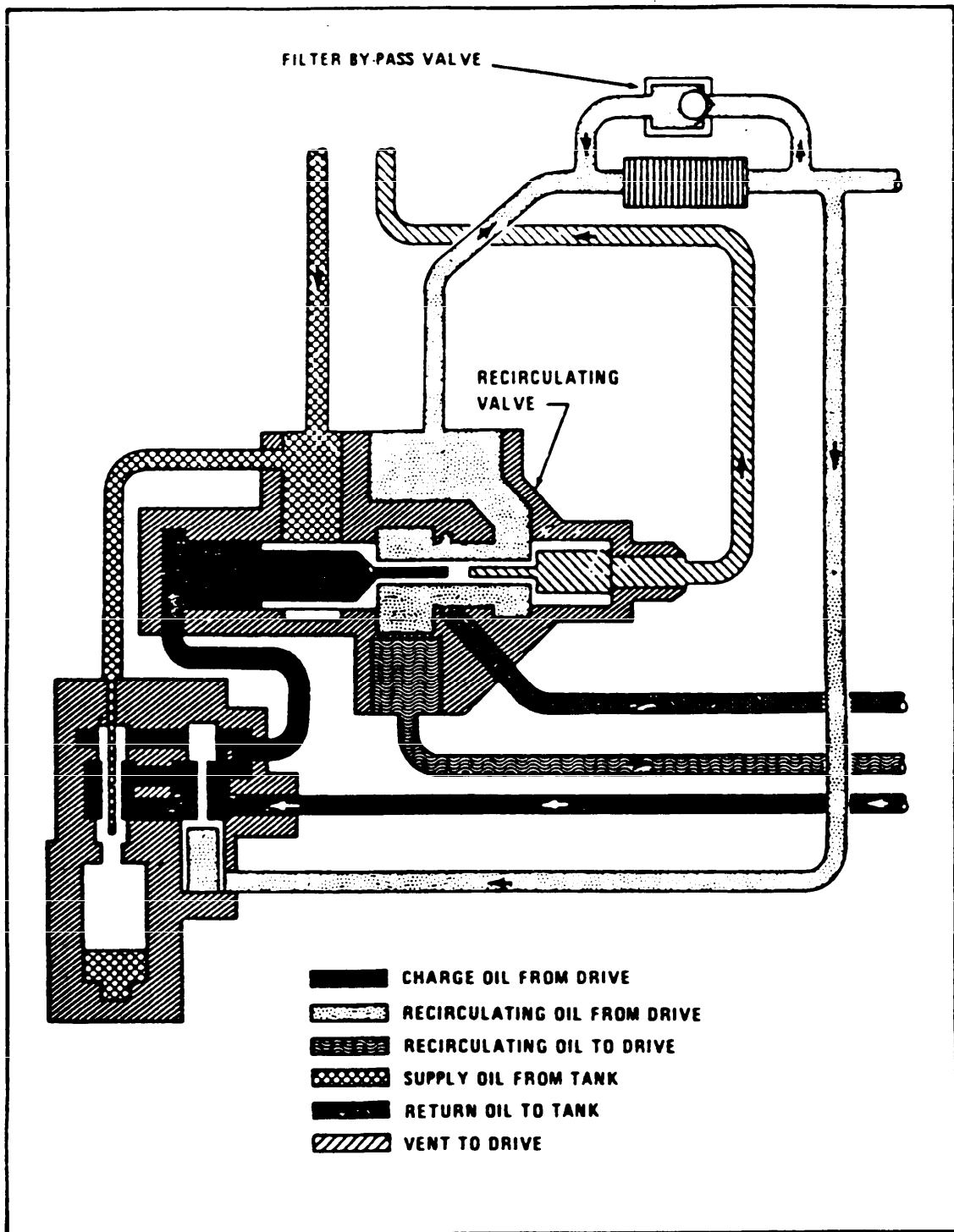


FIGURE 78. Use of patterns instead of colors.

MIL-M-24784(SH)

**A—FIRE EXTINGUISHER LINES, CHECK VALVES AND FITTINGS—REMOVAL OR INSTALLATION**

DISCONNECT LINES AND TUBING AT CONNECTING FITTINGS, CHECK VALVES, TIME DELAY VALVE, AND MANIFOLDS. REMOVE CLAMPS SECURING LINES. REMOVE LINES.

