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(See 6. 5)

MILITARY SPECIFICATION

MANUALS, TECHNICAL: FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM) FOR EQUIPMENT AND SYSTEMS

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

1. SCOPE

1.1 Scope. This specification sets forth the requirements for the content and preparation of Functionally Oriented Maintenance Manuals (FOMM), formerly Symbolic Integrated Maintenance Manuals (SIMM). These manuals contain instructions for installation, operation, maintenance, and repair, of electrical, electronic, mechanical, pneumatic, and hydraulic equipment or systems. The manuals are also used as a baseline by instructors for training of personnel.

1.1.1 The FOMM consists fundamentally of illustrations supported by narrative and is a complete technical data base for the equipment or system it supports. FOMM manuals present data in a disciplined manner that shows clearly the functional and physical relationships that exist in an equipment or system. FOMM illustrations consist of logically arranged functional block diagrams, blocked schematics, with keyed text, and maintenance dependency charts (MDC). These illustrations use symbols and distinctively shaped line art blocks to convey maximum information in a minimum of space. Shading techniques are used to denote the physical and functional relationships of systems and hardware. The maintenance dependency charts provide a comprehensive method for determining equipment/system performance status and give positive direction for fault isolation.

1.1.2 The FOMM is arranged to separate (normally by separate Support Volumes and Troubleshooting/Repair Volumes) the data required to troubleshoot and repair the equipment from that information required to install, operate and understand the functional operation of the equipment. This approach addresses the "Technicians Handbook" concept which is intended to provide the qualified technician during troubleshooting and repair in one volume only that information he requires to maintain the equipment without being encumbered by baseline data needed for other purposes. Farther, all information required for the maintenance and repair of the equipment is arranged into hardware data packages and indexed sequentially by unit, assembly, and subassembly number. This all data required to troubleshoot, maintain, and repair a given unit or assembly is in a single work package that can be used without reference to other parts of the manual. Hardware data packages can be bound separately, if desired, and placed at the location of the respective assembly when equipment units are installed in different rooms or compartments. In addition, this specification covers the r. requirements for an approximate 4 by 10-1/2 inch sized reprinting of the "Troubleshooting/Repair Volume" so that a technician can carry this volume in his pocket.

1.2 Service applicability. Certain paragraphs in this specification are not applicable to all Services. When the paragraph applies to less than all the using services, the paragraph text is prefixed with the letter (A) Army, (CG) U. S. Coast Guard, (MC) Marine Corps, and (N) Navy, as applicable. The designation for a numbered paragraph applies to all subparagraphs unless otherwise indicated.

1. 3 Classification. Manuals shall be one of the following types, as (specified (see 6.2):

Type I, IS*, or IX** - Equipment (all types) manuals.
Type II, IIS*, or IIX** - System manuals.

*Service test equipment or service test system manuals. **Experimental equipment or experimental system manuals.

1.4 Data items. The following technical manual data items are detailed by this specification and shall be as specified (see 6.2):

(a) Book Plan (Dummy Manual).
(b) Quality Program.
(c) Manuscript for Review.
(d) Preliminary Manual.
(e) Basic (final) Manual.
(f) Technician's Pocket Manual.
(g) Supplement.
(h) Change.
(i) Updated Revision.
(J) Complete Revision.
(k) Reproducible Copy.
(1) Photolithographic Negatives.
(m) Replenishment Material.
(n) Status Reports.
(o) Certification Check Off List.
(p) User Activity Comment Sheet.
(q) Microfilm

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or requests for proposal form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-116 - Preservation, Methods of.
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-M-8910 - Manual, Technical, Illustrated Parts Breakdown, Preparation of.
MIL-M-9868 - Microfilming of Engineering Documents, 35MM, Requirements for
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-F-17655 - Field Changes and, Field Change Kits, General Specification.
MIL-M-38748 - Microfiche, for Engineering/Technical Data, Reports, Studies and Related Data, Requirements for.
MIL-M-38748 - Manuals; Technical: General Requirements for Preparation of.
MIL-P-38790 - Printing; Production of Technical Manuals; General Requirements for.
MIL-M-63000 - Manuals Technical, General Requirements for Manuscripts.
MIL-M-63001 - Manual, Technical, Basic Issue Items List, Repair Parts and Special Tools List, and Consolidated Organizational Repair Parts List.

STANDARDS

MILITARY

MIL-STD-12 - Abbreviations for Use on Drawings and on Technical Type Publications.
MIL-STD-1364 - General Purpose Electronic Test Equipment.

PUBLICATIONS

MILITARY

DOD 5220. 22M - Industrial Security Manual for Safeguarding Classified Information.
NAVAIR 16-1-523 Avionics Preferred Standard Test Equipment.
NAVSHIPS 3791 - Shore Electronics Equipment Allowance.
NAVSHIPS 0969-919-7000 - Test Equipment Application Guide.
Technical Order 33K-1-01 - Calibration Standards and Calibration Equipment.
USMC TM-6625-15/1 - Electronics Test Equipment Listing.

HANDBOOKS

MILITARY

H4-1 - Federal Supply Code for Manufacturers, United States and Canada, Name to Code. H4-2 - Federal Supply Code for Manufacturers, United States and Canada, Code to Name. MIL-HDBK-131 - Identification Markings for Fasteners.
MIL-HDBK-172, Part 1, Vol. 1 - Electronic Test Equipment.
MIL-HDBK-300 - Technical Information File for Ground Support Equipment.

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity, or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply:

UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

X3. 5-70 - Flow Chart Symbols for Information.
Y14. 15-66 - Electrical and Electronics Diagrams.
Y32 2-70 - Electrical and Electronic Diagrams, Graphic Symbols for.
Y32. 10- 67- Graphic Symbols for Fluid Power Diagrams.
Y32. 14-62 - Logic Diagrams, Graphic Symbols for.
Y32. 16-68 - Reference Designations for Electrical and Electronics Parts and Equipments.

(Application for copies shall be addressed to the American National Standards Institute, inc., 1430 Broadway, New York, N.Y. 10018.)

(Technical society and techical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 General requirements.

3.1.1 Precedence. When conflict exists between the technical requirements of this specification and its referenced documents, this specification shall take precedence. When conflict exists between the requirements of the contract and this specification, or its referenced documents, the contract shall take precedence. When conflict exists between military and non-military referenced specifications, a military specification shall take precedence.

3.1.2 Applicability to type of manuals. The basic data requirements for each manual type are specified in 3.1.8 and 3.1.9. Also, certain paragraphs in this specification are only applicable to certain manual types. These paragraphs are prefixed by the type of manual to which they only apply. Paragraphs not so designated apply to all manual types. The designation for a numbered paragraph applies to all subparagraphs unless otherwise indicated.

3.1.3 Security classification. Marking, handling, and production of classified material shall be in accordance with DOD Instruction 5220. 22M (see 6. 3).

3.1.4 Issues. The issues of a technical manual shall be as specified in the contract or order and in accordance with this specification. Deliverable data items for the given issue shall be prepared in accordance with 3..13.

3.1.4.1 Final manual. The final issue or a superseding revision of a technical manual shall be the original final edition (see 3.13.5).

3.1.4.1.1 Technician's pocket manual. When specified in the contract or order, an approximate 4-1/8 by 10-1/2 inch page size reprinting of the troubleshooting/repair volume shall be provided.

3.1.4. 2 Preliminary manual. The preliminary manual shall include all data required for the final manual (See 3.13.4) but need not comply with the production requirements for a final maximal (see 3. 10.1). Preliminary Manuals may be Issued for use prior to availability of final manuals.

3.1.4.3 Supplement manual. A supplement manual shall complement the data in an existing final manual, preliminary manual, or commercial manual (see 3.13.6). Unless otherwise specified, the supplement shall conform to the Troubleshooting/Repair Volume (3.3.2) augmented by necessary information that relates to the basic manual and would logically fall in the basic manual or support volume.

3.1.4.4 Revisions. Revisions shall be one of two types, as specified in the contract or order, and shall be prepared in accordance with this specification (see 3. 13.8). A revision can be issued as an "Original" manual to cover one or more different models of an equipment or system than that of the basic manual when the basic manual can be supplied as Government Furnished Material for use as a baseline. In this case, reference shall only be made to the models covered, unless the data applies to all models. Unique identification numbers shall be assigned to all volumes and no supersedure notice shall be included.

3.1.4.4.1 Updated revision. An updated revision shall incorporate configuration modifications and all previous data issued as interim (temporary) changes to the existing manual, and shall be prepared in accordance with the content and format arrangement of the manual being revised and this specification (see 3. 13.3.1). All changes shall be validated and certified complete and accurate.

3.1.4.4.2 Complete revision. A complete revision shall be a completely rewritten manual and shall comply with all of the content and format requirements of this specification and shall be completely validated and certified accurate (see 3.13.8.2).

3.1.4.5 Changes. Changes shall incorporate corrections and additions resulting from modifications to the equipment or to correct deficiencies or errors in the existing manuals (see 3.9.1 and 3.13.7). Changes shall be validated and certified complete and accurate.

3.1.4.5.1 Interim (temporary) charges. Interim changes shall be issued by means of replacement sheets. Instructions for hand written pen-and-ink corrections (see 3. 9.1.1) shall only be included when authorization is obtained from the procuring activity and this effort is promulgated by a message, instructions, or published article.

3.1.4.5.2 Permanent changes. A permanent change shall be in the form of replacement pages. A permanent change- shall incorporate all outstanding interim (temporary) changes (see 3.13.7).

3. 1.4.6 Review manuscripts. Review manuscripts as required by the contract shall be prepared in accordance with 3. 10.8. 5 and 3.13.3.

3.1.5 Technical accuracy. All information shall represent exactly the system, equipment, and functions being described. Technical inaccuracies, or inconsistencies will constitute reason for rejection of the technical manual (see 3.11.5).

3.1.6 Level of writing and depth of coverage.

3.1.6.1 Types I, IS, II, and US. The level of writing and development of text for operational and service test use shall be in accordance with MIL-M-33784 and the following:

(a) As a general guide, the level of writing should be for a high school graduate having specialized training as a technician in military training courses.

(b) Operating instructions shall be written to the level of an operator having previous experience in the operation of similar or related equipment.

(c) The level of writing for other portions of the manual shall be to that of a technician having previous maintenance experience with similar or related equipment.

3.1.6.2 Types IX and IIX. Unless otherwise specified in the contract or order, manuals may be written to the level of a graduate engineer familiar with the type of equipment involved. Mathematical equations or notations shall be limited to those necessary for understanding the operation and maintenance of the equipment.

3.1.6.3 Depth of coverage. Unless otherwise specified in the contract or order, manuals shall provide all information necessary for maintaining the equipment or system through organizational and intermediate-level maintenance (see 3.8. 2. 2).

3.1.7 Style of writing. The style of writing shall be factual, specific, concise, comprehensive, and unambiguous. Descriptive writing shall be third person, present tense, active voice, and indicative mood. Instructions shall be second person, present tense, active voice, and imperative mood.

3.1.8 Arrangement. A FOMM manual shall be arranged into two volumes, a "Support Volume" and a "Troubleshooting/Repair Volume", except as noted in 3. 8. The support volume shall be designated Volume 1 and shall include all user support information. The troubleshooting/repair volume shall be designated Volume 2 and shall include all data necessary to troubleshoot, align, and repair the equipment. Further division of the manual shall be by parts, with covers and title pages (e. g. , Volume 1, Part 1, Volume 2, Part 3). When specified in the contract or order, the "Technicians Pocket Manual" shall be an approximate 4-1,'8 by 10-1/2 inch reduced size reprint of the troubleshooting/repair volume and shall be issued with a unique publication number on the cover and title page only.

3.1.8.1 Support volume. The support volume subject matter shall be arranged in the order shown and conform to the paragraphs referenced as follows:

(a) Cover: (See figure 1).
(b) Front Matter: (See 3. 2).
(c) General Information: (Type I - See 3.3.1.1 and figure 2).
(Type II - See 3.4.1.1).
(d) Safety Precautions: (Type I - See 3.2.3 and 3.2.11).
(Type II - See 3.4.1.2).
(e) Operating Instructions: (Type I - See 3.3.1.2 and figures 3 and 4).
(Type II - See 3.4.1.3).
(f) General Theory of Operation: (Type I - See 3. 3.1.3).
(Type II - See 3.4.1.4).
(g) Scheduled Maintenance: (Type I - See 3.3.1.4).
(Type II - See 3.4.1.5).
(h) Plan for Maintenance and Overhaul Procedures: (Type I - See 3.3.1.4.5).
(i) *Installation: (Type I - See 3.3.1.5).
(Type II - See 3.4.1.7).
(j) **Parts List: (Type I - See 3.3.1.6).
(Type II - See 3.4.1.8).

*Unless otherwise specified in contract or order.
**When specified in contract or order.

3.1.8.2 Troubleshooting/repair volume. - The troubleshooting/repair volume subject matter shall be arranged in the order shown below and shall conform to the referenced paragraphs:

(a) Cover: (See 3.2.1 and figure 5).
(b) Title Page: (See 3.2.2).
(c) Front Matter: (See 3.2 and figures 6, 7, and 8).
(d) Family Tree (See 3.3.2.1 and figure 9).
(e) Interconnecting Cabling/Piping Diagram: (Type I - See 3.3.2.2 and figure 10). (Type II - See 3.4.2. 1.4).
(f) Overall Functional Information: (Type I - See 3.3.2.4 and figures 11, 12, and 13). (Type II - See 3.4.2. 1).
(g) Major Function information: (Type I - See 3.3.2.5 and figures 14, 15, 16, 17, 18, and 19). (Type II - See 3.4.2.2).
(h) Hardware Information: (Type I - See 3.3.2.6 and figures 20, 21, 22, 23, and 24). (Type II - See 3.4.2.3).

3.1.8.2.1 Relationships of hierarchical data. The troubleshooting/repair volume shall be organized in information levels in accordance with Chart 1, as follows:

(a) Column 1 applies when it is possible to present the function/hardware information in three hierarchical levels.

(b) Column 2 applies when it is necessary to expand the overall function diagram because space limitations on the overall function diagram prevent full identification of all major functions.

(c) Column 3 applies when it is necessary to subdivide a major function diagram to fully depict the function details.

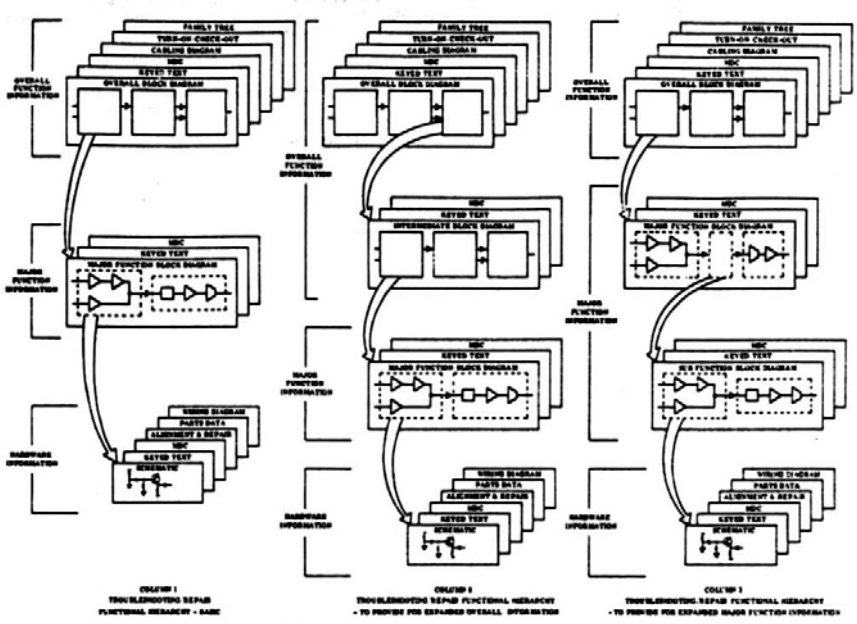
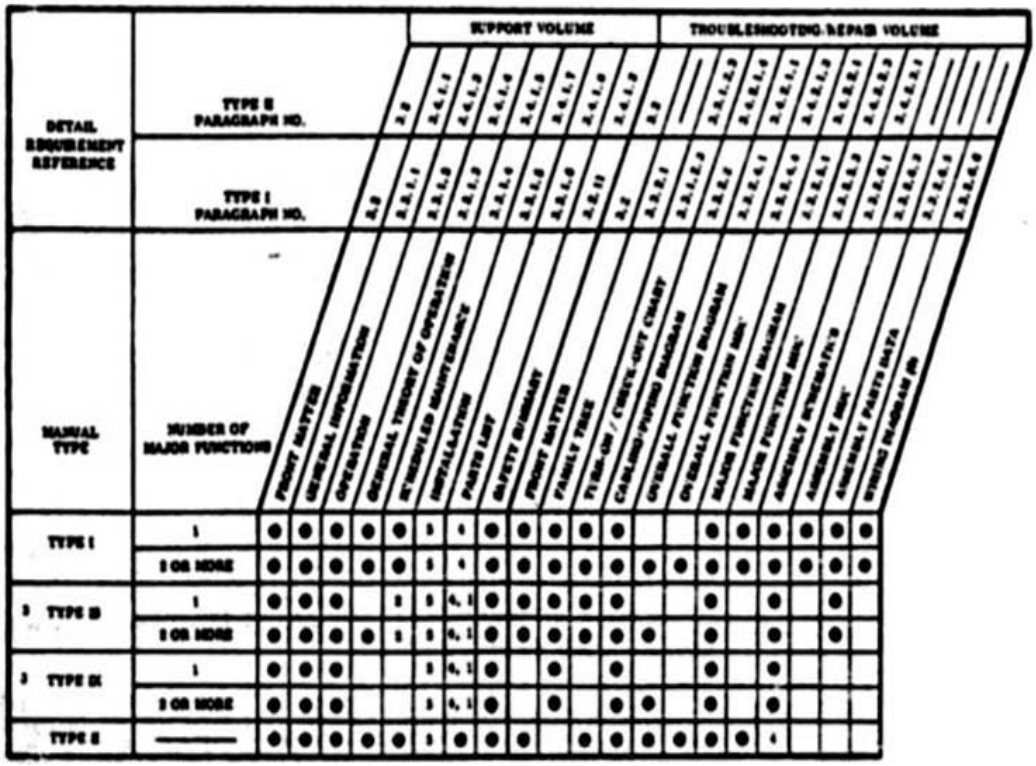


CHART 1 - TROUBLESHOOTING/REPAIR VOLUME ORGANIZATION

3.1.9 Data requirements chart. The data and diagram types required for the specified type of manual shall be in accordance with Chart



- Less attaching hardware, are (3.3. I. 4. 3.6).
- Less reference troubleshooting actions (3.3.1. 4.4.h).
- Production requirements in accordance 510 3.10.5.4.
- When specified in order or contract,
- Unless otherwise specified in order or contract, installation data shall be included.
- Only required for chassis, backplanes, and front panels.

CHART 2 - DATA REQUIREMENTS

3. 1.10 Warnings, cautions, and notes, Warnings, cautions, and notes shall be included on applicable pages as specified in MIL-M-38784.

3. 2 Detailed front matter requirements for equipment and systems manuals. The front matter shall consist of the following, as applicable:

(a) Cover (3.2.1).
(b) Title Page (3.2.2).
(c) Warning Page (A) (3.2.3).
(d) List of Effective Pages (3.2.4).
(e) Promulgation Page (CG, MC, N) (3.2.5).
(f) Change Record (MC, N) (3.2.6).
(g) Table of Contents (3. 2, 7).
(h) Functional Index (3.2.8).
(i) Foreword (3. 2.9).
(j) Description of symbols, codes, abbreviations, and shading (3.2.10).
(k) Safety Summary (CG, MC, N) (3.2.11).
(1) Integrated Circuit Data (3.2. 12). (m) Explanation of MDC Usage (3.2. 13).