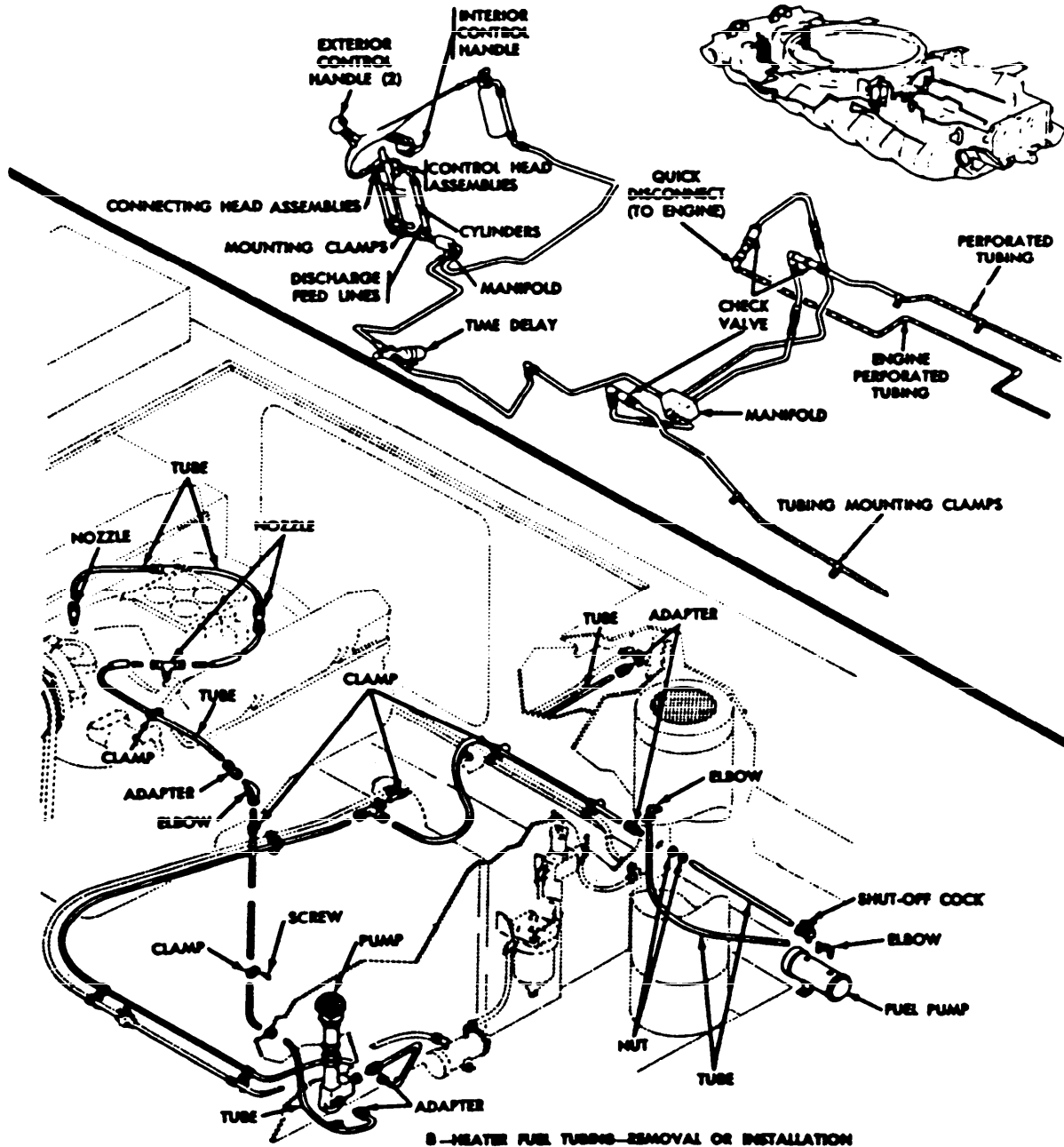


FIGURE 79. Functional illustration-location view. (Sample)

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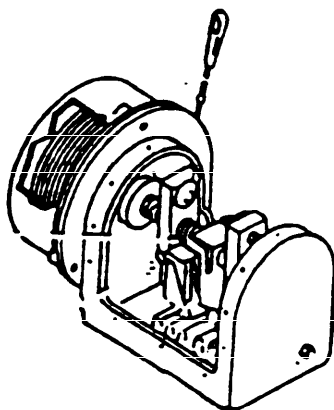
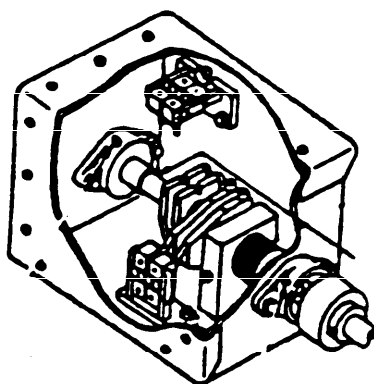


FIGURE 80. Cutaway illustration. (Sample)

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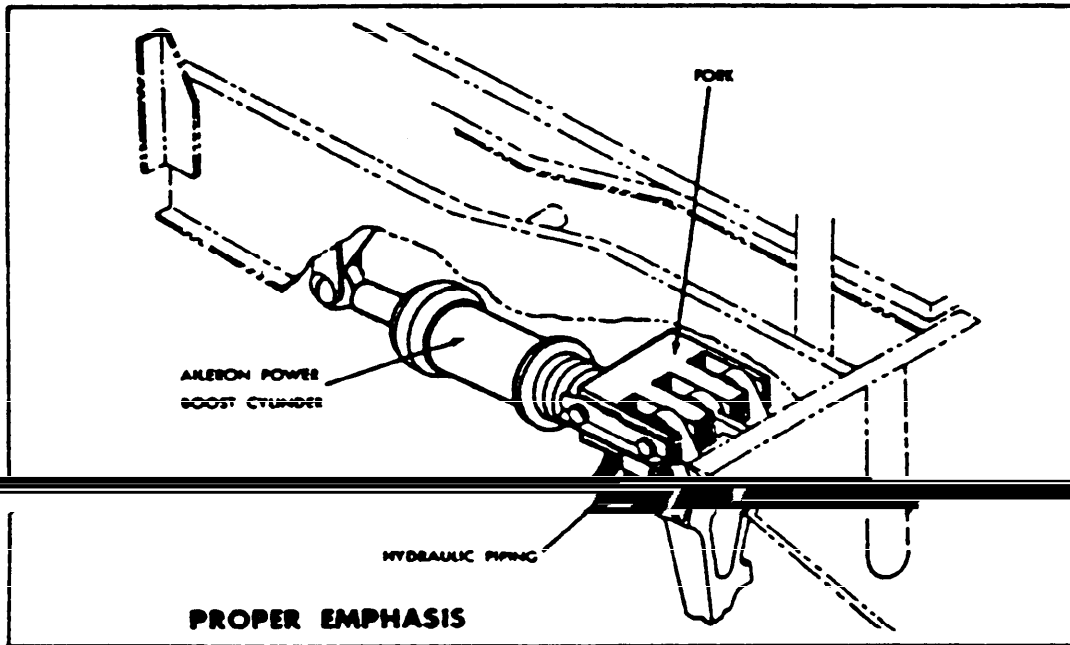
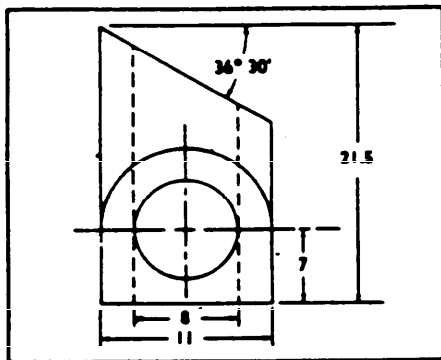
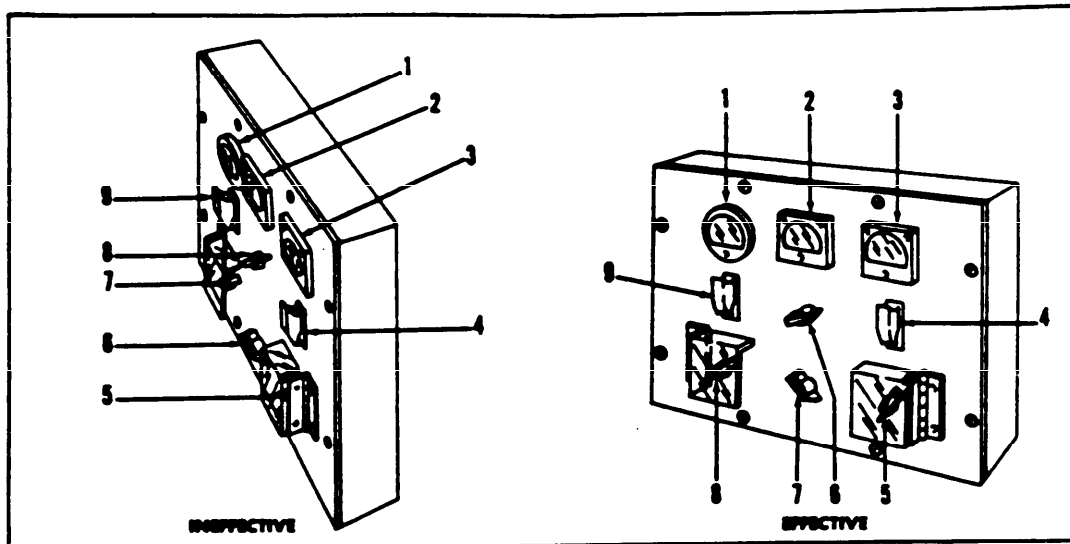
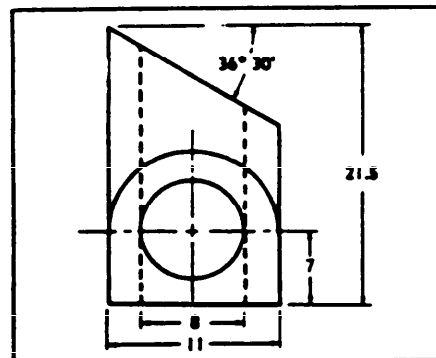