3. 2. 1 Covers. Covers shall be prepared in accordance with MIL-M-38784. It shall include, as applicable, a supersedure notice and a distribution release statement. It shall also be identified as a "FOMM Technical Manual for" and shall include the title "Support Volume" or "Troubleshooting/Repair Volume" as applicable (see figures 1 and 5).

3. 2. 2 Title pages. Title pages shall be prepared in accordance with MIL-M-38784 and shall have the same FOMM identifier data required for the covers. Limited distribution manuals shall contain a notice to that effect, as specified in the contract or order.

3.2.3 Warning page (A). The warning page shall be in accordance with MIL-M-38784.

3. 2.4 List of effective pages. The first volume of a manual set shall include a list of effective pages for all volumes, prepared in accordance with MIL-M-38784. The list of effective pages shall indicate "original" or the change status of each page. The second volume and separately bound parts shall include a list of effective pages for that volume or part only.

3.2.4.1 Identification of writing contractor. The front matter shall also include the name and address of the technical manual contractor/subcontractor, and publication contract number, if applicable.

3.2.5 Letter of promulgation (CG, MC, tin. A letter of promulgation shall be on the first right hand page following the list of effective pages in volume 1 of the manual. The contractor shall request the promulgating letter from the command or agency concerned when submitting the manuscript for acceptance.

3.2.6 Change record. The change record page shall be prepared in accordance with MIL-M-38784 and shall be inserted in the first volume within the front matter. The change record page shall be on a separate sheet and shall not be printed on the reverse side.

3. 2. 7 Table of contents and list of illustrations. A table of contents and list of illustrations in accordance with MIL-M-38784 shall be prepared for the data included in the support volume.

3. 2.8 Functional index. A functional index in accordance with figure 6 shall be prepared in the form of a chart which lists the functional breakdown and the hardware breakdown of the equipment versus types of data. Page numbers for each specific type of information shall be entered in the body of the chart. In multi-volume manuals, volume 1 in addition to the table of contents shall contain a functional index covering all parts of volume 2. Volume 2 shall contain a functional index for the entire volume. If volume 2 is subdivided into parts, the first part shall contain a functional index for all parts and each part shall include the index for that part.

3.2.9 Foreword. Information shall be provided in a foreword to the support volume to explain the content and usage of the manual. The foreword shall include:

(a) An explanation of the scope and intent of the manual.
(b) The types and arrangement of data included.
(c) Any additional information which will assist the user in efficient use of the manual.
(d) FOMM data use instructions shall be inserted in the troubleshooting/repair volume and shall explain how the data is used to troubleshoot and repair the equipment.

*Not all commands

3.2.10 Description of symbols, codes, abbreviations, and shading. The following charts shall be included in the troubleshooting/repair volume (see figure 6):

(a) A chart that lists and defines each of the functional entity identifier codes used in the manual.
(b) A chart that illustrates and describes the symbols peculiar to the manual.
(c) An illustrated chart that defines the two-color, multishading technique used with FOMM.
(d) A chart that defines all nonstandard abbreviations used in the manual.

3.2. 11 Safety summary (CG. MC, N). A safety summary in accordance with MIL-M-38784 shall be prepared for each volume/part and shall be included in the front matter.

3. 2. 12 Integrated circuit data. The technical data for each type of integrated circuit module shall be provided in the front matter of the troubleshooting/repair volume (see figure 7). This includes but is not limited to such things as:

(e) Type and description.
(f) The base configuration, indicating the key or index, and power and return pin numbers.
(g) Logic diagram for all two state IC's.
(h) Truth table for all two state IC's.

3. 2. 13 Explanation of MDC usage. The front matter of all volumes or parts of volumes that contain Maintenance Dependency Charts shall include instructions on the use of MDCs. Accompanying the instructions shall be a chart that illustrates and describes all symbols used in the MDCs (see figure 8).

3.3 Detailed content requirements for equipment manuals (Type I). Equipment manuals shall contain the data designated by Chart 2 (see 3.1.9). Included data shall be in accordance with the following paragraphs.

3.3.1 Support volume. The support volume shall be in one or more parts in accordance with 3.8.2.1.1. It shall include front matter in accordance with 3. 2 and the following data:

3.3.1.1 Section 1. General information. The content of this section shall be such that command-level, supervisory personnel, and other users having an interest in the equipment can easily and rapidly determine the purpose, physical and functional characteristics, and the operational capabilities of the equipment.

3.3.1.1.1 Introduction. The introduction shall provide an explanation of the purpose, scope, supersedure data, and applicability of the technical manual including the models, serial numbers, and configurations covered. Warranty/guarantee information shall be included.

3.3. 1.1.2 Equipment description. The equipment description shall explain the intended use (why, where, when, how, and with what), capabilities and limitations of the equipment. Text covering physical description or structural arrangement should be brief. Special attention should be given to avoiding unnecessary or repetitious details that are better illustrated. All units of the equipment shall be clearly illustrated and identified. If the technical manual covers more than one equipment model or configuration, a table defining the differences between equipments and models covered shall be included.

3.3.1.1.3 Relationships of units. A pictorial illustration representing all units comprising the equipment shall be included. The illustration shall show the major units of the equipment, relative, not necessarily proportional, size of each unit, basic interconnections between units, and interfacing equipment connections, as illustrated on figure 25.

3.3.1.1.4 Reference data. All reference data, equivalent to but not restricted to the following, shall be included in tabular form, (see figure 2):

(a) Descriptive (nameplate data) which identifies manufacturer, type, model, and component identification number (CID), if applicable.

(b) Functional characteristics, such as: power requirements, (overall and unit, including power factor), horsepower, pressure, capacity, modes of operation, power output, frequency, pulse characteristics, sensitivity, selectivity, including tolerances, where applicable.

(c) Capabilities and limitations, such as: pounds of thrust, knots, turning radius, minimum and maximum ranges, degree of coverage, resolution, accuracy.

(d) Rated outputs, such as: wattages, voltages, horsepower, gallons per minute.

(e) Environmental characteristics, such as: ambient temperatures, heat dissipation per unit, humidity limits, coolants (air flow in CFM, water/oil in GPM per unit, chilled/demineralized salt water.

3.3.1.1.5 Equipment, accessories and documents supplied. A tabular listing of all equipment and documents supplied shall be included. The equipment and its units, and accessories (such as hydraulic oil lines, waveguide, special cables, special tools, test equipment, miscellaneous parts, and government furnished items) which form a part of, or are supplied with the equipment shall be listed. The table shall include the following:

(a) Column 1. Quantity. This column shall contain the quantity of each unit and accessories supplied with the equipment.

(b) Column 2. Item name or nomenclature. This column shall contain the official name (e. g. , pump, winch) or nomenclature (name and designation) of each component, unit, or accessory.

(c) Column 3. CID number or unit number. This column shall contain the CID or unit number of each equipment unit or accessory.

(d) Column 4, Overall dimensions. This column shall detail the crated and uncrated height, width, and depth of each unit or accessory.

(e) Column 5. Weight and volume. This column shall detail the crated and uncrated weight and volume of each unit and accessory.

3.3.1.1.6 Equipment and publications required but not supplied. A tabular listing of all test equipment, equipment, tools, material, and publications required but not supplied shall be included. Selection of test equipment shall be made from NAVAIR 16-1-523, NAVSHIPS 3791, NAVSHIPS 0969-919-7000, and MIL-STD-1364 as applicable; authorization must be obtained in writing for listing nonstandard test equipment. For Army manuals, test equipment shall be selected from MIL-HDBK-172. For cross service manuals procured for Air Force use, test equipment shall be selected from MIL-HDBK-300 and TO 33K-1-01. For Marine Corps manuals, test equipment shall be selected from USMC TM-6625-15/1. The listing shall contain:

(a) Column 1. Category. This column shall contain the generic name of each piece of equipment required.

(b) Column 2. Recommended equipment. This column shall contain the Government nomenclature or identification of the recommended equipment.

(c) Column 3. Alternate. This column shall contain the Government nomenclature of an alternate test equipment.

(d) Column 4. Equipment test parameters. This column shall contain the range of equipment parameters that are to be tested by each recommended test equipment (not the range capability of the test equipment).

(e) Column 5. Application. This column shall indicate the intended use of the equipment (e. g., scheduled maintenance, troubleshooting, corrective maintenance, or installation).

3.3. 1.1.7 Government authorized changes and factory changes. A table of field', modification, change order, or alteration and factory changes shall be included as follows:

(a) Column 1. Change number. This column shall list the change number for each Government authorized and factory change considered and included in the preparation of the manual.

(b) Column 2. Nomenclature (or component identifier). This column shall list the equipment nomenclature or component and serial numbers of equipments affected by the change.

(c) Column 3. Description. This column shall contain a brief statement identifying the change and its purpose. *Naval Ship Systems Command and Naval Electronic Systems Command.

3.3.1.2 Section 2. Operation. Procedural instructions shall be included to provide routine operating procedures, emergency procedures, manual procedures, automatic procedures, safety precautions, operating limits, and equipment limitations. Additionally, the coverage shall address the relationships of controls to each other (as applicable) and their effect upon the displays.

Operating information shall be presented by a combination of four basic forms.

(a) Operators data table.
(b) Operating procedures.
(c) Turn-on/check-out procedures.
(d) O^{p}erator's maintenance actions and schedules.

3.3.1.2.1 Operators data table. The operators data table shall include the operating parameters and functional characteristics of the equipment. The table shall include a listing of the following:

(a) Operating controls and indicators of the system,
(b) Description of the purpose of the control or indicator.
(c) Normal operating position of the control to aid in the emergency use of the equipment by an untrained operator (see figure 3).

The operators data table 'shall be accompanied by an illustration of the related unit. When the size of the illustration precludes direct reading of the functional designation of controls, an alphanumeric coordinate method or leader call-out method and location table shall be used for locating the operating controls.

3.3. 1.2.2 Operating procedures. Operating procedures shall include the following:

(a) Safety precautions. A description of hazards associated with equipment operation shall be included in the operation section. The safety precautions shall cover, but not be limited to, such items as hazards due to radiation, noise, high voltage, jet exhaust, and moving machinery.

(b) Operator turn-on. This procedure shall include all steps necessary to bring the equipment from OFF through STANDBY condition to full operation.

(c) Modes of operation. Procedures shall be provided for each mode of operation, e. g., manual, automatic, local, remote, search, track, etc. The use and relative advantage of each mode shall be described.

(d) Operation tinder interfering conditions. Describe the sources and effects of interference. Describe the equipment anti-jamming and interference reduction features, the advantages of each feature, and the operating procedures to be followed.

(e) Operator turn-off. This procedure shall include all steps necessary to bring the equipment from full operation to OFF condition.

(f) Battle-short or emergency operation. This procedure shall cover operating the equipment during emergency conditions (cooling air failure, lube oil failure, loss of cooling water, etc.). Maximum allowable time for operation of equipment(s) shall be given before catastrophic failure can be expected to occur. Emergency operator maintenance instructions shall be included. A warning shall be provided to return the equipment to proper operation when the emergency is over.

3. 3.1.2. 3 Turn-on/check-out procedures. Procedures for determining operational readiness and the acceptable indications expected from built-in indicators such as meters, lamps, gages, cathode-ray-tubes and recorder readouts shall be described. Milestones in the operational status of the equipment shall be identified by brief statements such as "the generator is now in STANDBY", "the boom is lowering", "blower motor is running", etc. Check-out procedures shall be limited to those that can be performed at operating positions. Duplication of the turn-on/check-out chart specified in 3.3.2.3 is acceptable.

3.3.1. 2.4 Operator's maintenance actions and schedules. Required operator maintenance actions and a recommended schedule for performing the maintenance actions shall be included.

3.3.1. 3 Section 3. Theory of operation. This section shall contain all theory of operation and background necessary to inform the technician, or other user of the general principles of operation beyond the actual functioning of the equipment that is included in the troubleshooting/repair volume. The data shall provide sufficient insight into operational doctrine to enable the technician and other users to understand enough of the mission requirements to manipulate the set for optimum performance. Examples of this information would be gun-fire control problems, sonar or radar principles, basic logic on which operation is based, concepts of a communications systems, navigation theory, machinery operation, etc. In addition, this section shall be used to expand on that information provided in keyed text when it is necessary to explain the operation (how it operates) of a function or circuit. Illustrations such as patterns, nomographs and simplified schematic diagrams- shall be used to the maximum practical extent to augment narrative.

3. 1. 4 Section 4. Scheduled maintenance. This section shall contain preventive maintenance procedures and performance test instructions to be accomplished on a scheduled basis. (Normally, planned maintenance is conducted in accordance with a schedule and procedure set forth on planned maintenance cards. For guidance in establishing procedures, planned maintenance documents applicable to a particular generic family of equipment may be obtained from the procuring activity.) When the contract or purchase order requires the preparation and delivery of maintenance requirements cards (MRC), and all equipments will not necessarily be serviced under the planned maintenance system, the contractor shall include the preventive maintenance procedures in the manual in order to make the technical manual a complete data base (see figure M).

3.3.1.4.1 Introduction. The introduction shall be an explanation of the purpose, scope, and arrangement of the scheduled maintenance data. When a preventive maintenance procedure is critical to the operation of the equipment and the schedule for servicing is absolute (not just recommended), this information shall be conspicuously written as a CAUTION. For Navy manuals, the following statement shall be included:

> "Where conflict arises between the procedures contained on the Planned Maintenance System "Maintenance Requirement Cards (MRC)" for this e[q]uipment and those in this manual, the procedures on the MRCs shall take precedence."

3.3.1. 4. 2 Scheduled maintenance action index. This index shall include a listing of all scheduled performance tests and preventive maintenance procedures. The index shall be tabulated as follows:

(a) Column 1.Periodicity. This column shall contain an alphanumeric list of all maintenance actions contained in the section. The following periodicity symbols, as appropriate, shall be used in the order of increasing periodicity as listed below:

Interval	Symbols	Interval	Symbols
Daily	D	Semiannually (6 months)	S
Weekly	W	Annually (12 months)	A
Monthly	M	Overhaul cycle	C
Quarterly (3 months)	Q	As specified (explain circumstances)	R*

*An R periodicity will be preceded by a recommended calendar periodicity (e. g. , DR, WR, MR, etc. , which might mean, perform as recommended provided that the equipment is operated under full load).

(b) Column 2. Maintenance action. This column shall name the maintenance action which corresponds to the periodicity number in column 1.

(c) Column 3. Reference. This column shall state the paragraph number that contains the procedure listed in column 2.

3.3.1.4.3 Preventive maintenance procedures. These procedures shall include the information required to inspect, clean, and lubricate the equipment, and shall contain the following:

(a) Safety precautions.
(b) A listing of tools, parts, materials, and test equipment required.
(c) Instructions for dilution and use of cleaning solvents. Solvents shall be identified by Government specification numbers and Federal stock numbers.
(d) Instructions for properly maintaining all safety devices and interlocks, with warnings, and cautions.
(e) Instructions for lubrication at place of installation (on site); also types and quantities of lubricants to be applied. Lubricants shall be identified by Government specification numbers and Federal stock numbers. Specific lubricants for arctic or tropic environments shall be included.
(f) The minimum rating (skill level) of the technician who can be expected to perform the preventive maintenance tasks.
(g) Procedures for obtaining access to subassemblies or subcomponents.
(h) Instructions for in-place balancing and noise reduction.
(i) inspection procedures for parts which deteriorate due to cycles of use, age, or climatic conditions.
(j) Illustrations to identify lubrication points and other pertinent data.
(k) Any other information pertinent to these procedures.

3.3.1.4.4 Scheduled performance tests. These tests shall contain step-by-step procedures necessary to verify that the equipment is operating within standards in all modes of operation and shall contain the following:

(a) Safety precautions.
(b) A list of tools and test equipment identified by type, manufacturer, and model number or by assigned military designation.
(c) The title of the test to be performed.
(d) The minimum rating (skill level) of the technician expected to perform the test.
(e) Preliminary setup data required to perform the test.
(f) Detailed procedures for accomplishing the test. Procedures requiring lengthy and identical setup data may be presented in detail in one procedure and referenced in succeeding procedures.
(g) Values or conditions, with tolerances, indicative of normal operation.
(h) Troubleshooting references shall be provided at the end of each test procedure for location of the trouble-shooting, or corrective actions to be used if the test values are not within tolerances. Where cause of equipment failure can be predicted with reasonable confidence, reference may also be made directly to the appropriate maintenance procedure.
(i) Illustrations to support the test instructions.

3.3.1.4.5 Plan for maintenance of mechanical components. Instructions shall provide on a comprehensive and systematic basis, effective and efficient procedures for performing maintenance of those mechanisms designated as needing periodic overhaul.

3.3.1.4. 5.1 Representative considerations. Representative considerations to be weighed in development of maintenance procedures shall include the following:

(a) Reliability, maintainability, simplicity, and ruggedness.
(b) Transient and static operating conditions, shock, vibration, wear, corrosion, erosion, fatigue, operating temperature, moisture, roll, pitch, air-blast, and other environmental forces, as applicable, which will affect the continued satisfactory performance of each part.
(c) Accessibility, ease of removal and replacement of parts requiring frequent removal.
(d) Safety.
(e) Methods of calibration and adjustment.
(f) Rotatables (replacement of assembly for subsequent overhaul and reissue versus spot overhaul or repair).

3.3.1.4.5.2 Schedule. A recommended schedule for all maintenance actions (inspections, tests, adjustments, reconditioning, overhaul, and acceptance criteria) shall be included. The schedule shall assure reconditioning,' replacement before the degradation results in major failure.

3.3.1.4.5.3 Reconditioning procedures. The manual shall include reconditioning procedures for replaceable parts that are within the scope of the established maintenance philosophy. The procedures shall provide detailed maintenance instructions at all maintenance levels to accomplish the reconditioning or replacement of each part subject to continuing degradation.

3.3.1.5 Section 5. Installation. Unless otherwise specified by contract or order, drawings and information concerning installation shall be provided in this section. The following type of information shall be included: site selection, special tools and materials requirements, unpacking, and handling (if unusual procedures or precautions are required), preparation of foundations, mechanical assembly procedures, mounting instructions, bolting diagrams, safety precautions, grounding and bonding, clearances for access, ventilation, fluid cooling requirements, clearances for motion under shock, recommendations for reduction of electrical and electromagnetic interference, maximum/minimum cable length, minimum bending radius of cable, pipe, etc., and other interface requirements, as applicable. In addition, this section shall reference the performance standards in section 4 of the manual (see 3.3.1.4.4) for use in determining that the equipment, after installation, is capable of satisfying operational requirements.

3.3.1.5.1 Installation drawings. Installation drawings or legible reproductions of accepted drawings in accordance with category G of MIL-D-1000, as appropriate, shall be provided, as follows:

(a) Pictorial system diagram.
(b) Outline and mounting dimensions diagram.
(c) Interconnecting wiring and cabling/piping diagram or wire running lists.
(d) Summary list of all installation material required.
(e) Input and output interface data.

In addition, when applicable, reference shall he made to the cognizant agency cable running sheets. The reference shall be a tabulation of drawing numbers for the cable running sheets required to accomplish installation.

3.3.1.5. 2 Site information. This data shall contain information supplemental to the installation drawings. If all site information is contained on the installation drawings, reference shall be made to the applicable drawing(s) by figure number.

3.3.1.5.3 Reference publications. Reference shall be made to user available general publications required to complete the installation.

3.3.1.5.4 Tools and materials required for installation. Include information supplemental to the summary list of installation material. If no supplemental information is required, reference the drawing by figure number.