FIGURE 81. Emphasis and subordination of detail.

MIL-M-24784(SH)



ALL LINES OF EVEN WEIGHT

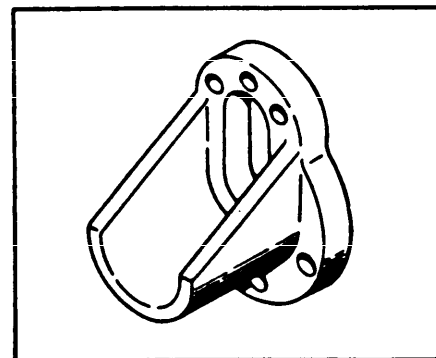


MAIN OUTLINE HEAVY, SECONDARY AND DIMENSION LINES LIGHTER



EXCESSIVE SHADING THAT DESTROYS FORM

BAD EXAMPLES



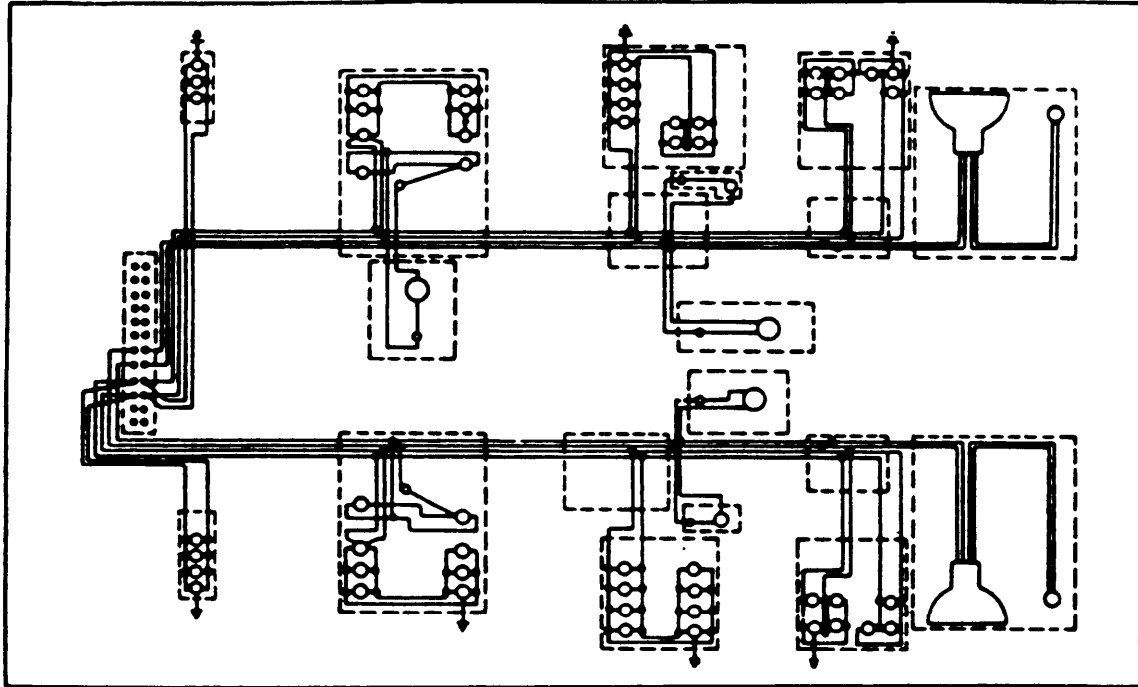
SUFFICIENT SHADING FOR DIMENSIONAL EFFECT