3.3.1.5.5 Unpacking, depreservation, represervation and repacking. Include information, supplemental to the installation drawings regarding unpacking, depreservation, represervation and repacking. Include step-by-step procedures to prevent deterioration or damage to the equipment or injury to personnel. The following list shall be used in determination of information to be provided:

(a) Unpacking procedures.
(b) Depreservation instructions.
(c) Recommended disposal procedures for packaging and packing materials where applicable.
(d) Methods of anchoring, blocking and bracing.
(e) Specialized cushion insert data.

(f) Identity of repairable items including their packaging and packing procedures.
(g) Specialized multiple use and reusable container data.
(h) Identity of hazardous, sensitive or fragile components.
(i) Need and requirements for special environmental storage conditions.
(j) Special handling procedures.

Supporting illustrations shall be provided to clarify procedures. Lists of parts that could require replacement due to loss or damage; i.. e. , attaching hardware, shock mounts, humidity indicators, etc. shall be included with the appropriate illustration. When instructions for reshipment or storage are required, step-by-step procedures for preservation, if applicable, and packing shall be included and illustrated. Where packing is simply the reversal of unpacking, a statement of this fact is sufficient.

3.3.1.5.6 Preparation of foundations. Include information supplemental to the installation drawings. If all foundation preparation information is contained on the installation drawing, refer to the drawing(s) by figure number.

3.3.1.5.7 Input requirements. A summary of the input data contained on the installation drawings shall be included. Parameters with tolerances shall be included with each of the inputs listed. Examples of inputs are as follows:

(a) Power.
(b) Ventilation.
(c) Dry air (waveguide pressure).
(d) Gyro information.
(e) Fluid cooling.
(f) Steam.
(g) Freon.

3.3.1.5.8 Installation procedures. The following types of supplemental information which are not provided on the installation drawings shall be included:

(a) Instructions required to assemble units.
(b) Instructions required to mount units. Include bolting and bracing diagrams and data on shock mounts.
(c) Instructions for making electrical, plumbing, transmission line and all other interface connections (external) to the equipment.
(d) Instructions for interconnecting units comprising the equipment.
(e) Servicing procedures, such as initial lubrication.
(f) Instructions for bonding and grounding.
(g) Instructions on specialized rigging and hoisting.

3.3.1.5.9 Installation checkout. Provide step-by-step procedures to demonstrate that the equipment operates correctly and within tolerances. These procedures shall provide for equipment checkout in three test phases s follows:

(a) Phase 1 - Installation inspection and pre-energizing procedures.
(b) Phase 2 - Turn-on and preliminary tests.
(c) Phase 3 - Installation verification test.

3.3.1.5.9.1 Phase 1.Installation inspection and pre-energizing procedures. Inspection procedures in the form of check lists shall be provided to verify the following:

(a) That all units of the equipment and required auxiliary equipments have been installed and that their location and orientation is proper; that all cables, antennas, waveguides, transmission lines, dehydrators, coolant lines, piping, etc. , have been installed in accordance with plans and specifications; that continuity exists in all interconnections.
(b) That the applicable test equipment listed in section 1 of the manual is available at the site, is operating satisfactorily, and has been calibrated.
(c) (N) That the Allowance Parts List (APL) is available, that the Coordinated Shipboard Allowance List (COSAL), etc., includes the equipment data.
(d) That all authorized field changes, modifications, alterations, and mandatory retrofits have been accomplished.
(e) That all rotating devices are free from obstruction.
(f) That there is access to the equipment for maintenance.
(g) That all pre-energizing servicing procedures, including lubrication have been accomplished.
(h) That it is safe to turn on the equipment.

3.3.1. 5. 9. 2 Phase 2. _ Initial turn-on and preliminary test. Include procedures for first energizing the equipment. This may be accomplished by reference to the applicable portions of the operating procedures. Include step-by-step procedures for testing the equipment electrical supply circuits including distribution panels, switches, breakers, relief valves, and interlocks. Include procedures for testing piping, electrical cables, wire rope, stays, for proper installation of transmission lines and waveguides, hangar spacing, torquing of connectors, pressure testing, flow rates, standing wave ratio and attenuation checks, etc.

3.3.1.5.9.3 Phase 3. Installation verification test. Include complete instructions for testing the equipment in all modes of operation. Where applicable, refer to the scheduled performance tests in section 4 of the manual (see 3. 3.1.4.4). Procedures shall cover checking gages, meters, alarms, and other sensing devices for proper operation and calibration. The tests shall verify that all inputs are in tolerance. As applicable, include resistance tests, voltage standing wave ratio (VSWR), and insertion loss tests to verify the proper installation of antennas, and antenna-to-equipment waveguide runs; transducer impedance and source level checks to verify proper installation of transducers, domes, and cables. Preliminary setup data shall be included in each procedure. When it is required that an alignment be accomplished prior to performing a test, the alignment shall be included, or, if lengthy, a reference given to the alignment procedure location elsewhere in the manual.

3.3.1.5. 9.3.1 Test procedure. Testing procedures shall be presented in a logical order as follows:

(a) Energize the equipment.
(b) Test the first units (normally power supplies) which must be operating properly. When test results are within the required tolerance, include reference to the next logical test. Include a reference to the corrective maintenance or troubleshooting data to be used if test results are not within tolerances.

3.3.1.5.9.3.2 Installation standards summary sheet. The installation standards summary sheet shall provide spaces for recording the results of all installation verification tests (see figure 26). Each space shall be identified by the step or paragraph number which provides the instructions for accomplishment. Each space shall contain the respective unit of measurement (e. g. , Amp, dB, or V). Waveforms shall be included to show the points on the pattern where the measurement is to be taken. In addition, critical installation data shall be included, such as the length of the transmission line.

3.3.1.6 Section 6. Parts list. When a separate parts list is specified in the contract or order, in addition to the parts data required by 3.3.2.6.5, the parts list shall be prepared in accordance with the requirements of the procuring activity as follows:

3.3.1.6.1 Separate parts list (NAVAIR). When specified in the contract or order, a separate illustrated parts breakdown shall be supplied in accordance with MIL-M-3910.

3.3.1. 6. 2 Separate parts list (A). When specified in the contract or order, a separate parts list shall be supplied in accordance with MIL-M-63001.

3,3.1.6.3 Equipment parts list (CG, MC, N). The parts list shall catalog and identify all shipboard, tender, and shore-based repair parts including attaching hardware. This section shall include the following:

(a) Introduction.
(b) List of major components or list of major units.
(c) Parts list.
(d) List of common item descriptions.
(e) List of attaching hardware.
(f) List of manufacturers.
(g) Parts location illustrations.

3.3.1.6.3.1 Introduction. The introduction shall contain an explanation of the scope and arrangement of the parts list. The following type of information shall he included:

(a) Models of equipments and serial numbers of equipments covered.
(b) Explanation of any special notes and symbols.
(c) Explanation and instructions for using the list of common item descriptions.
(d) Explanation and instructions for using the list of attaching hardware.
(e) Explanation and instructions for using the parts list.
(f) Explanation and use of the list of manufacturers.

3.3.1.6. 3.2 List of major components or major units. A list of major components or a list of major units in tabular form shall be included.

3.3.I.6.3.2, 1 List of major components (electrical, mechanical, hydraulic or pneumatic equipment). A list of major components in tabular form shall be included similar to the following:

(a) Column 1. APL/CID number. This column shall list the APL/CID number for each major component.
(b) Column 2. Quantity. This column shall list the quantity of components.
(c) Column 3. Name. This column shall contain the official name of the major components.

3.3.1.6.3.2.2 List of major units and assemblies (electronic equipment). A list of major units and major assemblies in tabular form shall be included as follows:

(a) Column 1. Unit number. This column shall list unit numbers for each major unit and major assembly.
(b) Column 2. Nomenclature. This column shall be subdivided into the following:

(1) Name of unit. This column shall list the official name of the unit or assembly.
(2) Designation. This column shall list the type designation of the unit or assembly.

(c) Column 3. Page number. This column shall list the number of the first page of the parts listing for the major unit or assembly.

3.3. 1.6.3.3 Parts list (electrical, mechanical, hydraulic, or pneumatic equipment). Parts listing shall be prepared in tabular form similar to the following:

(a) Column 1. Figure, index number, or locating coordinates. This column shall contain the figure number, index number or coordinates which shows the location of the part.
(b) Column 2. Part number. This column shall contain the part number or engineering drawing-index number.
(c) Column 3. Description. This column shall contain the designated name of the part with a brief description indicating its use and the military or manufacturer's specification number (e. g. , Cylinder Assembly, Drive Flap, Actuating, Dormer Company 66906). Attaching hardware, with quantity required, shall be identified. Subassembly parts shown on different figures shall reference the figure.
(d) Column 4. Notes. This column shall contain component information such as serial number, model number, configuration data, etc. When footnotes are used, reference the footnotes.

3.3.1.6.3.4 Parts list. arrangement (electronic equipment). The parts list shall be divided and arranged by major units in numerical sequence (e.g., Unit I with its parts, etc., will precede Unit 2 with its parts). Replaceable mechanical parts, such as gears, spacers, etc., shall be included in the parts list. All parts attached to the unit shall be listed first in alpha-numerical order, followed by unit assemblies with parts and subassemblies with parts, also listed in alphanumerical order as follows:

Unit 1	1
(Cabinet parts)	1ATI 1B 1 1C1 1CR1 1R1 etc.
Assembly	1A:
(Assembly parts)	1A1AT1 IA 1B 1 1A1C1 1A1CR1 1A1R1 etc.
Subassembly	1A1A1
(Subassembly parts)	IA1A1AT1 1AJA1B1 1A1AlC1 1A1A1CRI IA1A1R1 etc.
Unit 2	2 etc.

3.3.1.6. 3.4.1 Tabulation. Parts listing shall be prepared in tabular form with columns headed as follows:

(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 .ANSI Y 32.I6, shall be used to identify units, assemblies, subassemblies, and parts. The parts list shall be divided and arranged by major units in numerical sequence (e.g., Unit 1 with its parts will precede Unit 2 with its parts, etc.). 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 "thru". For example: 3A1 R69 thru 3A1RIOO not used.

(b) Column 2. Notes. This column shall contain equipment reference information such as serial number, model number, configuration data, etc.

(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, the electrical characteristics, and military type number of the item. Those parts not having a military type number shall also include physical characteristics (material and sufficient dimensions) to identify the parts within the set. For identical parts that are used five or more times in the equipment, the complete item description shall be given in the list of common item descriptions and reference made thereto by the item number. Following the item description, the equipment contractor's part number, manufacturer's part number, part manufacturer's Federal supply code number, and military type designation, as applicable, shall be included in the part description column. Attaching hardware used for mounting assemblies or components to the equipment with quantity required, shall he 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.

(d) Column 4. Parts location reference. This column shall reference the parts location illustration normally contained in the troubleshooting/repair volume (see 3.3.2. 6.5.1) by assembly reference designation number. If the parts location illustration follows the parts list, (see 3.3.1.6. 3.8) reference shall be by figure number, followed by item number or locating coordinate number in parentheses.

3.3.1.6.3.5 List of common item descriptions This list shall include the description of all multiple use parts (over five applications). The description shall contain the same information specified in 3.3.1.6.3.4.1. Like parts should be grouped and arranged in alphabetical order. Item numbers shall be assigned consecutively, for example:

Item Number	Description
1	CAPACITOR, FIXED, CERAMIC: DI-ELECTRIC 3PF, 500 VDCW: MIL TYPE CCZ1UJ030C
2	CAPACITOR, FIXED, GLASS: DI-ELECTRIC 5100 PF, +/-1% 300VDCW, mfr 86262, dwg 231B743H15
3	RESISTOR, FIXED, COMPOSITION: 3000 ohms +5% 1/2w; mfr 42384, dwg 446D9
4	RESISTOR, FIXED, COMPOSITION: 4000 ohms +/- 5% 1/2w; MIL TYPE RC20GF402J

3.3.1. 6.3.6 List of attaching hardware. A list of standard attaching hardware shall be included and identified by MIL-HDBK-131 and further identified by Military Standards (e.g., AN, JAN, MS) numbers. (Items used fewer than five times need not be included, but if not included shall be completely identified in the parts list.) For example:

Letter Code	Name and Description
A	SCREW, CAP, HEX HEAD, DRILLED HEAD, CRES: MS51100-8 1/4-28, UNF-2A, 1 in lg.
B	WASHER, FLAT, STEEL, ROUND, .750 in OD, .312 in ID, .066 in thickness

3.3.1.6.3.7 List of manufacturers. The list of manufacturers shall contain the names, addresses, and code symbol of all manufacturers supplying items for the equipment as referenced in the parts list. The list shall be presented in numerical sequence by code number. Code numbers shall be in accordance with Handbooks H4-1 and H4-2.

3.3. 1. 6.3.8 Parts location illustrations. Parts location Illustrations shall be provided to locate all parts listed in the parts list. When the parts location illustration is not included in the troubleshooting. repair volume, it shall be included at the end of the parts list in accordance with 3.3.2.6.5, 1. (Suitable parts location illustrations located in other parts of the manual may be referenced.) Standard attaching hardware items (such as nuts, bolts, washers, screws) need not be called cut or illustrated (except on exploded views) unless they are referenced in a procedure. Illustrations required for repair and replacement in the troubleshooting/repair volume need not be repeated but shall be referenced.

3.3.2 Troubleshooting/repair volume. The troubleshooting/repair volume for equipment manuals shall be in one or more parts in accordance with 3.8.2 and shall include front matter in accordance with 3.2 and the following data:

(a) Family tree.
(b) Interconnecting cabling/piping diagram.
(c) Turn-on/check-out chart.
(d) Overall function information:

(1) Diagram.
(2) Text.
(3) MDC.
(4) Equipment alignment instructions.

(e) Major function information:
(1) Diagram.
(2) Text.
(3) MDC.

(f) Hardware information:
(1) Blocked Diagrams
(2) Text
(3) MDC
(4) Repair/alignment instructions
(5) Parts data
(6) Wiring diagrams

3.3.2.1 Family tree. A family tree shall be provided which shows the breakdown structure of the equipment into units, assemblies, and subassemblies as shown on figure 9.

3.3.2.2 Interconnecting cabling/piping diagram. A pictorial representation (see figure 10) of all electrical, hydraulic, and pneumatic interconnections shall be provided. The diagram(s) shall identify all cables, pipes, wave-guides and connecting devices by reference designation. A tabular listing of parts information shall be included for all items not included in the other parts tables.

3.3.2.3 Turn-on/check-out chart. A combined turn-on/check-out chart shall be supplied (see figure 4).
The chart shall be similar in appearance to the overall function level maintenance dependency chart except that only the sensory indications will be included in the body. The heading of the turn-on/check-out chart shall identify the major function information which shows the respective indicator. A specification table shall augment the sensory indication so that the user can judge whether the indications are within the desired range (e. g. antenna rotates at 4 rpm). Noncritical information such as the speed of a blower need not be included.

3.3.2.3.1 Check-out procedures. Check-out procedures shall be limited to those that can be performed at operating positions. Turn-on and check-out steps shall be the same steps and in the same sequence as those contained in the overall function level maintenance dependency chart. The procedures in the left-hand columns shall be the normal operational sequence and shall account for the complete exercising of all functions within the equipment that result in a normal operating sensory display.

3.3.2.4 Overall function information. Overall function information shall provide troubleshooting information which will permit fault diagnosis to a major function. This information shall include an overall function diagram, keyed text, and an MDC.

3.3.2.4.1 Overall function diagram. The overall function diagram shall identify all major functions and the interrelationship between the various major functions that comprise the equipment as shown on figure 11. One of the major functions shall be power distribution.

3.3.2.4.1.1 Intermediate function diagram. When the total number of major functions on the overall function diagram becomes too numerous to be shown clearly on one page, one or more intermediate function diagrams as shown on figure 13, shall he used to simplify the presentation of the overall function diagram.

3.3.2.4.2 Presentation (see 3. 5). The overall function diagram (and intermediate function diagram) shall be arranged so that a user can readily understand and identify the major functions performed by the equipment. Each major function shall be represented on the overall function diagram by a single level blue shade (see 3.5.1). Each signal that interfaces between major functions shall be identified with a signal nomenclature flag. Signal lines shall also have arrowheads that show direction and nature of the information flow. Mechanical linkage interfaces between major functions shall also be shown. Each front panel switch or control, as well as indicators that are involved with the major function, and the major function MDC shall be identified by front panel markings and shall he shown in a white background area. Grey shades shall be used to define hardware boundaries (see 3.5.2).

3.3.2.4.3 Keyed text. Keyed text shall be in accordance with 3. 6 and shall describe the operation of each of the major functions as they relate to each other and to the overall equipment operation.

3.3.2.4.4 Maintenance dependency chart. The maintenance dependency chart shall be in accordance with 3.7 and shall contain all data necessary to isolate a potential fault to a major function (see figure 12).

3.3.2.4.5 Overall alignment. Overall alignment instructions in accordance with 3.3.2.6.4. 1 shall be included.

3.3.2.5 Major function information. This information shall include a major function diagram, keyed text, and MDC. Troubleshooting information shall be provided which will permit fault isolation to a given hardware unit/ assembly.

3.3.2.5.1 Major function diagrams. A major function diagram shall be prepared for each functional block shown on the overall function diagram. The diagram shall show the interrelationships between the functional entities as established on the blocked schematics (see 6.4. 1). Major function diagrams fall into four general categories or combinations thereof:

(a) Block diagrams for analog circuitry (see figure 15).
(b) Block diagrams for logic circuitry (see figure 19).
(c) Power distribution diagrams (see figure 14).
(d) Equipment ground/return diagrams (see 3.3.2.5.1.2.1(d).

The functional bounds of the diagram shall be decided by the function performed and shall not be limited by the physical subdivisions of the equipment. Additionally, the Functional bounds shall be chosen to minimize the number of interfaces to other major functions. Major function diagrams shall be limited to a single page. All interfacing functions and connections shall be included. When it is impractical to include all functional entities on a major function diagram, one or more functional entities may be symbolized by a rectangle and expanded on a subfunction diagram, provided the inputs and outputs are clearly indicated.

3.3.2.5.1.1 Subfunction diagrams. Subfunction diagrams shall be constructed to simplify the major function diagram. Each subfunction diagram shall be limited to a single page. Subfunction diagrams shall be developed by the same. rules as major function diagrams. Interfacing points to the major function diagram shall be clearly indicated.

3.3.2.5.1.2 Presentation. The diagrams shall be constructed to illustrate the operation and interrelationships of the functional entities. The details of the diagrams shall be arranged such that major signals flow from left to right to the extent possible and feedback signals flow from right to left. Power circuits shall not be included as part of the analog and logic block diagram(s), but shall be included on the power distribution diagram(s). Relay coils shall be grouped on the diagrams in a manner consistent with the equipment design or construction and by the logic operations performed. Such grouping may be by control functions, mode of operation, physical limits of cabinet or assembly, etc. A functional name shall be shown for each relay coil. Mechanical linkage from a relay coil to its contact sets shall be used to signify the direction of motion for the moveable contact. Contacts of relays and switches shall be identified by the contact number/letter code which appears on the blocked schematic. Lamps, indicators, and switches shall be labeled by reference designation and by the assigned panel inscription. General and specific notes shall be used to clarify any conditions which are not apparent by observation of the diagram.

3.3.2.5.1.2.1 Symbology. Symbology shall conform to the examples shown on figure 6 and the following:

(a) Analog circuits. Each functional entity on a blocked schematic, comprised of piece parts, (as opposed to integrated circuits) shall be represented by a line art triangle, truncated-triangle, rectangle, or a square. Other electronic symbols specified in ANSI Y32.2 may be used to improve understanding. See figure 6 for definition and use of the shapes for electrical/electronic diagrams. Mechanical, hydraulic and pneumatic diagrams shall use pictorial views to the extent possible to convey the relationships. Electrical circuits in combination with mechanical, hydraulic, and pneumatic devices shall integrate appropriate symbols as required, (see figure 16).