GOOD EXAMPLES

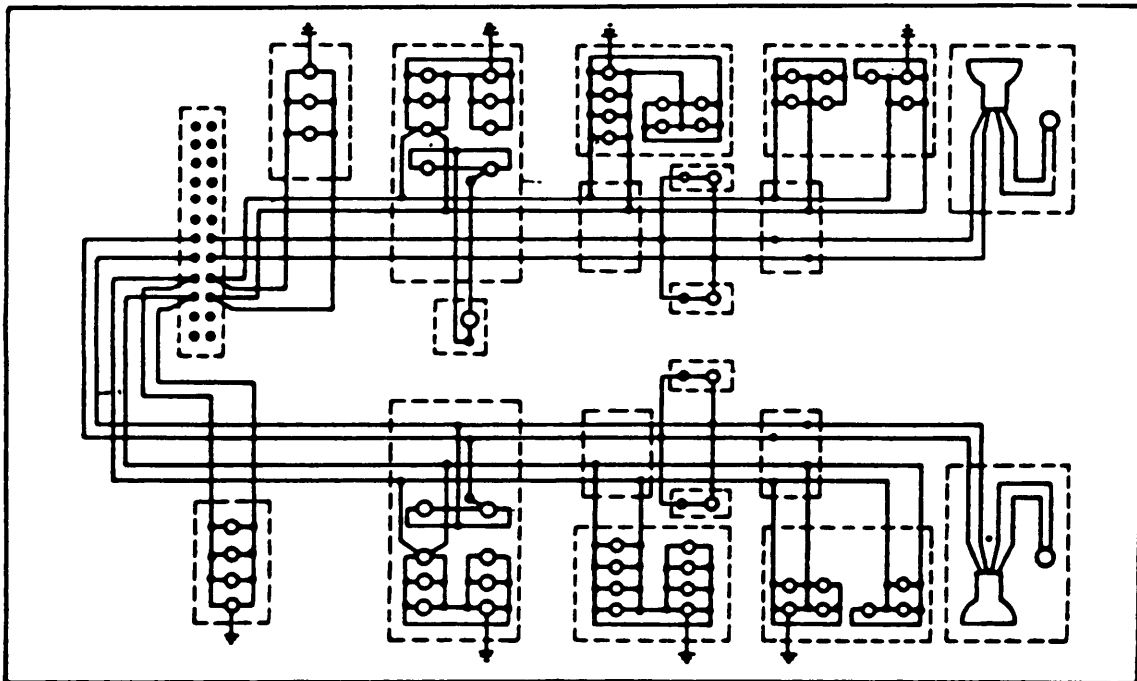
FIGURE 82. Angle view, line weight and shading. (Example)



MIL-M-24784 (SH)



**Congested Schematic—Hard to Read**



**Neat Schematic—Easy to Read**

FIGURE 83. Line separation on diagrams.

MIL-M-24784(SH)