(b) Logic circuits. The distinctive shape logic symbols as shown in ANSI Y32. 14 shall not be used if they are a duplication of the blocked schematic symbology. Rather, a line art rectangular box shall be shown which represents the lightest shade of blue (a group of functional entities) on the blocked schematic. The line art box shall contain the same name or circuit identifier code as the corresponding blocked schematic blue shaded area. Inputs shall be to the long dimension on one side of the rectangle and outputs shall be to the other long dimension. The size of the rectangle shall be chosen to accommodate the number of signal leads shown. (Figure 19 and figure 21 show the relationship between the major function diagram and the block schematic diagram respectively.)

(c) Power distribution diagrams. Power distribution diagrams shall depict the distribution of primary a. c. power, secondary a. c. power, and d. c. power from the terminal board, breaker, or fuse box to the various subassemblies or modules of the equipment. Normally, an individual diagram shall be prepared for each separate voltage used within the equipment. The requirements for symbology shall be the same as for analog circuits (see 3.3.2.5. 1.2. 1(a)). The following rules apply in the preparation of power distribution diagrams:

(1) Show and identify motors, transformers, regulators, power supplies, assemblies, subassemblies, and modules.
(2) Show and identify all power line devices such as fuses, circuit breakers, switches, and relay contacts.
(3) Show and identify all connections including plugs, jacks, and terminal boards in the distribution path.
(4) Include voltages and tolerances, as required.
(5) Show and identify all metering circuits and indicators.
(6) Show all grounds, commons, neutrals, and return lines. The symbology used shall be the same as appearing on the associated blocked schematic.
(7) Whenever practicable, power paths are displayed from left to right and from top to bottom.

(d) Equipment ground/return diagrams. Equipment ground/return diagrams shall be prepared for equipments wherein excessive diagram space would be necessary to illustrate the equipment's grounding and signal returns on functional block diagrams and power distribution diagrams. The symbology used shall be the same as on the associated blocked schematics.

3.3.2.5. 1.2.2 Interface with other functions. Energy, signal or data entering or leaving a :unction, must be interconnected and consistently identified to establish an interface between block diagrams. The output of a function shall terminate in a blue shaded area representing the major function diagram on which the signal is to be used. The input to a function shall originate in a blue shaded area, representing the function from which it came. Whenever possible, interface points shall be selected at connectors or other identifiable tie points where measurements may be made. These connectors or tie points shall appear on both interfacing functional diagrams. Except for cases involving mechanical motion, such as in relays, interfaces shall be avoided internal to single components. When interface tie-in is to other equipment, include all signal nomenclature and other pertinent interface considerations. Shaded areas are not required for external equipment.

3. 3. 2. 5.1.2. 3 Interconnections. All plugs, jacks, cables, piping, and junction boxes which provide the interconnection between the units, assemblies, etc., shall be shown and identified. Point-to-point wiring between circuit elements within an assembly need not be shown; however, all interconnections between assemblies shall be accounted for.

3.3.2.5.1.2.4 Hardware identification. Each identifiable unit, assembly, or subassembly shall be identified as follows: major hardware units shall be identified in the upper left-hand corner of the hardware area with the unit reference designation, followed by official nomenclature, e.g., Unit 2, R-4107/ URQ Receiver. Assemblies and subassemblies shall be identified in the upper left-hand corner of their respective hardware areas with the reference designation.

3.3.2.5.1.2.5 Functional entity arrangement. Functional entities shall be grouped and enclosed in a blue shaded area to illustrate their functional relationship. Each blue shaded area shall be assigned a name that denotes the function of the shaded area, e.g., divide by 10 counter, AGC Network, Servo Amplifier. When individual parts function independently, the individual part shall be enclosed in a separate blue box and shall be properly identified. Normally each major function diagram will contain only one level of blue shading. Blue shading shall not overlap hardware boundaries. Functions that overlap hardware boundaries shall be split and identified as "Part of".

3.3.2. 1.2.6 Functional entity identification. Each functional entity symbol shall contain the same circuit identifier code or name as the schematic entity which is being represented. Symbols representing a single part or device shall be identified by its assigned reference designation.

3.3.2.5.2 Keyed text. Keyed text shall be in accordance with 3.6 and shall describe the "what" and "when" of each of the functional entities.

3.3.2.5.3 Maintenance dependency chart. An MDC shall be prepared for each major function/subfunction diagram and shall contain data necessary to isolate a potential fault to a subfunction or piece part mounted on the mainframe, (see figures 17 and 18). MDC development shall be in accordance with 3.7. Troubleshooting information for major functions that contain large amounts of digital circuitry may consist of fault logic diagrams in accordance with 3.3.2.5.4 instead of MDCs. Such fault logic diagrams shall only be provided when the complexity of the digital circuitry makes the MDC an ineffective troubleshooting method. When an automatic test program is used with built-in performance monitoring/fault localization circuits, MDCs or fault logic diagrams are required for the performance monitoring/fault localization circuitry and test programs. MDCs or fault logic diagrams are not required for functions in which fault localization is accomplished by the automatic test.

3.3.2.5.4 Fault logic diagrams. Fault logic diagrams shall be based on a fault indication observed during troubleshooting (see figure 27). The diagram 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 informatioe needed to complete the fault isolation and repair. Each diagram shall include or make reference to information establishing the initial conditions required for the fault isolation procedure.

3.3.2.6 Hardware information packages. A hardware information package shall be prepared for every unit, assembly, and subassembly. Hardware packages can be combined on one or more pages provided the data is clearly arranged in reference designator sequence. Each hardware information package shall consist of the following parts, as applicable:

Blocked schematic.

(a) Keyed text.
(b) MDC'.
(c) Alignment/repair data
(d) *Parts data.
(e) Wiring diagrams.
(f) 'MDC, repair data and parts data not required for assemblies contractually designated "throw-away", although schematic, logic and other relevant information required for understanding is required.

3.3.2.6.1 Blocked schematic diagram. Regardless of the contractual designated maintenance philosophy (repairable, return for repair, or throw-away), one blocked schematic diagram shall be provided for each different assembly. However, identical assemblies need be illustrated only once. This requirement includes a schematic for each drawer or chassis and all other enclosures.

3.3.2.6.1.1 Presentation. The blocked schematic shall be arranged to produce an easy to understand, functional layout. Circuit elements shall be grouped into functional entities (see figure 20). The arrangement of elements within functional entities shall assist in circuit comprehension for a reader trained in the related subject. The location of functional entities and functional devices on the page shall cause the direction of signal flow to be obvious and when possible, from left to right. When possible, feedback signal flow shall be from right to left. Voltage information shall be included on the diagrams of vacuum tube and transistor circuits as an aid to fault localization and isolation. The voltage value at each pin and test point shall be placed next to the pin or test point on the diagram, if the value is significant.

3.3.2.6.1.2 Symbology. Schematic symbols for discrete electrical or electronic circuit parts shall be in accordance with ANSI Y32.2. Schematic symbols for logic integrated electronic circuits shall be in accordance with the distinctive shape requirements of ANSI Y32. 14. Symbols for mechanical, hydraulic and pneumatic devices shall clearly portray how the parts relate and operate to produce the motion or energy transformation required. The symbols for mechanical devices shall be pictorials, cutaways, or exploded views (see figure 22). To indicate signal flow on piping diagrams, symbols in accordance with ANSI Y32. 10 may be used.

3.3.2. 6.1.3 Functional entities. All circuit elements and functional devices shall be grouped into functional entities according to the following rules:

(a) Circuit elements and functional devices which work together to perform a basic operation shall be grouped as a single functional entity, e.g., amplifier, emitter follower, multivibrator, etc.

(b) The symbols representing portions of integrated circuit elements working together to perform a basic function shall be grouped to form functional entities, e.g., amplifier, gates, Gip-flops, etc. Discrete circuit parts associated with an integrated circuit element (pull-up resistor, integrating capacitor) shall be grouped within the integrated circuit functional entity.

(c) Basic grouping shall consist of the least number of circuit elements or functional devices which perform a discrete operation.

(d) Parts of mechanical, hydraulic, and pneumatic devices, such as gears, pumps, etc., shall be grouped so that the functional entity portrays a discrete operation (see figure 23).

3.3.2.6.1.3.1 Electrical power circuits. Circuit elements and functional entities involved with the control and distribution of electrical power within an assembly, e.g., the decoupling filters, voltage dividers, voltage regulators, etc., shall be grouped within a composite power entity. To the extent possible, the composite power entity (C-PWR-1) shall be positioned in the lower left-hand corner of the schematic (see figure 20).

3.3.2.6. 1.3.2 Functional entity identification. Each functional entity shall be enclosed in a blue shaded area (see figure 20). The entity identifier codes which describe fundamental circuits usually consist of three or more letters and a number(s) arranged as shown on figure 6. The list on figure 6 does not include all possible combinations of coding. It is not the intent of this specification to preclude the generation of new codes to meet specific needs. To the extent possible, the functional entity identifier codes shall be placed in the upper left-hand corner of their respective color-shaded areas. Preceding the identifier code shall be an encircled text reference number. .A single circuit element or a single functional device which constitutes the complete functional entity shall be identified by its assigned reference designation. Solenoids of all electrical-mechanical devices such as relays, valves, brakes, shall be identified by a functional name, in addition to any reference designation.

(a) The first letter of a functional entity code defines a general characteristic of the functional entity.

C - composite
H - hydraulic
I - integrated circuit
L - magnetic
M - mechanical
N - network (passive)
P - pneumatic
Q - transistor
V - electron tube U U - microwave
X - semiconductor diode

(b) The second grouping of letters defines the purpose of the functional entity.

AMP - amplifier
OSC - oscillator
EF - emitter follower
VD - voltage divider
FF - flip-flop

(c) The number differentiates between similar classifications of a functional entity used more than once in an assembly.

Q-OSC-1
Q-OSC-2 etc.

3.3.2.6. 1.3.3 Treatment of logic circuits. Schematic symbols for integrated electronic logic circuits shall be in accordance with the distinctive shape requirements of ANSI Y32. 14. Logic functional entities shall be grouped into two functional orders. The larger grouping shall be shown in the lightest blue shading and assigned a circuit identifier code or a function name, e.g., DECODER, DIVIDE BY 10 COUNTER, etc. The assigned name and text key number shall appear in the upper left corner of the blue area. The distinctive shaped symbols shall be enclosed in a second (darker) shade of blue and assigned a circuit identifier code. Flow charts for digital devices shall be provided to support the explanation of machine instructions and test programs, and shall conform to ANSI X3. 5.

3.3.2.6.1.4 Electronic tube filaments. Tube filaments shall not be treated as functional entities. All tube filaments (except those filaments which are an integral part of the cathode) shall be grouped and positioned just above or to the right of the composite power entity. Tube filament groupings shall show each filament pin connection and identify each filament by its associated tube reference designation.

3.3.2.6.1.5 Power circuit distribution lines. Power circuit distribution lines shall terminate with a break symbol (-S) inside the composite power entity. Power, ground, and return lines shall not be shown connected to tae functional entities by lines but connections shall be implied by the use of symbols for grounds and returns and by break symbols for supplied power. Distribution of power to integrated circuits may be indicated by statements in the general and specific notes. The voltage shall be indicated at the break symbol of each distribution line. When the voltage data is not definable because of varying circuit parameters, then the distribution line shall be identified at the break symbol by its polarity and identifying letter(s), e.g., -V(A), +V(B), -V(A), etc.

3.3.2.6.1.6 Hardware identification. Each unit, assembly or subassembly which has a military nomenclature or reference designation shall be identified by means of gray shading and as follows: The reference designation followed by the name of the assembly shall appear in the upper left-hand corner of the hardware area. The words REF DESIG PREFIX followed by the reference designation shall appear in the lower right-hand corner of the hardware area.

3.3.2.6.1.7 Circuit element data. In addition to the assigned reference designation, the following types of data for circuit elements or functional devices shall be included:

(a) Resistors - resistance value, tolerance, and wattage.
(b) Capacitors - capacitance value, tolerance, and voltage rating.
(c) Coil, motors, and other wire-wound devices - value, tolerance, and resistance when significant.
(d) Power transformers - the measured voltage across secondary windings.
(e) Pumps - volume per unit time.
(f) Breakdown diodes - zener voltage level.
(g) Diodes and transistors - type number (JAN designation, if available).
(h) Integrated circuits. Integrated circuit element symbols shall contain the reference designation. Pin numbers shall be positioned next to input and output lines, external to the symbol. The description of inputs and outputs of flip-flops, dividers, etc., shall be identified within the symbol, e.g., C, D, J, K, Q, Q. Identification of noninverting and inverting inputs to operational amplifiers shall be by + and - signs within the symbol.

3.3.2.6.1.8 Unused terminal information. Spare relay contacts, connector pins, terminal connections, other connective-type devices, switch contact sets, or spare leads, etc., which are available for future use, shall be shown either in the schematic area, or listed in tabular form on the same or facing page.

3.3.2.6.1.9 Notes and source data blocks. A portion of the diagram, preferably in one of the four corners, shall contain such notes as are required, and the source data of the diagram. General notes shall be of the "unless otherwise specified" variety; e.g., resistance values are in ohms; diodes are type 1N270; etc. Flag notes shall explain special or unusual situations shown in the diagram, e.g., R10 is 15K for serial numbers 22 and up; C13 is selected per receiver alignment procedures; etc. The source data block shall identify the specific engineering documents and their issue used to create the blocked schematic.

3.3.2.6. 1.9.1 Multiple-use assembly table. A multiple use assembly table shall be provided in the notes area when identical assemblies are used in the equipment. The table shall indicate the hierarchical location of assemblies.

3.3.2.6.2 Keyed text. Keyed text shall be provided for each blocked schematic diagram, in accordance with 3. 6, and shall describe each functional entity included on the blocked schematic.

3.3.2.6.3 Maintenance dependency charts. Maintenance dependency charts (MDCs) shall be supplied for each different assembly in accordance with 3.7 to permit fault isolation to the functional entity level. Identical assemblies need be illustrated only once. Certain assemblies may not require MDCs if they contain few functional entities (front panels, mainframes, etc.), or if the functional entities are covered on another maintenance dependency chart because related piece parts; e.g., servo amplifiers, etc., are on different assemblies.

3.3.2. 6.4 Alignment and repair.

3.3.2. 6.4.1 Alignment. Each assembly containing adjustable parts shall be provided with detailed alignment instructions. Interacting adjustments shall be referenced to equipment alignment procedures.

3.3.2. 6.4.2 Assembly repair. Instructions shall be provided for removal, repair, adjustment, and replacement of assemblies, subassemblies, and parts when the method or procedure is not obvious, e.g., removal of other assemblies in order to gain access, replacement of brushes, etc. Information such as mechanical adjustments, tolerances, clearances, wear limits, bolt-down torques including bolt-head identifications, in-place balancing, and means of reducing noise level shall be included.

3.3.2. 6.4.2.1 Repair illustrations (CG, MC, N). Exploded and sectional views giving details of mechanical assemblies (such as gear trains, etc.) shall be provided as necessary to supplement detailed removal and replacement instructions. All mechanical and electromechanical parts covered in the procedures shall be keyed to the illustration by a call-out (index) number. These parts shall be tabulated and described by item name, manufacturer's part number, or vendor's (true manufacturer) number. However, only one identification number may be used for each item. The illustration and procedures shall be provided on the same or facing pages. Information on the use of special tools and test equipment supplied with the equipment shall be provided. Any warnings or cautions which must be observed to protect personnel and equipment shall also be included.

3.3.2. 6.4.2.2 Repair illustrations(A). Exploded and section views giving details of mechanical assemblies (such as gear trains, etc.) shall be provided to supplement detailed piece-part removal and replacement instructions. Each part covered in the procedures shall be keyed to the illustration by a call-out (index) number. Views and procedures shall be provided on the same or facing pages. Any warnings or cautions required to protect personnel or equipment shall be included. A statement shall be made that the special tools, parts, and special equipment sets supplied with (or issued for use with) the material is listed in the Basic Issue Items List and Items Troop Installed or Authorized List,

or Repair Parts and Special Tools List, as applicable, and that common tools are authorized in the Table of Organization and Equipment, Modified Table of Organization and Equipment, Table of Distribution and Allowance, Modified Table of Distribution and Allowance. These items need not be described or explained. However, the proper use of certain tools in these sets may be illustrated in connection with assembly, disassembly, or adjustment of the material when appropriate. The use of special designed tools and equipment issued for the purpose of maintaining or adjusting the material shall be briefly described.

3.3.2.6.5 Parts data. Parts data shall be provided for each repairable assembly (including mainframe assemblies, cabinets, and other enclosures) of the equipment. Parts data shall consist of a parts location diagram and a parts list-

3.3.2.6.5.1 Parts location diagrams. Line art diagrams shall be used for parts location whenever possible. Expanded views shall be used with the main illustration to highlight areas of importance. A sufficient number of illustrations and views shall be used so that all reference designated parts can easily be located. Also, in equipments having modular construction, an illustration shall be provided to identify each module and its location.

3.3.2.6. 5.2 Location method. All assemblies and parts assigned a reference designation or name, including hardware parts referred to in disassembly and repair procedures, shall be located by means of leaders and call-cuts or an alphanumeric coordinate system. Illustrations, except exploded views, locating 15 or more items shall use a coordinate system for parts location. A blue overlay grid may be used when the grid will not diffuse the clarity of the illustration. Otherwise, only zone indicating borders shall be used. The coordinate locators shall appear on all four sides. Zone size shall be as required to clearly locate all reference designated parts (see figure 20).

3.3.2. 6.5.3 Parts data table. Parts data shall be listed in tabular form with columns headed as follows (see figure 20):

(a) Column 1. Reference designation. This column shall list the part's reference designation in alphanumeric sequence.

(b) Column 2. Locating coordinate or figure reference. This column shall provide the locating coordinate of the parts (if grid method is used) or by item number.

(c) Column 3. Name and description. When a separate parts list is provided in accordance with 3.3.1.6, this column need only provide the generic name of the item. When a separate parts list is not specified in the contract or order, this column shall include descriptive data to identify the parts of the equipment. Parts list shall include, hit not be limited to, such items as electrical-electronic circuit elements, valves, bearings, special threaded fittings, transformers, power circuit breaker and replacement items such as contact tips, coils, 0-rings, gaskets, shims, gears, and brushes. Identification of the part shall be by military type number, contractor's or true manufacturer's numbers. Identification of contractor and manufacturer may be by name or federal supply code. Common hardware items (nuts, bolts, washers, etc.) of mechanical assemblies shall be listed. Common hardware items of electronic chassis need not be listed unless they are referenced in a procedure. Hardware items with special characteristics; e.g., stainless steel, nonmagnetic, extra hardness, shall be listed.

3.3.2. 6. 6 Wiring Diagrams. A pictorial diagram showing point to point wiring shall be prepared for each chassis, backplane and front panel assembly, (see figure 24). Wiring diagrams for printed circuit boards are not required. Double-entered running wire list may be substituted for backplane wiring diagrams. All entries in wire lists shall be arranged in alpha-numerical order. Wiring diagrams or wire list shall be located with the appropriate hardware data package.

3.4 Detailed content requirements for system manuals (type II). System manuals shall provide system-oriented instructions for operation, maintenance, installation, and performance standard testing. Detailed equipment data should be provided by reference to the equipment manuals. However, equipment level technical data shall be included for all equipment not covered by an equipment technical manual. Unless otherwise specified, a FOMM system manual shall be arranged into two volumes. The first volume shall include all the general support information. The second volume shall include all data necessary to isolate a malfunction to a particular equipment or system component. A single volume approach shall be used when all material required for both volumes can be included on 20 pages excluding parts lists (11 X 27 inches) or less. The title of a single volume manual shall be "FOMM System Technical Manual for

3.4.1 Support volume. The support volume shall be arranged in sections according to the following:

(a) Front matter (see 3.2).
(b) Section 1 - General information (see 3.4.1.1).
(c) Section 2 - Safety precautions (see 3.4.1.2).
(d) Section 3 - Operation (see 3.4.1.3).
(e) Section 4 - Theory of operation (see 3.4. 1.4).
(f) Section 5 - Scheduled maintenance (see 3.4.1.5).
(g) Section 6 - Alignment (see 3.4.1.6).
(h) Section 7 - Installation data (see 3.4.1.7).
(i) Section 8 - Parts list (see 3.4.1.8).

3.4.1.1 Section 1. General information. Section 1 shall describe the system in general physical and functional terms as specified in 3.4.1.1.1 through 3.4.1.1.5.

3.4.1.1.1 Introduction. The introduction shall define the system and its relationship with other systems. The mission of the system shall be stated. The text shall be supported by a diagram(s) showing the interrelationships of the system equipments (see figure 29). The major functional relationship and inputs and outputs to related systems shall be indicated.

3.4.1.1. 2 Physical arrangement. System areas and compartments shall be described and the system equipment and units contained in the areas shall be listed. The physical arrangement description shall be supported by the following illustrations.

(a) An inboard profile drawing of the vehicle, aircraft, ship, building, or station showing compartment, room, or area locations and identifying equipment units comprising the system (see figure 30).

(b) Separate illustrations of each compartment and area, identifying the listed system equipment (see figure 31). Other equipment, which is installed in the subject system compartments and areas, need not be listed in the text or called out in the illustrations if they do not directly affect the operation or maintenance of the subject system.

3.4.1. 1.3 System equipment. Each of the equipments comprising the system shall be identified and described. Descriptions of operator-attended equipment shall include statements as to the nature and purpose of units and indicators. The text shall be supported by illustrations. All equipments shall be shown, in relative-scale, not necessarily proportional. Equipment shall be separately illustrated with significant features called out for proper support of the text used to relate equipments to each other.

3.4.1.1.4 Associated-system equipment. Descriptions and illustrations of associated-system equipment shall be limited to the major units thereof. The descriptions shall be more condensed than those of subject system equipment; otherwise, the same requirements are applicable. In the descriptions, emphasis shall be placed on those associated systems equipments that constitute operational or functional interfaces with the subject system. Such units shall be included in the system illustrations.

3.4.1.1.5 Reference data. Reference data shall include a list of the equipment comprising the system, and its official designations. A list of common names and abbreviated or informal nomenclature, and system characteristics together with a list of referenced publications shall be included as follows:

(a) Capabilities. A summery of system capabilities shall be provided. The summary shall include data such as gallons per minute, transfers per hours, boom capacity, rated ranges, resolution, accuracy, data handling capability, number of channels, etc. Such data should be presented in tabular form.

(b) Reference publications. A list of the manuals that pertain to system and system equipments, and other documents of interest, such as training manuals and manuals for associated systems equipment shall be included. The list of publications shall include the title and publication number of the referenced publications.

(c) Tools and test equipment. A list of all special tools and test equipment for system-level maintenance tests shall be included. Selection of test equipment shall be in accordance with 3.3.1.1.6. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in offices of the Defense Contract Administration Service (DCAS)). An illustration and description of special items required shall be provided for identification. Information shall be presented in tabular form. For each item the description or table shall include:

(1) The official name or nomenclature.
(2) Identifying number.
(3) A brief description of the use of the item with a reference to the procedure(s) requiring its use.

3. 4.1.2 Section 2. Safety precautions. Section 2 shall describe the hazards associated with system operation and maintenance. To permit wide and unrestricted use, Section 2 should contain only unclassified information.

3.4.1.2.1 Introduction. This introduction shall be directed at system supervisory personnel, and shall include the following:

(a) Purpose, scope and organization of the system safety instructions.
(b) Basic safety concepts.
(c) Basic responsibilities for safety.

3. 4.1.2.2 Electromagnetic radiation hazards and precautions. Describe the radiation hazards: n personnel and the precautions to be taken. The hazards of radiation to flammable or explosive materials also shall be described. The description shall include discussions of the following:

(a) Locations of radiation hazardous areas.
(b) Minimum safe distances on the axis of beam radiation.
(c) Precautions to be taken when entering areas of radiation hazard (such as the wearing of copper-screen goggles).
(d) The effect of radiation on flammable or explosive material such as induction of rf currents in metals, sparking, and the consequent possibility of igniting flammables or detonating explosives. The text shall be supported by one or more illustrations identifying the areas of radiation hazards and the location of antennas, etc.

3.4.1.2.3 Hazards to divers. When applicable, the description of hazards to divers shall include but shall not necessarily be limited to the following:

(a) The nature and intensity of sound energy in water as related to divers.
(b) Precautions to be taken when working near operating equipment.
(c) Illustrations identifying the hazardous areas and locations of sonar domes, propellers, water intakes, etc.

3.4.1.2.4 System hazards and precautions. Include descriptions of system hazards and precautions, addressed to system personnel and referenced to particular system equipments. The descriptions shall be organized to be consistent with the operation of the system. The descriptions shall supplement and extend equipment safety instructions to the system level, by warning of potential hazards that can be caused during operation or maintenance.

3.4.1.2.4.1 Operational safety summary. A summary shall be included which emphasizes the proper use of equipment controls and describes the hazards to operators and shall include a listing of the hazards to persons in areas remote from the operation. This summary shall also recommend operator precautions. An emergency operational procedure shall be included which emphasizes the controls that permit immediate braking or deenergizing of the system.

3.4.1.2.4.2 Maintenance safety summary. A maintenance safety summary shall emphasize the proper use of controls, describe the hazards to maintenance personnel, potential damage to the equipment, and recommended precautions.

3.4.1. 2.4.3 Hazardous components. Identify and briefly describe the hazardous components including radioactive devices and elements used with the system and summarize the general handling precautions for such components. The description of a hazardous component shall include brief statements as to the purpose, manner of functioning, nature of built- in safety devices, and nature of the hazardous element; it shall also indicate the relative sensitivity of the component to mechanical shock, vibration, electromagnetic and radioactive radiation, and electrostatic discharges.

3.4. 1.2.5 Warnings, cautions, notes. Warnings, cautions, and note blocks shall be included on applicable pages, as prescribed in MIL-M-38784.

3.4.1.3 Section 3.Operation. Section 3 shall be divided into two parts; Part one shall be entitled Operator Instructions; Part two shall be entitled Conditions of Readiness.

3.4.1.3.1 Operator instructions. Operator instructions shall describe system operating situations, modes, and procedures. The descriptions shall be detailed to the level required for an understanding of the operational interfaces of the system equipments and associated systems. Illustrations shall be included when necessary for clarity (see figure 3). The various operating modes shall first be described to acquaint the operator with all equipment combinations that can be employed to effect a given mode of operation.

3.4.1.3.1.1 Preoperational conditions and setup. These instructions shall list specific preoperational conditions presumed to be in effect prior to system operation. A system readiness checkoff list of significant switch positions and indicator status shall be tabulated. Controls provided fee maintenance or self-test shall be included in the checkoff list. For indicators such as dials, where a band of readings is possible, upper and lower limits shall be delineated. The initial conditions of associated-system equipment that directly affect system operation shall also be given.

3.4.1.3.1.2 Operating modes. The primary operating mode shall be discussed in detail, and alternate modes shall be treated as modification of the primary mode. Operating procedures common to all modes shall be detailed under the primary mode and referred to under the alternate modes, with such modifications of procedures as may be necessary. Each mode shall be described in the logical sequence of major phases, events, options, supervisory commands, and responsive actions and the following:

(a) Those equipment operational controls and indicators having system significance shall be explained in the description. When controls must be actuated and indicators observed in a sequence to achieve system operation, the descriptions shall cite each control and indicator with a number to indicate the order in the sequence.

(b) Warnings and cautions shall be used to emphasize the safe operation of controls where improper use could result in hazards to personnel or damage to the equipment. Each control shall be followed by a brief description of its effects (equipment actuation or display indication, or both) at the operator station and at remote stations. The primary mode description shall be supported by both general and detailed illustrations.

(c) Operational phases which involve operator judgment shall be illustrated by operational diagrams. The diagrams shall indicate the conditions that must be favorable prior to an operator action, or if unfavorable, indicate the alternate action. Illustrations showing dials, gages, status lights, etc., which indicate the favorable or unfavorable conditions shall be included. Special procedures to be followed when an equipment failure may be bypassed (as separate from emergency procedures) shall also be described.

3.4.1. 3.1.2.1 Normal operation. The duties of system operators shall be described in terms of general responsibility and specific step-by-step procedures for operating the system in all of the primary modes. System controls and indicators provided only for maintenance and nonsystem application shall not be called out.

3.4.1.3.1.2.2 Emergency operation. Step-by-step procedures shall be provided for emergency operation of the system. If specially designated controls have been provided for emergencies, a short statement shall be included describing how they modify or otherwise affect normal system operation. Emergency procedures shall be supported by illustrations. .

3.4.1.3.1.2.3 Special operation. Special operations such as test checkout, training, or evaluation exercises shall be described. Supporting illustrations shall include block diagrams and pictorial diagrams.

3.4.1.3.2 Conditions of readiness. This part of the operation section shall be provided for guidance purposes and shall represent engineering considerations. It shall list conditions of readiness requirements prior to the operation of the system. Activities or conditions within compartments or areas outside the system shall be described as necessary.

3.4.1.3.2.1 Conditions coverage. An orientation of system personnel shall be included. The condition of readiness shall be included as follows:

Watch condition
General quarters condition
Emergency condition

Coverage shall include but not be limited to the following:

(a) A block diagram showing signal paths of the conditions of readiness (see figure 32).
(b) Block diagrams and descriptions of interior communications links between compartments and areas, including telephone circuits, announcing systems, and closed-circuit television.
(c) Presumptions relative to systems status at specified times. (For example, from watch condition to general quarters conditions, or from general quarters condition to emergency condition.)

3.4.1.3.2.2 Watch condition. Describe the condition of all systems equipment and the personnel situation for watch condition. The control settings shall be described and illustrated when necessary.

3.4.1.3.2.3 General quarters condition. Describe the condition of all systems equipment and personnel situation for general quarters condition. The control settings shall be described and illustrated when necessary.

3.4.1.4 Section 4. Theory of operation. This section shall contain all theory of operation necessary to inform the supervisory personnel and technicians of the general principles of operation beyond the actual functioning of the system. Examples of this information would be missile trajectory solutions, computing principles, basic logic (reasoning) upon which the system operation is based, tactical data system operations, concepts of missile handling, missile system operation, navigation theory, etc. In addition, this section shall be used to expand on the information provided in the keyed text of the troubleshooting/repair manual. Illustrations such as patterns, nomographs, maps, and simplified diagrams shall be used to reduce narrative.

3.4.1.5 Section 5. Scheduled maintenance. Section 5 shall contain all system scheduled test procedures, together with necessary explanations and illustrations. (Scheduled system maintenance may be planned to be conducted in accordance with a schedule and procedures set forth on planned maintenance cards. For guidance in establishing procedures, planned maintenance documents applicable to a particular generic family of equipment may be obtained from the procuring activity.) When the contract or purchase order requires the preparation and delivery of system maintenance requirements cards, and all system installations will not necessarily be serviced under the planned maintenance system, the contractor shall include the preventive maintenance procedures in the manual in order to make the technical manual a complete data base (see figure 28).

System test procedures shall be based on measurements that ascertain proper performance and operation of two or more equipments in the system. It is not intended that individual equipment tests be made unless a system test will not ascertain proper operation of the equipment. Section 5 shall comprise the following:

(a) Introduction.
(b) Scheduled maintenance action index.
(c) Scheduled test procedures.

3.4.1.5.1 Introduction. The introduction shall be an explanation of the purpose, scope, and arrangement of the scheduled maintenance material. When a preventive maintenance procedure is critical to the operation of the system and the schedule for servicing is absolute (not just recommended), this information shall be conspicuously written as a CAUTION. For Navy manuals, the following statement shall be included: "The scheduled maintenance instruction. in this manual are cancelled when the Planned Maintenance Subsystem (PMS) is implemented for this system at your site or aboard your ship or station as applicable."

3.4.1.5.2 Scheduled maintenance action index. This index shall include a listing of all required scheduled performance tests, The index shall be tabulated as follows:

(a) Column 1. Periodicity. This column shall contain a list of all scheduled actions contained in the chapter. The following periodicity symbols, as appropriate, shall be used:

Interval	Symbol	Interval	Symbol
Daily	D	Semiannually (6 months)	S
Weekly	W	Annually (12 months)	A
Monthly	M	Overhaul cycle	C
Quarterly (3 months)	Q	As specified (explain circumstances)	R`

*An R periodicity will be preceded by a recommended calendar periodicity (e.g. , DR, \VR, MR, etc.) which might be specified to mean perform as scheduled 'except when ship is in port ".

(b) Column 2. Maintenance action. This column shall list the title of the maintenance action which corresponds to the periodicity number in column 1.

(c) Column 3. Reference. This column shall state the paragraph or table number of the maintenance procedure that corresponds to the maintenance action listed in column 2.

3.4.1.5.3 Scheduled test procedures. Include the detailed procedures for setting up and performing complete system tests. Each procedure shall be numbered and titled to clearly define the test action and the output to be tested. The procedures shall contain the data specified in 3.3.1.4.4.

3.4.1.6 Section 6. Alignment. Section 6 shall present the corrective adjustment procedures and support information necessary to restore electrical and mechanical alignment between the various system equipments, include all values and tolerances. The alignments shall be cross-referenced to respective fault isolation procedures and diagrams in the system troubleshooting/repair volume. Alignment procedures shall include references to equipment publications when additional procedures are required at the equipment level. The alignment procedures shall be presented in step-by-step sequence.

3.4.1.7 Section 7. Installation data. Unless otherwise specified by the contract or order, installation drawings and information not contained in the equipment technical manuals, that are necessary to install and check out the system, shall be provided. System installation data shall include but not be limited to, the following:

(a) Summary of all utilities required by the system, such as air, water, power, steam, freon, etc.
(b) System interconnection diagrams.
(c) Cable run diagrams.
(d) System piping diagrams,
(e) Running wire list.
(f) System cable interconnection check.
(g) Active system tests.
(h) System component installation procedures.
(i) Installation drawings.
(j) Installation checkout.
(k) Test procedures.
(l) (1) Installation standards summary sheet.

Reproductions of appropriate installation diagrams in accordance with MIL-D-1000, cognizant agency cable running sheets or drawings included in station or ships information books may be provided if informationally complete and the quality is sufficient for 24X reduction and legible reproduction by microfilm.

3.4.1.7.1 Utilities list. A tabular list shall include all utilities required, and the quantities of each, for each system, compartment, and area.

3.4.1.7.2 System interconnection diagrams. Interconnection block diagrams shall be presented in accordance with 3.4.2.1.4 and shall reference the diagram in the troubleshooting/repair volume.

3.4.1.7.3 Cable run diagrams. When the system is to be installed in a specific class or type of vehicle, aircraft, ship or station, isometric diagrams shall be used to indicate the location of all cable runs between compartments, rooms, or areas. When the system manual does not cover specific installation location, idealized diagrams can be provided. Each cable run diagram shall indicate by floor, deck, room, or compartment and frame identification, the location of all cables shown on the interconnecting diagrams.

3.4.1.7.4 System piping diagrams. When the system is to be installed in a specific class or type of vehicle, aircraft, ship or station, isometric diagrams shall be used to indicate the location of all system piping runs between compartments, rooms, or areas. When the system manual does not cover specific installation location, idealized diagrams can be provided. Each piping run diagram shall indicate by floors, deck, room, or compartment and frame identification, the location of all pipes, valves, fittings, tanks, etc.

3.4.1.7.5 System cable interconnection check. Continuity and megger check procedures shall be provided to verify the proper installation of all system cables. These checks shall be conducted with all power off and all equipment completely shut down and isolated from power sources.

3.4.1. 7. 6 Active system tests. All active system test procedures required to verify the proper installation and operation of the system shall be included. References may be made to applicable tests and procedures in section 3. Procedures for complete setup, testing, shut down, and data analysis shall also be provided.

3.4.1.7.7 System component installation procedures. Complete step-by-step instructions shall be provided for installation of system components not covered in any of the equipment manuals for the equipments comprising the system. The following types of supplemental information not provided in the equipment technical manual shall be included:

(a) Instructions required to assemble components.
(b) Instructions required to mount components. Include boring and bracing diagrams and data on shock mounts.
(c) Instructions for making electrical, waveguide, plumbing and all other interface connections between equipments, components, and other systems.
(d) Servicing procedures, such as initial lubrication and adjustments.
(e) Instructions for bonding and grounding.

3.4.1.7.8 Installation drawings. The following drawings shall be included:

(a) Pictorial diagrams.
(b) Outline and mounting dimension data.
(c) Interconnecting wiring and cabling diagrams or cable running sheets.
(d) Primary power distribution.

3.4.1.7.9 Installation checkout. Provide step-by-step procedures to demonstrate that the system operates correctly and within tolerances. These procedures shall provide for system checkout in three test phases as follows:

(a) Phase 1 - Installation inspection and pre-energizing procedures.
(b) Phase 2 - Initial turn-on and preliminary tests.
(c) Phase 3 - Installation verification test.

3.4.1.7.9.1 Phase 1. Installation inspection and pre-energizing procedures. Inspection procedures shall be provided in the form of check lists to verify the following:

(a) That the system and required auxiliary equipments have been installed and that their location and orientation is proper; that all cables, antennas, waveguides, transmission lines, dehydrators, coolant lines, piping, etc., have been installed in accordance with plans and specifications; that continuity exists in all interconnections.

(b) That special system test equipment listed in section 1 is available at the site, operating satisfactorily, and has been calibrated.
(c) That all field changes, alterations, mandatory retrofits, or modifications have been accomplished.
(d) That all rotating devices are free from obstruction.
(e) That there is access to the system components for maintenance.
(f) That all pre-energizing servicing procedures, including lubrication, have been accomplished.
(g) That it is safe to operate the system.

3.4.1.7.9.2 Phase 2. Initial turn-on and preliminary test. Initial turn-on tests shall include procedures for energizing the system for the first time. This may be accomplished by reference to the applicable portions of section 3. Step-by-step procedures for testing electrical, steam, and fluid supply circuits, distribution panels, breakers, and interlocks shall he included. Procedures for testing piping, cables, transmission lines, and waveguides for proper installation, including checks for hangar spacing, torquing of connectors, pressure testing, standing wave ratio, and attenuation checks shall be included as applicable.

3.4.1.7.9.3 Phase 3. Installation verification test. Include complete instructions for testing the system in all modes of operation. Reference may be made to the scheduled performance tests in section 5. Procedures shall cover checking gages, meters, alarms, and other sensing devices for proper operation and calibration. Tests shall verify that all Inputs are in tolerance. As applicable, VSWR and insertion loss tests to verify the proper installation of antenna-to-equipment waveguide runs; transducer impedance and source level checks to verify proper installation of transducers, domes, and cables; dynamic and static load tests for hoists, winches, etc., shall be given. All alignment to be accomplished prior to performing a test shall be included or referenced in the procedure.

3.4.1.7.10 Test procedure. Testing procedures shall be presented in a logical order as follows:

(a) Energize the system.
(b) When test results are within the required tolerance, the procedure should direct the technician to the next logical test. When test results are out of tolerance, include a reference to the corrective maintenance or trouble-shooting data. Reference shall be made to troubleshooting diagrams except where precise causes of failure can be predicted, in which case reference may be made directly to an alignment or repair procedure.

3.4.1.7.11 Installation standards summary sheet. The installation standards summary sheet shall provide spaces for recording the results of all installation verification tests (see figure 26). Each space shall be identified by the step or paragraph number which provides the instructions for accomplishment. Each space shall contain the respective unit of measurement (e. g. , Amp, dB, V, or psig). When applicable, waveforms shall be included to show the points on the pattern where the measurement is to be taken. In addition, critical installation data shall be included, such as length of transmission line.