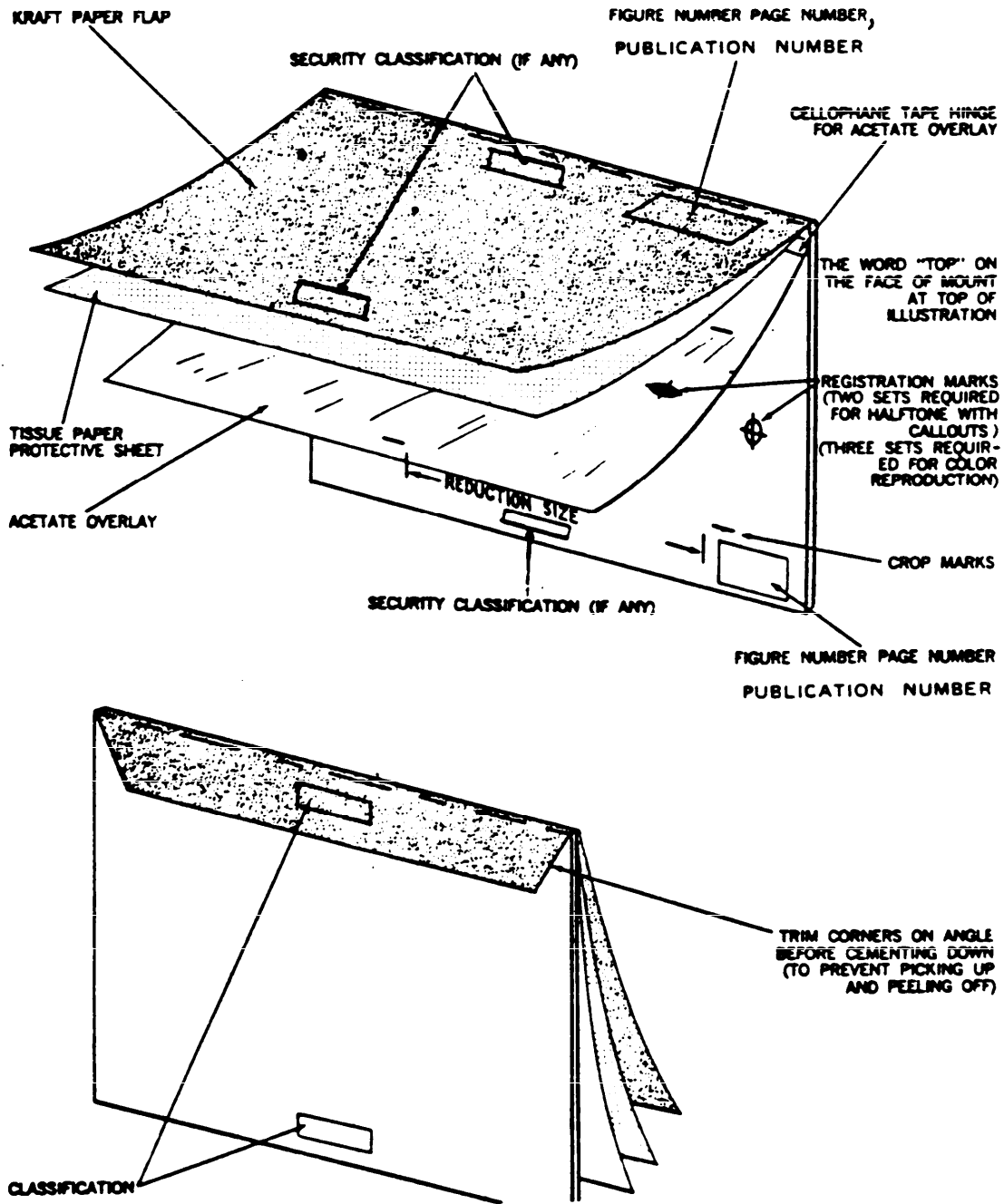


FIGURE 84. Identification, marking, and protective covering of artwork.

MIL-M-24784(SH)

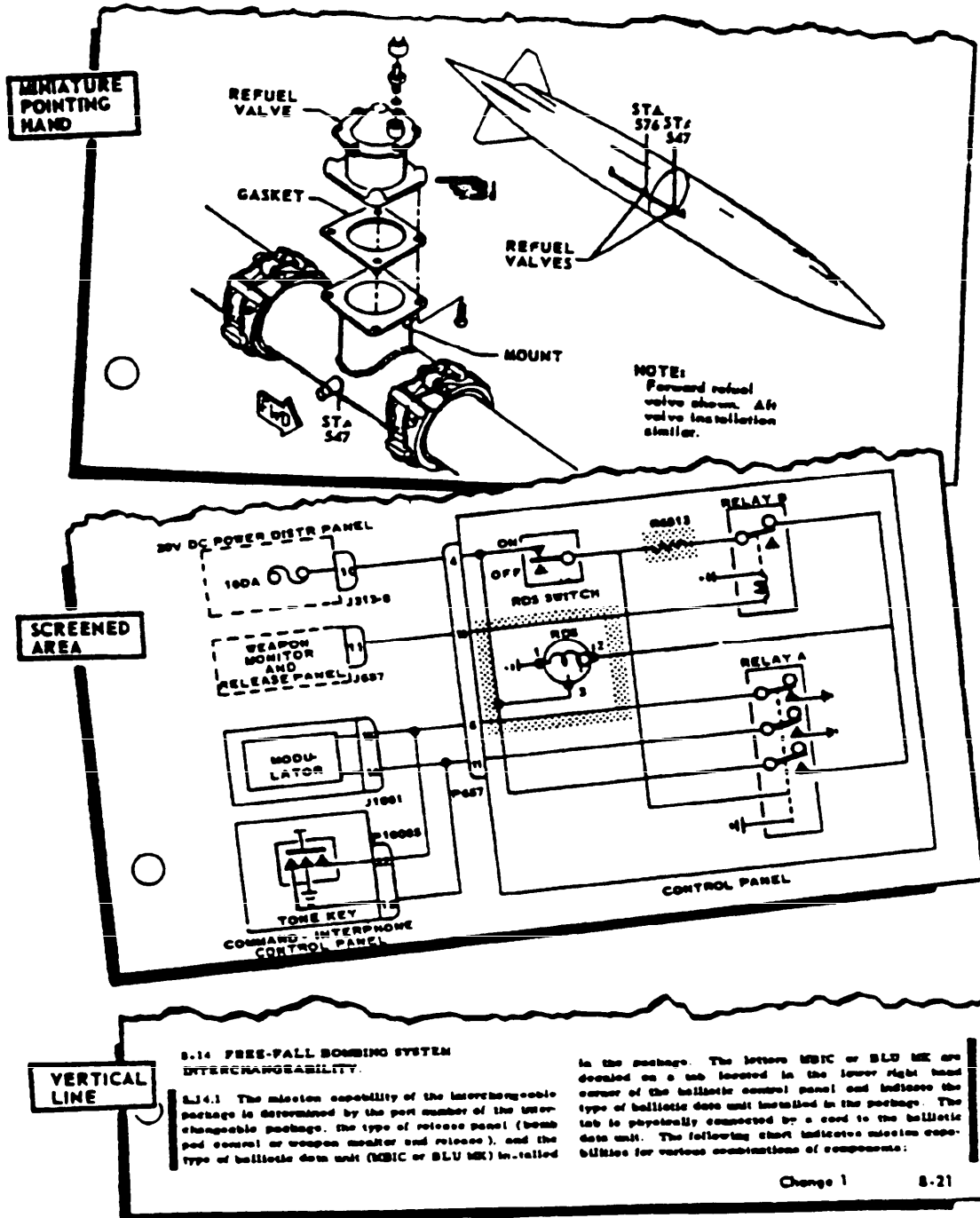


FIGURE 85. Change symbols. (Example)

MIL-M-24784(SH)

T.O. XX-XXX-X-XX

**L9 PRIMARY SIDEHEAD.**

**1.9.1 First Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output. Text following a subordinate sidehead to fill two lines of output.

**1.9.1.1 Second Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output. Text following a subordinate sidehead to fill two lines of output.

**1.9.1.1.1 Third Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output. Text following a subordinate sidehead to fill two lines of output.

**L10 PRIMARY SIDEHEAD FOLLOWED BY PROCEDURAL STEPS.**

a. **First Level Procedural Step.** No title. Block indented under first word of paragraph.

(1) **Second Level Procedural Step.** No title. Block indented under first word of paragraph.

(a) **Third Level Procedural Step.** No title. Block indented under first word of paragraph.

1 **Fourth Level Procedural Step.** No title. Block indented under first word of paragraph.

a **Fifth Level Procedural Step.** No title. Block indented under first word of paragraph.

(1) **Sixth Level Procedural Step.** No title. Block indented under first word of paragraph.

(a) **Seventh Level Procedural Step.** No title. Block indented under first word of paragraph.

**L11 PRIMARY SIDEHEAD.**

**L11.1 First Subordinate Sidehead.** Followed by procedural steps.

a. **First Level Procedural Step.** No title. Block indented under first word of paragraph.

(1) **Second Level Procedural Step.** No title. Block indented under first word of paragraph.

(a) **Third Level Procedural Step.** No title. Block indented under first word of paragraph.

**L12 PRIMARY SIDEHEAD.**

**L12.1 First Subordinate Sidehead.** Followed by a paragraph with text.

**L12.1.1 Second Subordinate Sidehead.** Followed by procedural steps.

a. **First Level Procedural Step.** No title. Block indented under first word of paragraph.

(1) **Second Level Procedural Step.** No title. Block indented under first word of paragraph.

(a) **Third Level Procedural Step.** No title. Block indented under first word of paragraph.

**L13 PRIMARY SIDEHEAD.**

**L13A INSERT PRIMARY SIDEHEAD.**

**L13B INSERT PRIMARY SIDEHEAD.**

**L14 PRIMARY SIDEHEAD.**

**L14.1 First Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.1A Insert First Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.1B Insert First Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.2 First Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.2.1 Second Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.2.1A Insert Second Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.2.1B Insert Second Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

**L14.2.2 Second Subordinate Sidehead.** Text following a subordinate sidehead to fill two lines of output.

Change 1 1-3

FIGURE 86. Decimal paragraph numbering. (Example) (Sheet 1 of 2)

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T.O. XX-XXX-X-XX

1.14.2.2.1 Third Subordinate Sidehead. Text following a subordinate sidehead to fill two lines of output.

1.14.2.2.1A Insert Third Subordinate Sidehead. Text following a subordinate sidehead to fill two lines of output.

1.14.2.2.1B Insert Third Subordinate Sidehead. Text following a subordinate sidehead to fill two lines of output.

1.14.2.2.2 Third Subordinate Sidehead. Text following a subordinate sidehead to fill two lines of output.

- a. First Level Procedural Step. No title. Block indented under first word of paragraph.
- a1. Insert First Level Procedural Step. No title. Block indented under first word of paragraph.
- a2. Insert First Level Procedural Step. No title. Block indented under first word of paragraph.
- b. First Level Procedural Step. No title. Block indented under first word of paragraph.
  - (1) Second Level Procedural Step. No title. Block indented under first word of paragraph.
  - (1A) Insert Second Level Procedural Step. No title. Block indented under first word of paragraph.
  - (1B) Insert Second Level Procedural Step. No title. Block indented under first word of paragraph.
  - (2) Second Level Procedural Step. No title. Block indented under first word of paragraph.
    - (a) Third Level Procedural Step. No title. Block indented under first word of paragraph.
    - (a1) Insert Third Level Procedural Step. No title. Block indented under first word of paragraph.
    - (a1) Insert Third Level Procedural Step. No title. Block indented under first word of paragraph.
    - (b) Third Level Procedural Step. No title. Block indented under first word of paragraph.
      - 1 Fourth Level Procedural Step. No title. Block indented under first word of paragraph.