3.4.1.8 Section 8. Parts list. A parts list shall be included in a systems manual unless otherwise specified in the contract or order. The system parts list shall be prepared in accordance with 3.3.1.6 and shall cover only those interfacing equipments, units, assemblies, components, and parts that are installed between equipments and are not included in the parts list of the equipment technical manuals.

3.4.2 System troubleshooting/repair volume. The system troubleshooting/repair volume shall be in one or more parts in accordance with 3. 8. 2.1.2 and include the data shown in Chart 2 (see 3.1.9).

3.4.2.1 Overall function information. Overall function information shall provide troubleshooting information which will permit fault diagnosis to a major function of the system. This information shall include an overall function diagram, keyed text, MDC, and a system interconnection diagram(s).

3.4.2.1.1. Overall function diagram. The overall function diagram shall identify all major functions and the interrelationship between the major functions that comprise the system.

3.4. 2.1.1.1 Intermediate function diagram. When the total number of major functions on the overall function diagram becomes too numerous to be shown on one page, one or more intermediate function diagrams as shown on figure 13 shall be used to simplify the presentation of the overall function diagram.

3.4.2.1.1.2 Presentation. The overall function diagram (and intermediate function diagram) shall be arranged so that a user can readily understand and identify the major functions performed by the system. Each major function shall be represented on the overall function diagram by a blue shaded area. Each signal that interfaces between major functions shall be identified with a signal nomenclature flag. Signal lines shall also have arrowheads that show direction and nature of the information flow. Mechanical linkage interface between major functions shall also be shown. Each equipment, involved in system operation, shall be shown inside a major function area. When one equipment is used in more than one major function, it shall be represented in each function. Grey shades shall be used to define equipment boundaries. Pertinent switches or controls, as well as indicators that are involved in system operation shall be identified by front panel markings and shall be shown in a white background area.

3.4. 2. 1. 2 Keyed text. Keyed text shall be in accordance with 3. 6 and shall describe the operation of each of the major functions and the relationship of the equipments involved.

3.4.2.1. 3 Maintenance dependency chart. The maintenance dependency chart shall be in accordance with 3. 7 and shall contain data which aids a technician in isolating a potential fault to one of the major functions. Selection of signal specifications and indications shall be based on front panel and easily accessible indicators. The use of external test equipment shall be held to a minimum. When an automatic test program is used with built-in performance monitoring/fault localization circuits, MDCs or fault logic diagrams are required for the performance monitoring/fault localization circuitry and test programs. MDCs or fault logic diagrams are not required for functions in which fault localization is accomplished by the automatic test.

3.4.2.1.4 Interconnection diagram(s). Interconnecting diagrams shall be provided which show each equipment or interfacing component as a block (or pictorially). All cables running between equipments shall be identified by cable number. The illustration shall indicate all junction boxes, switchboards, components, etc., from which interconnections enter or leave. The area location (room or compartment) of all hardware items shall be indicated.

3.4.2. 1.4.1 Wire identification. All wires used in system interconnection, and spare wires within any given cable shall be shown by schematic diagram or wire list. Source destination connection numbers/letters, and signal name or other identification shall be included for each wire.

3.4.2.2 Major function information. Each major function information package for the system shall provide troubleshooting information which will permit fault isolation to a given equipment or equipment unit: This information shall include a major function block diagram, keyed text, and MDC.

3.4.2. 2. 1 Major function block diagrams. One major function diagram shall be prepared for each function block shown on the overall function diagram. The diagram shall show the interrelationships between the equipments (units). Only those units involved with the major function need be shown. Identification of the overall equipment shall be indicated so that the unit can be related to its equipment. All interfacing components, junction boxes, and switches involved with the major function shall be included. Presentation shall be similar to the overall block diagram. However, all points of entry and exit between equipments shall be indicated by cable, connector, and pin number. Signal names shall be included and shall be consistent from diagram to diagram.

3.4.2.2.2 Keyed text. Keyed text shall be in accordance with 3. 6 and shall describe the operation of each equipment or unit shown on the major function diagram. The description shall also relate the equipment to its mode of operation or effect on the major function.

3.4.2.2.3 Maintenance dependency chart. The maintenance dependency chart shall be in accordance with 3. 7 and shall contain data sufficient to isolate a potential fault to an equipment or unit, providing that there is an equipment panel having fault isolation information. When no such panel exists, data sufficient to isolate the potential fault to the component shall be provided.

3.4.2.3 Hardware information.

3.4.2.3.1 Blocked schematics. Blocked schematics in accordance with 3.3.2.6.1 shall be supplied for all interfacing components, switches, voltage regulators, filters, line drivers, transformers, junction boxes, etc., as may be used for system operation and for which there is no technical manual. If these items can be incorporated schematically on the major system function diagrams, separate blocked schematics are not required.

3.4.2.3.2 Keyed text. Keyed text in accordance with 3.6 shall be included to describe functional operation.

3.5 Diagramming techniques.

3.5.1 Function definition. Functional block diagrams shall portray the functional hierarchical subdivisions by blocked areas as required by the following types of diagrams:

(a) Overall and intermediate function diagrams. Each major function of the equipment or intermediate function shall be represented by a block.

(b) Major function and sub-function diagrams. Functional entities shall be portrayed by line art shapes (see 3.3.2.5.1.2.1). A single or group of line art shapes which work together on a single piece of hardware shall be enclosed in a blocked area and given a functional title.

(c) Blocked schematic diagrams. Each functional entity shall be blocked to show functional significance (see 3.3. 2. 6.1.3).

3. 5. 1. 1 Final manuals. Functional blocks in final manual shall be entirely shaded blue. Darker shades of blue shall be used to indicate functional subordination except for functional entities which shall be line art symbols (see figure 15).

3.5.1.2 Preliminary manuals. Functional blocks in preliminary manual shall appear on a white background, i. e. , not overprinted with blue.

3.5.1.3 Review manuscript. Functional blocks in review manuscripts shall be enclosed in a dotted border, except for functional entities which shall be line art symbols.

3.5.2 Hardware definition. Hardware (units, assemblies, or subassemblies or parts thereof) shall always be enclosed by blocks, with the hardware identity shown in the upper left corner of the hardware block.

3.5.2.1 Final and preliminary manuals. In final and preliminary manuals hardware shall be represented by levels of grey shading. When a unit, assembly, and subassembly are shown on the same diagram, the lightest shade of grey shall represent the unit; the next darker shade of grey shall represent the assembly; and the next darker shade of grey shall represent the subassembly, etc. A diagram treating a single assembly will use the lightest shade of grey to represent the assembly and darker shades for subassemblies. Consistency of grey shades shall not be maintained for hardware levels between different diagrams, so that the lighter grey shades can be used. All diagrams shall be planned so that functional blocks (see 3.5.1.1) may have the grey shading undercut so the blue shading shall not overprint the grey shadings. Hardware blocks shall be shaped or broken as necessary to accommodate this requirement.

3.5.2.2 Review manuscripts. Hardware definition for review manuscripts shall be by dash, dot, dash lines. with the number of dots denoting hardware level of containment, e.g., one dot indicating lightest shade of grey, two dots indicating second shade of grey, etc.

3.5. 2. 3 Signal flow precedence. Direction of signal flow shall be given priority over hardware layout; accordingly hardware blocks shall be shaped or broken as necessary to accomodate the requirements for signal flow to be shown as a flow from left to right.

3.5.3 Keyed text reference number. Each functional blue shaded area (functional entities, parts, and other blocked areas that need ex-planation) shall be assigned an encircled arabic key number just prior to the name or functional entity identifier code or reference designation (see figure 20). The key number should be assigned sequentially in direct relationship to functional signal flow.

3.5.4 Energy, signal, or data flow. The nature and direction of energy, signal, or data flow shall be coded by use of special arrowheads superimposed on signal lines in addition to appropriate flagged annotations. (See figure 6 and ANSI Y32. 2 for a listing of flow codings.) (It is not the intent of this specification to preclude the use or generation of new coded arrowheads or symbols to meet specific needs beyond those covered.) Flow lines shall be connected in a manner to illustrate subordination or coordination of flow importance as indicated below.

Subordinate junctions are shown as follows:

Coordinate junctions are shown as follows:

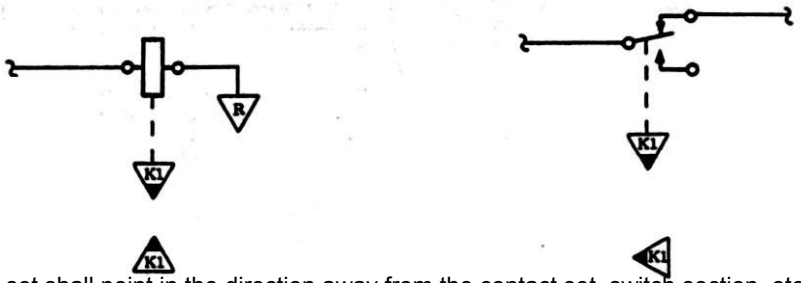
3.5.5 Identification of data flow. Meaningful signal names or codes shall be provided for each connection into and out of blocked schematic diagrams. Signal names shall be located within the body of diagrams as necessary to identify the significant signal paths. Such names shall be placed within a flag. When there is no room for signal flags, the signal name or code may be placed in line with the signal line.

Names of particular signals shall be consistent from one diagram to the next.

3.5.6 Line weight. Significance of signal paths shall be indicated by line weight. Heavy weight lines represent a major signal path. The ratio between normal line weight and heavy line weight shall be at least 3 to 1. Line weights on a diagram of one hierarchical level are not necessarily the same (for the same signal) on a different hierarchical level diagram.

3.5.7 Test points. Where possible, test points shall be shown outside of functional (blue shaded) areas. The marked nomenclature of front panel test points shall appear on a white background.

3.5.8 Mechanical connections. Mechanical connections shall be represented by dashed-lines unless pictorially illustrated. However, relay contact sets which are separated from their operating solenoid, sections of a multi-section switch separated from each other, a motor illustrated remote from the driven device, etc., may have their mechanical connection broken and illustrated with triangular flags pointing in the direction of connection to avoid crossing lines as follows:



The lower triangular flag set shall point in the direction away from the contact set, switch section, etc. , to the activating device (e. g. , solenoid, front panel control, etc.).

3. 5. 9 Shielding. Shielding shall be shown on major function diagrams, subfunction diagrams, and assembly schematic diagrams. The ground return symbol shall identify the end of the shield where the return is accomplished.

3.5.10 Adjustments, controls, and indicators. Adjustments and controls shall be identified pictorially to indicate the means of adjustment, or indication; e. g. :

The adjustment or control marked nomenclature and its appropriate symbol shall appear in the hardware area representative of the hardware upon which it is located. The relationship of an adjustment or control to the proper part shall be illustrated by means of a dashed-line connection.

3.5.10.1 Front panel controls and indicators. Front panel adjustments, or controls and indicators shall appear on a white background outlined by a bold line with shadowing on two adjacent sides as shown below.

3.6 Keyed text (Troubleshooting/repair volume). Each functional block diagram shall be supported by keyed text with any required augmenting illustrations (timing diagram, etc.). Keyed text shall be referenced by encircled numbers from corresponding numbers in the functional blocked areas of diagrams (see 3.5.3). Text shall be located on the same or facing page as the diagram it describes. It shall be in columnar format and in numerical sequence. In addition to the keyed text used to describe the functional blocked areas of a diagram, there shall be text that describes the overall purpose of the major or subfunction and/or assembly as applicable. Such text shall precede the keyed text descriptions. Reference shall be made to section 3 of the support volume when background information is required.

3.6.1 Coverage. Text shall comply with 3.1.6 and 3.1. 7 and provide the following: "what it is, "what it does", and "how it is done". See figure 20 for examples. When space is restrictive, sentences need not be complete if a clause can convey the technical meaning adequately.

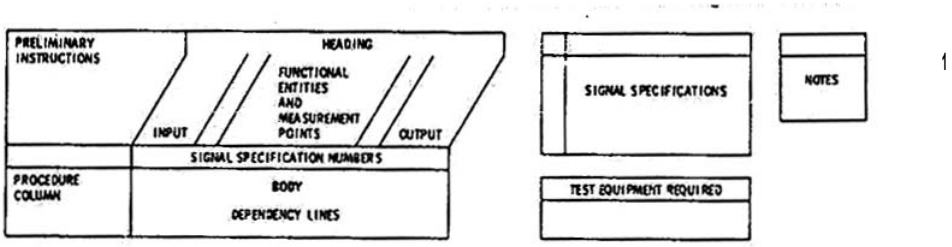
3. 6.2 Supplementary data. Truth tables, timing diagrams, equations, etc., shall be used to supplement keyed text.

3. 7 Maintenance dependency charts (MDC).

3. 7. 1 Layout. Each maintenance dependency chart shall consist of the following areas:

(a) Procedure column.
(b) Heading.
(c) Body.
(d) Signal specification number.
(e) Signal specifications.
(f) Notes.
(g) Test equipment required.
(h)

A typical layout with the relative location of the seven basic areas is shown in the following illustration:



3.7.1.1 Procedure column. The procedure column for each maintenance dependency chart shall consist of three types of procedural information: (1) preliminary instructions, (2) procedural steps, (3) check-out steps. All procedural columns shall be located in the left-hand area of the maintenance dependency chart. For purposes of troubleshooting analysis, the total of the procedural steps shall exercise each functional division of the corresponding schematic or block diagram. The procedural steps shall exercise applicable positions of all switches and operating controls. These procedural actions shall take maximum advantage of built-in self test features. They shall also include improvised check-out steps covering portions of the equipment for which no external symptoms are developed incident to malfunction and for which no self-test facility exists.

3.7.1.1.1 Preliminary instructions. The top portion of the procedural column adjacent to the heading shall be labeled preliminary instructions and contain a listing of all initial switch positions, control settings, man or equipment actions, etc. , which must be accomplished or verified before proceeding with the subsequent procedural and check-out steps.

3.7.1.1. 2 Procedural steps. Procedural steps shall consist of those procedures which must be performed to bring the equipment into full, operational status and shall be numbered sequentially and placed flush left in the procedural column. Each procedural step shall be enclosed between bold horizontal lines across the body of the chart to indicate those events which are associated with the particular step. The procedures required to energize and exercise the equipment shall be complete. Warning and caution notices shall be placed immediately prior to the written procedure to which it applies when actions (e. g. , measurement of high voltages) might be dangerous to personnel or damage to equipment may result.

3.7.1.1.3 Check-out steps. Check-out steps shall consist of those procedures which can be exercised as options on the part of the technician. For example, they shall include those steps necessary to check out and troubleshoot fault detection circuits, feedback circuits, built-in test features, etc. Check-out steps shall be lettered sequentially and shall be indented and located within the numbered procedural step which established the operation configuration of the equipment required for the check-out step.

3.7.1.2 Headings. The column headings in the maintenance dependency chart shall identify the hardware locations of functional entities and the associated event measurements or observation points which correspond to symbols in the body of the chart. Entries in the heading corresponding to functional entity symbols (●) shall be identified by functional name, alphanumeric code, or by reference designators as appropriate. Entries corresponding to event symbols (A) shall provide a check point at which that event occurs and shall have an assigned number in the signal specification number, row.

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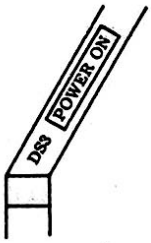
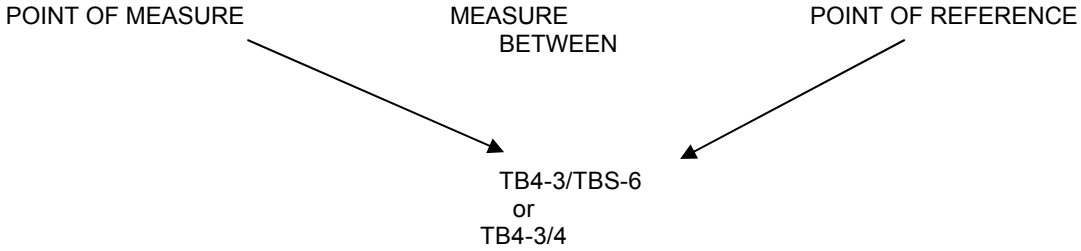
3.7.1.2.1 Event entries.

(a) For event entries to be observed on the equipment, the point of observation shall be illustrated as follows:



When the indication is observable from outside of the equipment, the panel nomenclature (if any) for the indicator shall be illustrated by a black-line box around the panel nomenclature.

(b) For events to be measured, the points of measure shall be listed as follows:



3.7.1.2.2 Physical location of entered items , The physical location of the functional entity or event shall be identified in the heading at the top of each column. Assembly numbers or short colloquial names shall be used as a reference key. When adjacent columns refer to items in the same assembly, the location identifier can be so placed that it applies to more than one column.

3.7.1. 3 Signal specification number assignment. All events requiring specific data shall be assigned a signal specification number for the particular MDC. These numbers provide a reference to the detailed signal data contained in the signal specification table. Numbers should be assigned sequentially, left to right, to all events requiring an entry in the signal specification table. Events that are from other MDCs need not carry the original signal specification number as long as the originating MDC and measurement point are identified in the heading.

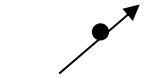
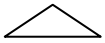
3.7.1.4 Body. The body of the maintenance dependency chart shall consist of a series of horizontal lines upon which are represented the dependency or circuit action that results from the performance of a procedural step. Each line shall represent a short series path from an event point (test point or other) to an indication or a second event point through one or more functional entities. Such horizontal lines representing short serial paths are called dependency lines. These dependency lines shall be arranged from top to bottom in the order of increasing dependency.

3.7.1.4.1 Body symbology. Three basic symbols shall be used in the body of the chart as follows:

Event box 	Indicates input or output signal or indication. Nomenclature in the event box specifies the type of action and availability of the event. To assist in determining the accessibility of the events listed in the MDC, front panel observables shall be indicated by use of a black background and white lettering.
Dependency event. Marker 	Indicates dependency upon an input or previous
Functional Entity Dot 	Indicates a precisely definable circuit element, functional entity, replaceable module, or any other group or device.

The mapping shows that the output event at 0 is dependent upon functional entity Z and the input events at O1 and O.

3.7. 1.4.1.1 Variations. Variation of the three basic symbols may be used to increase the versatility of the MDC. Sample variations are shown below:

Adjustable Functional Entity 	Indicates output of functional entity is adjustable.
Partial Functional Entity dot	Indicates a precisely definable circuit element, functional entity, replaceable module, or any other group of devices which require more than one test action to prove the entity totally good.
Relay Contact 	Variation of the partial functional entitiy dot used to identify relay contact position. Dot above slanted line indicates contact must be good when solenoid is deenergized. Dot may also be below the line (energized) or on both sides (vibrates).
Contracted Event 	Indicates more than one (n) distinct event occurs. The individual measuring points must be specified in the signal specification.
Combination Dependency 	Indicates the number (m) out of the total (n) events which must exist. Letter P indicates a particular selection of the total number is required.
Or Dependency 	Indicates a functional entity requires only one of the dependencies shown to produce :he described event output.
Feedback Dependency 	Indicates a function of the output event is supplied as an input dependency for the structure shown.

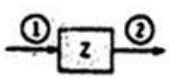
3.7.1.4.2 Dependency structure. A dependency structure consists of a series of dependency lines. Each dependency line is constructed using the three basic symbols. The simplest dependency line would appear as follows:

This dependency line indicates that the event (A) is dependent upon the proper operation of the functional entity (•) and the availability of some previous event (▲)

3.7.1.4.3 Mapping methods and techniques.

3.7.1.4.3.1 Simple dependency line. The mapping of a functional entity with one input and a single output results in a simple dependency line as follows:

BLOCK DIAGRAM



MDC

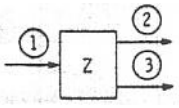
The mapping shows that the output event at (2) is dependent upon a functional entity Z and the input event at (1).