1A Insert Fourth Level Procedural Step. No title. Block indented under first word of paragraph.

1B Insert Fourth Level Procedural Step. No title. Block indented under first word of paragraph.

2 Fourth Level Procedural Step. No title. Block indented under first word of paragraph.

a Fifth Level Procedural Step. No title. Block indented under first word of paragraph.

a1 Insert Fifth Level Procedural Step. No title. Block indented under first word of paragraph.

a2 Insert Fifth Level Procedural Step. No title. Block indented under first word of paragraph.

b Fifth Level Procedural Step. No title. Block indented under first word of paragraph.

(1) Sixth Level Procedural Step. No title. Block indented under first word of paragraph.

(1A) Insert Sixth Level Procedural Step. No title. Block indented under first word of paragraph.

(1B) Insert Sixth Level Procedural Step. No title. Block indented under first word of paragraph.

(2) Sixth Level Procedural Step. No title. Block indented under first word of paragraph.

(a) Seventh Level Procedural Step. No title. Block indented under first word of paragraph.

(a1) Insert Seventh Level Procedural Step. No title. Block indented under first word of paragraph.

(a2) Insert Seventh Level Procedural Step. No title. Block indented under first word of paragraph.

(b) Seventh Level Procedural Step. No title. Block indented under first word of paragraph.

1-4 Change 1

FIGURE 86. Decimal paragraph numbering. (Example) (Sheet 2 of 2)

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## CHAPTER 1

## HANDLING AND STORAGE

## SECTION I WEAPON HANDLING

EQUIPMENT  
IDENTIFICATION1.1 GENERAL

Compliance with AFR 127-100 and the instructions in this manual will ensure safe handling, storage, and serviceability of SPECIFICATION SAMPLE. Waivers and deviations will be in accordance with AFR 127-100. Stored SPECIFICATION SAMPLE should be protected from adverse climatic conditions. The predominant hazard linked with the storage and handling of items listed in this technical manual are:

- a. Blast. Added words to show a secondary line on a first level procedural step.
- b. Fragments. Added words to show a secondary line on a first level procedural step.
- c. Fire. Added words to show a secondary line on a first level procedural step.

1.2 SPECIAL TERMS

The following terms, as defined, apply to SPECIFICATION SAMPLE.

**NOTE**

Shelf and service lives are not cumulative. Any combination of shelf and service life accrued by an item cannot exceed the shelf life.

1.2.1 Shelf Life. The length of time an item can remain in storage. The expiration date for shelf life on items with the month and year listed is the last day of the month.

1.2.2 Service Life. The length of time an item can remain in operating configuration or in actual usage.

1.3 IDENTIFICATION

The use of standard nomenclature and lot number/serial number is mandatory for all storage records and communications. Legible identification markings will be kept on munitions in storage.

1.4 COORDINATION

The use of coordinated nomenclature and lot number/serial numbers are mandatory for all storage records and communications.

SECTION I  
WEAPON HANDLING1.5 HANDLING**WARNING**

SPECIFICATION SAMPLE contain explosives and will not be handled roughly or dropped as personnel injury could result.

**CAUTION**

Packaged SPECIFICATION SAMPLE dropped more than TEST feet or an unpackaged TEST dropped more than TEST feet shall be considered unserviceable and shall be reported in accordance with AFM 67-1, Vol I, Part One, Chapter 20.

1.5.1 Title to First Subordinate Paragraph. Damaged containers will be repaired as soon as possible and markings restored to the repaired area.

1.6 STORAGE DATA

For storage data, see T.O. 11A-1-46, and DOD ammunition catalog.

1.7 STORAGE REQUIREMENTS

The following requirements are for storage of SPECIFICATION SAMPLE.

1.7.1 General Requirements

1.7.1.1 Specification sample shall be stored and stacked by type, lot number, and compatibility group.

1.7.1.2 Different lots shall be stacked separately, and separation between lots clearly defined.

1.7.1.3 Incomplete packages shall be securely closed and properly marked in accordance with T.O. 11A-1-10 to identify contents and quantity.

1.7.1.4 Runners, skids or integral dunnage affixed to containers shall be considered part of required

Change 1 1-1

FIGURE 87. Technical manual page, typical. (Example)

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