3.7.1.4.3.2 Multiple input dependency line. A functional entity with more than one input and a single output is mapped as a multiple input dependency line as follows:

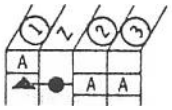
The mapping shows that the output event at (3) is dependent upon functional entity Z and the input events at (I) and (2).

3. 7.1.4. 3.3 Multiple output dependency line. A functional entity having one input and multiple outputs is mapped as a multiple output dependency line as follows;

BLOCK DIAGRAM



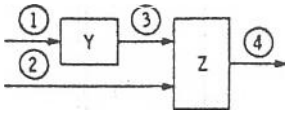
MDC



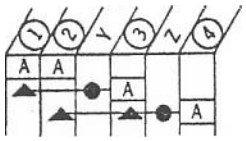
The mapping shows that the output events at both O and O3 are dependent upon functional entity Z and the input event at @l .

3.7.1.4.3.4 Dependency chain. A dependency chain consists of a series of interrelated dependency lines. The following example shows a dependency chain consisting of two dependency lines:

BLOCK DIAGRAM



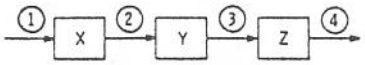
MDC



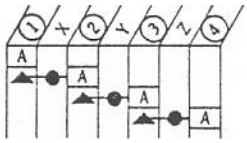
The last dependency line in this example shows that the output event at 0 is dependent upon functional entity Z and the events at 3 and O .

3.7.1.4. 3.5 Serial relationships. As a rule, serial relationships are shown as follows:

BLOCK DIAGRAM

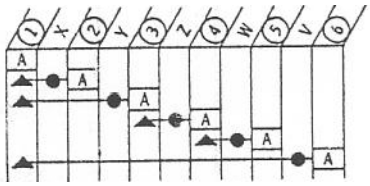


MDC

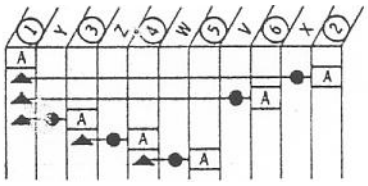


3.7.1.4.3.6 Serial parallel relationships. The following example illustrates the preferred serial parallel relationships:

UNDESIRABLE

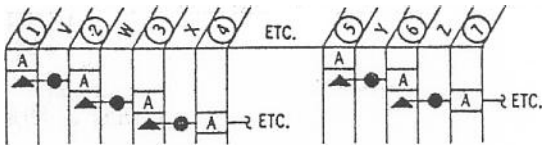


DESIRABLE



The undesirable presentation erroneously infers by its structural layout that there is one serial dependency chain. The desirable presentation shows clearly by its structural layout that there are three separate parallel dependency chains. It also shows that one of the dependency chains has several serial relationships.

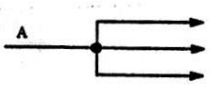
3.7.1.4. 3.7 Horizontal line usage. Normally, only one dependency line is used for each horizontal segment of the chart. However, if height is a problem on an MDC, more than one dependency line may be placed on a particular horizontal segment if care is exercised. The dependency chains should be separated by ample space to avoid confusion. An example of this technique is as follows:



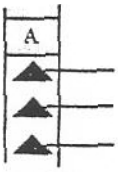
Notice that each dependency chain is easily identifiable.

3.7.1.4.3.8 Parallel divergent branches. When a path diverges into a number of paths, it is depicted by an event/dependency column using a single event and the appropriate number of dependency markers. This situation is shown as follows:

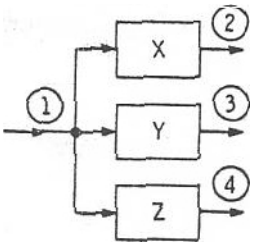
BLOCK DIAGRAM

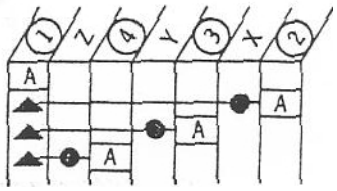


MDC



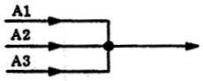
The following example utilizes this method:



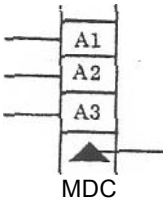


3.7.1.4.3.9 Parallel convergent branches. When paths converge into a single path, they are depicted by an event/dependency column using a composite event and a single dependency marker. This situation is shown as follows:

BLOCK DIAGRAM

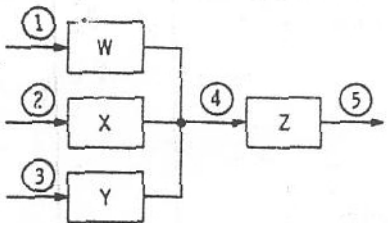


MDC

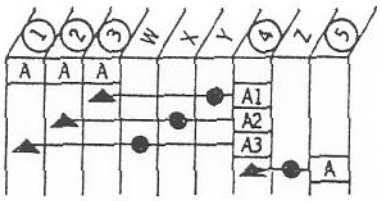


The following example illustrates this rule:

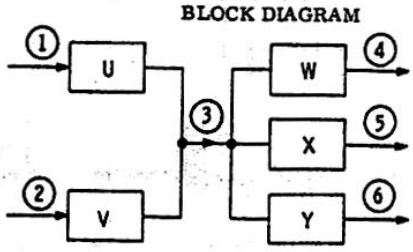
BLOCK DIAGRAM

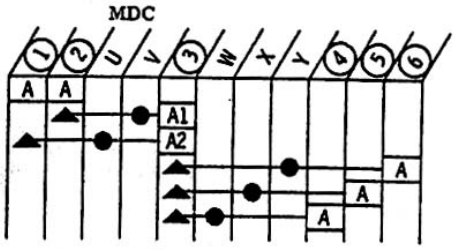


MDC

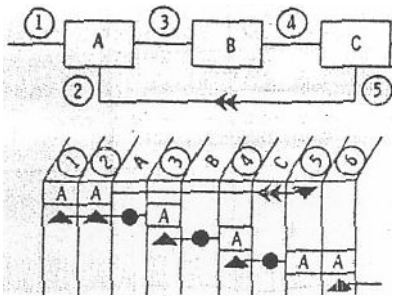


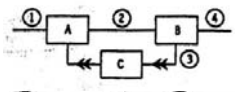
3.7.1.4. 3.10 Convergent divergent branches. The following example illustrates a situation in which both divergent and convergent branches exist:

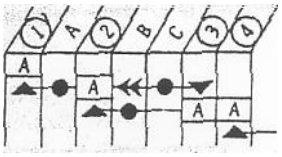




3.7. 1.4.3.11 Feedback circuits. The following examples illustrate mapping feedback circuits:

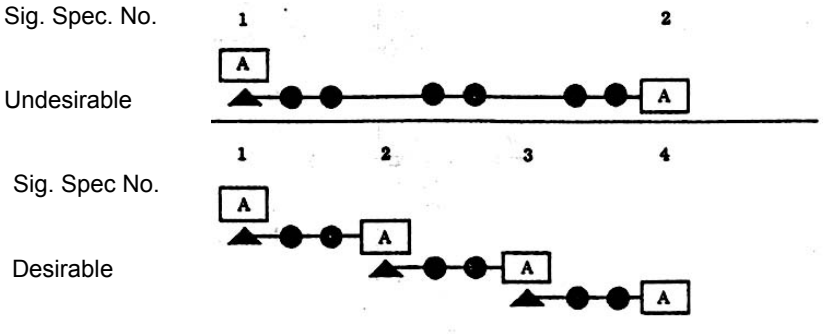






3.7.1.4. 3.12 Relay holding path. The following example illustrates mapping a relay circuit when it is held energized by a path separate from the initial energizing path:

3. 7.1.4. 3.13 Fault isolation. To simplify fault isolation, dependency charts shall not be constructed with a large number of dots (functional entities) depicted on the same horizontal line.



3.7.1. 4. 3. 14 Time delays. Protective time delays which occur after an operational step is initiated are illustrated by placing a band of screen shading horizontally across the page immediately after the entry of the time delay device. Time is assumed to begin with the action that initiates the step in which the time delay occurs. The length of time delay is indicated within the shaded band. When the time delay is not directly related to the step, special 'notations may be added within the time delay band - e.g., "2 seconds after motor exceeds 3000 rpm".

3.7.1.5 Signal specification table. The signal specification table shall list the description, specifications, characteristics, tolerances, etc., for every event in the body of the maintenance dependency assigned a signal specification number. The description shall be a voltage, photograph of the waveform, or other measurable/observable characteristics which are associated with each of the specifications. The test equipment settings shall be included as part of the signal specification to ensure that waveforms on oscilloscopes will agree with those illustrated. When photographs of waveforms are supplied, they shall be retouched to ensure that the pertinent technical information is visible and will reproduce when copied and reproduced on microfilm; i. e. , rise time, etc. (Refer to figure 18 for a typical event specification table.) A signal specification shall be given for each significant change in signal character, at points of signal divergence, and at points of signal convergence. A warning block shall be included at the heading of the signal specification when the table indicates that voltages over 70 volts must be measured using external test equipment.

3.7.1.6 Chart notes. The chart notes portion of each maintenance dependency chart shall consist of general and flag notes (as required).

3.7.1.6.1 General and flag notes. General and flag notes shall be provided as required. General notes shall be of the "unless otherwise specified" type; for example, "All voltages are -10 percent". Flag notes shall explain special or unusual situations on the maintenance dependency chart; for example: "Duty cycle can vary greatly as a function of the relative phase of the input signals".

3.7.1.7 List of test equipment. A table of all recommended test equipment needed to perform required maintenance tasks shall be included with each MDC. Selection of test equipment shall be in accordance with 3.3.1.1.6.

3.8 Format. The format of every FOMM manual shall be based upon the functional complexity, the user environment (shipboard, aircraft, flight line, depot, etc.), and the maintenance philosophy for the overall equipment or system. Maximum use shall be made of illustrations. Text will be used to present required data. Keyed text in accordance with 3.6 can be used to support any diagram or illustration when it will serve the function of brevity or clarity.

3. 8. 1 General requirements. Style and format for the support volume shall conform to MIL-M-38784 and 3.8. 2.1.1. Graphic symbols and reference designations for electrical and electronic diagrams shall be in accordance with ANSI Y14. 15, Y32. 2, and Y32. 14. Abbreviations used in text and on illustrations shall be in accordance with MIL-STD-12.

3.8.2 Volume breakdown. Unless otherwise specified in the contract or order, FOMM manuals shall be divided into two volumes. The first volume shall be entitled "Support Volume" and the second volume shall be entitled "Troubleshooting/Repair Volume". However, if for type I manuals, the requirements of the support volume can be accomplished on 5 pages or less (11 x 27 inches) the manual shall be only a single volume and entitled "FOMM Technical Manual for .....", or for type II manuals, "FOMM System Technical Manual for .....".

3.8.2. 1 Rib-volume breakdown.

3.8.2.1.1 Support volume. The support volume shall not exceed a three inch thickness. When the thickness exceeds three inches, the volume shall be designated Volume 1, Part 1, and the operation section shall be bound separately and designated Volume 1, Part 2. When three or more parts of the support volume are required to maintain the three inch thickness limitation, one or more additional sections shall be bound separately in the following order:

(a) Installation, designated Volume 1, Part 3.
(b) Parts list, designated Volume 1, Part 4.
(c) Scheduled maintenance, designated Volume 1, Part 5.
(d) General theory of operation, designated Volume 1, Part 6.

3.8.2. 1.2 Troubleshooting/repair volume. When this volume exceeds approximately 100 pages (50 sheets), the troubleshooting/repair volume shall be bound in two or more parts. The first subdivision shall contain functional information and be designated Volume 2, Part 1. The second subdivision shall contain the hardware information and be designated Volume 2, Part 2. When it is necessary (or desirable, to store the hardware information with the unit) or to subdivide the troubleshooting/repair volume further, the hardware data packages may be divided in parts, and bound separately. Additionally, the troubleshooting/repair volume may be divided into parts to facilitate storage with the respective assembly when equipment units are installed in different rooms or compartments.

3.8.2.2 Division of volumes by level of maintenance.

3.8.2.2.1 Maintenance levels. Unless otherwise specified in the contract or order, the technical manual shall be divided into volumes for issue to the level of maintenance designated. Data required for each volume shall be in accordance with chart 3. Data shall be duplicated in the different manuals as indicated.

USING SERVICE	MAINTENANCE LEVEL	SUPPORT VOLUME: FRONT MATTER	GENERAL INFORMATION	OPERATION	GENERAL THEORY OF OPERATION	SCHEDULED MAINTENANCE	INSTALLATION	PARTS LIST	SAFETY SUMMARY	TROUBLESHOOTING/REPAIR VOLUME: FRONT MATTER	TURN-ON/CHECK-OUT CHART	CABLING/PIPING DIAGRAM	OVERALL FUNCTION DIAGRAM	OVERALL FUNCTION MISC	MAJOR FUNCTION DIAGRAM	MAJOR FUNCTION MISC	ASSEMBLY SCHEMATICS	ASSEMBLY MISC	ASSEMBLY PARTS DATA	ILLUSTRATED PARTS BREAKDOWN	WIRING DIAGRAMS
A	OPERATOR	●	●	●		●			●												
A, MC	ORGANIZATIONAL	●	●	●	●	●	1	1	●	●	●	●	●	●								
A, MC	INTERMEDIATE (FIELD)	●	●	●	●	●	1	1	●	●	●	●	●	●	●	●						●
A, MC	GENERAL SUPPORT	●	●	●	●	●	1	1	●	●	●	●	●	●	●	●	●	●	●			●
CO, M	ORGANIZATIONAL THRU INTERMEDIATE	●	●	●	●	●	1	1	●	●	●	●	●	●	●	●	●	●	●			●
ALL	DEPOT (3)	●	●	●	●	●	1	1	●	●	●	●	●	●	●	●	●	●	●	3		●

1 Included unless otherwise specified in the. contract or order
I Included only when specified IA
3 IPBs shall M prepared in accordance with the governing specification of the procuring activity.

CHART 3

3.8.2.2.2 Maintenance levels for Navy manuals (N). Unless otherwise specified in the contract or order, all manuals shall include all organizational and intermediate level data necessary for designated repair through all levels of maintenance except overhaul.

3.8.2.3 Single volume manual. When a single volume FOMM is supplied, the support volume data shall be presented preceding the troubleshooting/repair data. Front matter data requirements for the entire manual shall be combined logically in the front of the manual.

3.8.2.4 Roadmap type manuals. For small equipment, that can be treated fully on a single roadmap-type folded sheet, the keyed text shall be on the same side of the sheet as the schematic. Operator data, maintenance data and parts data shall be located on the opposite side of the sheet, and shall be arranged to be compatible with the folding. Functional block diagrams are not required for roadmap type manuals.

3.8.3 Arrangement of data.

3.8.3.1 Data packaging. Data shall be arranged for efficient use of space consistent with the requirement for presentation by microfilm (see 3.10.1.2). Diagrams, related text, MDC, repair data, and parts data as applicable shall la located on one page when space permits. When two or more pages are required, the diagram shall always appear on the bottom (or right) page and the keyed text shall appear on the same or facing page. The other required data (MDC, etc.) shall be included on the same or facing page, or when necessary, on immediately succeeding pages.

3.8.3.2 Order of data packages.

3.8. 3.2. 1 Function information packages. Functional information shall begin with the overall equipment/system information followed by the major function packages. Major function packages shall be arranged in numerical sequence by text key number, as assigned on the overall block diagram.

3.8.3. 2. 2 Hardware information packages. Hardware information packages shall be arranged in a top-down breakdown order by reference designation (Unit 1, 1A1, IA1A1, 1A2, 1A2A1, etc.). When space permits, hardware data for two or more assemblies may appear on the same or facing pages.

3.8.4 Numbering.

3.8.4.1 Support volume. Numbering for paragraphs, pages, tables and illustrations shall be in accordance with MIL-M-38784.

3.8.4.1.1 Paragraph number. A decimal suffix number shall be used for subordination (e. g., 1-1, 1-1.1, 1-1.2, 1-1.2.1, etc.).

3.3.4. 1.2 Procedural steps. Procedural steps shall be identified by sequential Arabic numerals.

3.8.4. 2 Troubleshooting/repair volume. With the exception of appendices and check-out steps on MDCs, Arabic numerals shall be used throughout.

3.8.4.2.1 Pages. Pages of the troubleshooting/repair volumes shall be numbered sequentially within each volume, beginning with the title page as page 2-1. Appendix pages shall be numbered sequentially within each appendix with Arabic numerals prefixed by the letter designation of the appendix; e.g., page B-6 is the sixth page of Appendix B. Pages having one side blank shall carry two page numbers on the printed side. The page number of the blank page shall be followed parenthetically by the word "BLANK"; e.g., 1-71/(72 blank) or (1-71 blank)/72.

3.8.4. 2. 2 Procedural steps. Procedural steps used to present step-by-step instructions shall be numbered in sequence in Arabic numerals. However, the indented check-out steps listed on the maintenance dependency chart and the turn-on and check-out chart shall be lettered sequentially: A, B, C, D, etc.

3.8.4.2.3 Appendices. Appendices, if more than one, shall be identified by capital letters in alphabetical order.

3.8.5 Running heads and feet. Running heads or feet, as applicable, shall include the manual identification number, the nomenclature or identification of the equipment or system covered, the security classification, if applicable, and the change status of the page. Diagram pages shall indicate the diagram type and function designation of the diagram. Blocked schematic diagrams shall also carry the reference designation number. Each 8 1/2 X 11 inch panel of foldouts and troubleshooting/repair volume pages shall contain the security classification, the publication number and the microform identification, page/panel number (for example, 2-25a), (see figure 27). Arrowheads shall be placed in the center of the top and bottom margin of each panel for microfilm alignment purposes. Microform indexing numbers shall be included as specified by the procuring activity. Location and arrangement shall be similar to that shown on figure 27.

3.9 Changes and revisions. Changes and complete revisions shall be issued to correct all inaccuracies or omissions determined during review or usage or for contractor-generated design or production changes to the equipment or system. The contractor shall be responsible for issuing necessary corrections and changes to technical manuals throughout the life of the contract and guarantee period.

3.9.1 Changes. Changes to an existing manual shall be issued in the form of replacement pages and shall be prepared in accordance with this specification. Changes may consist of two types, interim and permanent, as specified in the contract or order. Reproducible copy shall be furnished for altered or additional pages.

3.9.1.1 Interim (temporary) changes (CG, MC, N). An interim (temporary) change is an expeditious method of promulgating a minor manual change by means of change pages. Interim changes are used when there is insufficient time available to publish a permanent change prior to need, or as specified in the contract. Interim changes are subject to replacement by the next issued permanent change. An interim change shall be identified, dated, and shall contain an instruction sheet (see 3.9.1.4).

3.9.1.2 Permanent changes (CG, MC, N). Changes to an existing manual shall be issued in the form of replacement pages as specified in MIL-M-38784. Upon application, change numbers will be assigned by the command or agency concerned. Permanent changes for the FOMM shall be in the same format as the basic manual and shall include all corrections issued in previous interim changes (unless they were covered in a previous permanent change) in addition to all other changes required by the contract; or order. The permanent change shall include an instruction sheet prepared in accordance with 3.9.1.4. Change numbers and publication numbers shall be requested from the procuring activity when the manuscript incorporating changes is submitted for review and acceptance. Changes shall be prepared in accordance with the following:

(a) Changes made to any given page of the FOMM shall require a complete check and correction of associated pages that reflect the subject change.

(b) Production of changes shall be prepared to the same style, format, and specifications as the basic manual except preliminary manual printing requirements may apply. When the manuals are available, the changes shall be inserted (by the contractor) into the manuals to be shipped with the equipment.

(c) A revised title page, including the original approval date of the publication and the approval date of the change, shall be prepared. The publications and change numbers for the change shall be inserted below the change number and date. The basic publication number appearing in the upper left-hand corner shall remain unchanged.

(d) When the review manuscript of the change is submitted for acceptance, the contractor shall request a publication and change number from the Government activity. Change numbers shall be assigned in numerical sequence for changes made within each volume.

(e) When a change is made to a maintenance dependency chart, the entire chart shall be reprinted including the back-up page. Markings shall be the same as for all changed pages.

(f) A revised list of effective pages shall be included in the front matter.

(g) Revised pages, list of effective pages, and index, as applicable, shall be prepared in accordance with this specification and MIL-M-38784.

(h) The numbering of steps of procedures or a list of items changed, deleted, or added by a change shall be given the number of the preceding step or item suffixed starting with the letter "A".

3.9.1.3 Changes for Army manuals (A). Changes shall he prepared as replacement pages. Pages shall be revised only when substantial changes are required. Minor changes such as editorial corrections, changes in terminology, updating of references, etc., shall be held until the page requires substantial revisions. Copy shall be furnished for both sides of the page on which the change is made. Unless otherwise specified in the contract or order, camera-ready copy for the changed page and the back-up page shall be supplied. If the changed portion of the page is brief, the new material shall be identified for ready reference by the user. This shall be accomplished by placing a vertical bar in the margin opposite the changed material. An explanation of the method used shall be included in the transmittal page. The transmittal page for changes shall include, in tabular form, a list of pages to be removed from the basic publication and new or revised pages to be added, a supersedure note, if applicable, and any special instructions. Changes shall be numbered in a single consecutive series for each publication.

3.9.1.4 Instructions sheets. A change (interim and permanent) shall include an instruction sheet which shall provide instructions for inserting new and revised pages and disposing of superseded pages. The instruction sheet shall include the following, as applicable:

(a) The publication number shall appear in the upper left hand corner of each page. The interim change snail be identified with a "T" (interim) or assigned (permanent) identification number (assigned by the procuring activity■ and the publication number to which it applies, for example, T4-NAVSHIPS 0967-000-1230 would designate the fourth interim change to NAVSHIPS 0967-000-1230.

(b) The total number of pages of the change shall be indicated on the first page only.

(c) A supersedure notice (see 3.9.2.3), shall appear in the front matter.

(d) The security classification shall be located on all pages of classified interim changes and shall appear on top and bottom center of the page.

(e) A statement shall be included indicating when the interim change is in effect. If it supersedes an earlier interim change or a permanent change, a statement of that fact shall be given.

(f) If an equipment change is involved (field or production change), a statement shall be included indicating the purpose of the change and the extent (serial numbers or conditions of application) to which it applies to the equipment population.

(g) A list of revised pages (if any) issued as part of an interim change shall be included with instructions for inserting the new or revised pages, for disposition of superseded material, and for correcting the title page and list of effective pages.

(h) When the equipment nomenclature has been changed because of a production or field change to the equipment, the nomenclature references in the text and illustrations need not be modified merely to include the new nomenclature providing that information equivalent to the following is included in the general information section:

"Unless otherwise indicated, all references in the manual to Radar Set AN/SPS-10 apply equally to Radar Set AN/SPS-10A.

(i) If an equipment change does not affect the entire equipment population, the change shall be prepared in such manner that it will describe both the affected and unaffected equipment.

(j) When the change applies to the entire equipment population, the change shall cover only the modified equipment. A note shall be included in the first paragraph of the instruction sheet to the effect that maintenance support activities should not dispose of the superseded pages until it is established that all of the equipment population has been modified.

(k) Instructions shall be concise and clear, illustrations and diagrams corrected, as applicable, and specific data to be changed shall be set off in quotation marks.

(l) The instructions shall be followed by a statement that the interim change instructions shall be inserted in the manual immediately under the front cover.

(m) The user shall be instructed to update his publications when the modification has been accomplished.

(n) Printed matter shall be arranged on the page so that all copy is readable when bound in the manual.

(o) Quantity and distribution shall be in accordance with 3.12.

3.9.1.5 Numbering (changes). Added pages, procedural steps, multiple sheet illustration changes, index number changes, deleted pages, paragraphs, illustrations, table change numbers, and change symbols, shall be in accordance with MIL-M-387S4.

3.9.1.6 Pen and ink corrections. Pen and ink corrections are not acceptable unless the correction is promulgated by a message, letter, or a published article and the change is followed up by issue of a page change.

3.9.2 Revisions.

3.9.2.1 Updated revision. An updated revision is required when the current manual is basically adequate both in format and accuracy but does not completely cover the equipment because of production or field changes made to the equipment subsequent to the issue of the manual. Material for the updated revision shall be prepared in the same manner as replacement pages of a permanent change. The manual shall be reprinted in its entirety and issued as a revised manual as opposed to being assembled by the user.

3.9.2.2 Complete revision. A complete revision shall be a completely rewritten manual incorporating all previous corrections and changes and shall comply with all content and format requirements of this specification.

3.9.2.3 Supersedure notice. Each revision of a manual shall include, as applicable, a supersedure notice.

3. 9. 3 Quantity of changes and revisions. The quantity of changes and revisions shall be as specified in the contract or order. The distribution of change material shall be to all activities holding the original manuals, in the same quantity, or as directed by the command or agency concerned.

3.9.4 Supplements. Supplements shall be prepared in accordance with the content and format requirements of this specification and be arranged in accordance with MIL-M-38784.

3.10 Production.

3.10.1 Reproduction.

3. 10.1.1 Hardcopy. The FOMM manual pages shall be produced by the offset process or an equivalent process. Letters, lines, and symbols shall be of uniform contrast throughout the final printed manual. The final manual shall have clear cut uniform differentiation of the shades of grey and shades of blue. Blurred or smudged printing or drop-out of characters, lines, letters, or failure to meet the other requirements listed herein shall be cause for non-acceptance from the contractor or the Government agency responsible for the printing. For manuscripts and preliminary manuals, reproduction in black and white shall be accomplished by any process that provides clear readable copy with white background. All final manuals shall meet the requirements for good reproduction from the manual by microfilm in accordance with 3.-10.1.2.

3.10.1.1.1 Presentation.

(a) Support volume(s); Reproducible camera-ready copy shall be prepared in 8 1/4 by 10 1/2 inch size, or for reduction to that size. The maximum printing area (image area) shall be 7 by 10 inches. Foldout pages are permitted, providing final printed length, including blank aprons, does not exceed 34 inches. Binding shall be along the 10 1'2 inch dimension.

(b) Troubleshooting/repair volumes; Two styles of data presentation are permitted; Top bound, and left hand edge bound. The troubleshooting/repair volume shall be the top bound style if the technicians pocket manual is one of the deliverable items.

(1) Top bound troubleshooting/repair volumes. All pages of top bound volumes shall be the same size, maximum 11 by 27 inches final printed size. Printed area (image area) shall not exceed 9 5/8 by 26 inches. Top bound volumes shall be bound along the long dimension and shall have a binding edge margin of 7/S inch. The other three margins shall be 1/2 inch. A tolerance of 1/16 inch is permitted on all margin dimensions. Pages shall be laid out allowing for binding margins at the top of odd numbered pages and the bottom of even numbered pages. Preference shall be given to placing schematics, block diagrams, and MDCs on the bottom page with supporting data (keyed text, parts data, signal specifications) on the top page.

(2) Left hand edge bound troubleshooting/repair volumes. All schematics, block diagrams, and MDCs shall be prepared as right hand pages, with maximum foldout length not to exceed 34 inches. Each foldout page shall have a 8 1/4 inch blank apron. Supporting data shall be prepared in 8 1/4 by 10 1/2 inch size or for reduction to that size. The supporting data for each schematic, block diagram, or MDC shall be placed on pages immediately preceding the appropriate diagram. The maximum printing area (image area) for 8 1/4 by 10 1/2 inch pages shall be 7 - 10 inches. When all of the supporting data will fit on one side of a 8 1/4 inch page, the supporting data may be placed on the apron of the appropriate foldout. Binding shall be the same as the support volume.

3.10.1.2 Microfilm. Microform for FOMM manuals shall be produced in accordance with the National Microfilm Association 24X ninety-eight frame standard Microfiche or 24X 16MM roll or cartridge roll or 35MM microfilm processes, as specified in the contract or order. Each document page image shall be processed so that every line and character shall be transferred to the microfilm with sufficient clarity, resolution, and contrast to maintain black and white legibility through the subsequent generation of a paper from a microfilm reader/printer. Microfiche shall be in accordance with the requirements specified in MIL-M-38748. 35MM microfilm shall be in accordance with MIL-M-9865.

3. 10.2 Typography and lettering. Typography and lettering for final manuals shall be in accordance with table I. Type shall be sans serif unless an option is indicated in the table. Review manuscripts and preliminary manual illustrations and diagrams may be hand lettered but shall be legible when reduced to final size.

3.10.2.1 Typo[9]raphy and lettering for technicians pocket manual. Final type size for pocket manuals shall be no less than one-third of the size appearing in the associated troubleshooting/repair manual, but no upper ease character shall have a printed final size of less than 0.030 inch.

Table I. Typography and lettering.

Use	Face and point (final size)	Case
Security Classification	14 point	Upper
Section Titles	12 or 14 point extra bold	Upper
Note (Word Only)	12 or 14 point extra bold	Upper
Caution (Word Only)	12 or 14 point extra bold	Upper
Warning (Word Only)	12 or 14 point extra bold	Upper
Figure Titles	12 or 14 point	Upper
Diagrams, Schematics*	Not less than a letter size of 0. 050 inch. Type shall be equivalent to that obtained by reducing Varityper 1040-12A, IBM 12 or 14 point registry, or IBM 14 point directory.	Upper
Text, Procedural Data, and other large blocks of written matter. *	Upper case letter size not less than 0. 060 inch with lower case letters of corresponding size. Serif is permissible but equivalency to reductions of Varityper 1040-12A, IBM 12 or 14 point registry, or IBM 14 point directory is preferred.	Upper or Upper and Lower
The following items apply to Covers and Title Pages only		
Nomenclature and Title	18 to 24 point extra bold	Upper
Publication Number	18 to 24 point extra bold	Upper
Security Classification	24 point extra bold	Upper

*When a Technician's Pocket Manual (see 1-4(f)) is specified for delivery, selection of type and size shall be based on the typography requirements specified in 3.10.2.1.

3.10.3 Photolithographic negatives. For each page of a manual and covers, the following kinds of fully-composed, lithographic stable base negatives are required:

(a) Pages having blue and grey shading. A negative that has been screened to provide the required tints (one for blue tints and one for grey tints) plus the appropriate line art negatives. The grey tint negative may be composited with the line art negative.

(b) Pages having only line art, half-tones, or text. A lithographic negative with half-tone negatives stripped in place or taped over a clear window on the basic page negative, and a separate negative of the parts location grid when blue overlay grid is used.

3.10.3.1 Negative registration and quality. Line negatives used to produce plates for the printing of each page or revision shall be stable base film and shall be pin-bar registered, free of defects, and opaqued free of pinholes and shaded area crop markings. Screen negatives shall not be opaqued for purposes of removing pinholes.

3.10.3.2 Negative identification. All negatives shall be identified such that no confusion can exist as to their relationship. Mating negatives shall be clearly identified to preclude any confusion or mismatch.

3. 10.4 Illustration and artwork production. Line artwork is preferred over photographs and renderings unless the use of photographs and renderings will appreciably reduce the cost of the manual to the Government and will meet the microfilm reproducibility requirements specified in 3. 10.1.2. Illustrations and artwork production shall be prepared in accordance with 3. 10.4.1 and 3. 10.4.2.

3. 10.4.1 Continuous tone artwork. Line artwork is preferred. Continuous tone artwork shall only be prepared when it can be justified to represent a considerable cost saving and the nature of the illustration will be such as to reproduce legibly by microfilm printers. Continuous tone artwork (photographs and renderings) shall provide a clear definition of shapes, tonal qualities, and surface texture when reproduced from microfilm. Photographs shall be well-lighted, commercial quality to preclude loss of detail in shadow areas. Retouching shall be used only to highlight the technical detail of the photograph. Retouching to remove or lessen scratches or abrasions on the equipment or for appearance purposes shall be minimal. Artwork shall appear on a white background. Rub-down (no wax) or stick-down materials used in preparation of the final artwork shall be permanently affixed to the artwork.

3.10.4.2 Line artwork. Final line artwork shall be prepared on stable base materials. Line weights shall be of sufficient strength to reproduce sharp and clear in the final reproduction size when reduced to final page size and shall meet the requirements of 3.13.9. The artwork shall be prepared in such a manner that ozalid or equivalent copies of the original artwork can be obtained early for training purposes. Rub-down or transfer symbols and lettering are acceptable provided there is no wax-backed material used on the rub-down or transfer symbols and letters. When transfer symbols are used, they shall be adhered in such a manner to prevent drop-off when copies are prepared for working or review prints.

3. 10.5 Page size.

3.10.5.1 Final manuals. A final page size of 11 X 17 inches is preferred, however, maximum page size of single-volume manuals shall not exceed 11 X 27 unless otherwise authorized by the procuring activity. Foldout pages shall not exceed 34 inches in length, including blank aprons. The page sizes for multi-volume manuals shall be as follows:

Volume	Page Size (Inches)
Support Volume	8-1/4 X 10-1/2
	Troubleshooting/Repair Volume 11 X 17 (preferred) 11 X 27 (maximum)
Technician's Pocket Manual	4-1/8 X 10-1/2

3.10. 5.1.1 Roadmap page sizes. The maximum unfolded size for a roadmap-folded manual shall be 30 X 36 inches. 3.

10.5.2 Preliminary manuals. Page sizes shall be the same as for final manuals.

3.10.5.3 Review manuscripts. Page sizes shall approximate final size and shall never exceed 150 percent of final size.

3.10.6 Masks. Masks for the preparation of shaded areas shall be prepared as follows: (Other methods that produce the same results are acceptable.) Mask material shall be Llano Graphic Arts Supplies, Inc. Rubylith DM3, Amberlith D3M, or equivalent. One mask for each shade of blue and one mask for each shade of grey shall be prepared. The area to be shaded shall be stripped away and the area not to be shaded shall be left opaque.

3.10.6.1 Technician's pocket manual masks. A second set of masks in accordance with 3. 10. G shall be provided for making a 4-1/8 by 10-1/2 inch size printing of the troubleshooting repair volume.

3.10.7 Screens. Screens (for all levels of grey and blue) plus either Rubylith or Amberlith masks used in the screen making, shall be supplied by the contractor unless otherwise specified in the contract or order. Screens shall be prepared from a 133 line per inch master screen. Techniques that are not predicated upon precise dot dimensions are acceptable provided the contractor demonstrates with printed samples of different pages that adequate shade separation and the requirements of 3.10.1 can be attained and will be uniform throughout the manual. Dot orientation on screens Shall be such that Moire patterns are not evident in final printed manuals.

3. 10. 7. 1 Technician's pocket manual screens. A second set of screens in accordance with 3. 10.7 shall be provided for making a 4-1/8 by 10-1/2 inch size printing of the troubleshooting/repair volume. The screens for this volume shall be 200 lines per inch.

3.10.7.2 Dot sizes. The dot sizes required of the screen negatives and as printed shall be as follows:

	Dot Size (Blue)		Dot Size (Black)	
Level	133 line screen (Inch)	200 line screen (Inch)	133 line screen (Inch)	200 line screen (Inch)
First	0.0025	0.0017	0.0015	0.0010
Second	0.0035	0.0023	0.0025	0.0017
Third	0.0045	0.0030	0.0035	0.0023
Fourth	0.0050	0.0033	0.0045	0.0030
Fifth	0.0055	0.0036	0.0055	0.0033

A deviation of 0.0005 inch is allowable for both blue and grey shading. For an individual illustration, deviations, if any, shall be in the same direction to assure adequate shade separation. Except for the technician's pocket manual, no shaded area on diagrams shall have a width dimension less than 1/8 inch when printed.

3.10.8 Use of color. When requirements for blue shades are waived, functional areas shall be identified in accordance with 3.10.8.4.

3.10. 8.1 Color on schematics and block diagrams. Grey shades shall be used to define the physical hierarchy of the equipment (or system) (see 3.5.2.1). Blue shades shall be used to define the functional entities and functional groupings (see 3.5.1.1). When more than one shade of blue or grey is used, the first level shade (lightest) shall represent the highest level in the hardware (grey) or functional (blue) hierarchy shown on a particular diagram. Higher levels shall not be used to maintain the hierarchy between illustrations.

3.10.8.2 Color on maintenance dependency charts. Alternate columns in the body of the maintenance dependency chart may be a screened shade of blue or a shade of grey (see figure 17). The level of shading shall be the first level of blue or grey. A final size screen negative (stable base film), the line negative, and a mask for producing the shaded column shall be supplied by the contractor unless otherwise specified in the contract or order.

3.10.8.3 Color in parts Location illustrations. When the color overlay grid method is selected for the final printed manual, the grid shall be blue, with a line weight sufficient to stand out over the darker areas of the halftone (see 3. 3., 6. 5. 2).

3.10.8.4 Color shading for preliminary manuals. Grey color shading in conformance with 3.10.3.1 shall be used in preliminary manuals to define hardware boundaries. Blue color shades shall not be used in preliminary manuals, rather, functional entities shall be contained in white areas within the grey hardware shades. The grey shading shall meet the contrasting requirements for final manuals.

3. 10.8.5 Review manuscripts. Color shading is not required for review manuscripts. When shading is not used, hardware containment for review manuscripts shall be indicated by means of dot-dash coded lines. The number of dots shall indicate the shade of grey to be used in the final manual. Dotted lines shall be used to define functional boundaries as shown on figure 11.

3.10.8.6 Color shading for type IS and type IX manuals. Color shading shall be as specified in 3.10.8.4.

3. 10.9 Frame page. A frame page shall be supplied for each different size volume of the manual to show exact locations of security classification markings, page titles, page numbers, publication numbers, etc. The frame pages shall locate exact image area, final trim size, and drilling locations. The data included on the frame page shall account for all pages in the volume top and bottom, left hand, right hand, etc.

3.10. 10 Ink requirements. Ink requirements for printing are as follows:

Blue Ink - Color No. 169 sgB (strong green blue) as listed in National Bureau of Standards Circular 553 and supplement 2106, or equivalent.

Black ink - Sleight Helmuth Tri-dimensional Balance Process Black No. 6543, or equivalent.

3. 10. 11 Page stock. Unless otherwise specified in the contract or order, page stock shall be in accordance with table II. Each page of top bound troubleshooting/repair volumes shall be laminated with a reinforcing strip of 0.0015 inch thick clear polyester, fused on one side of the page. The reinforcing strips shall be 0. 75 inch wide and run the full length of the binding edge of each page. The binding edge of all foldout pages shall have a similar reinforcing strip.

Table II - Paper stock.

Type manual	All pages
Support Volume	Paper stock shall be in accordance with MIL-P-38790.
Troubleshooting/Repair volume Type I, II	E20 high wet strength lithographic finish white map paper, substance weight not less than 48 pounds per 1000 sheets, basis 17 x 22 inches as described in the U.S. Joint Committee Printing Specifications.
Types IS, IX, IIS, ILX Preliminary Manuals and Review Manuscripts	Any paper compatible with printing or duplicating process and its intended use that provides clear, readable copy with white background can be used.
Technicians Pocket Manual	Casco or Shorewood gloss enamel or equivalent, substance weight not less than 80 pounds per 1000 sheets, basis 25 x 38 inches.

3.10.12 Covers. 3.10.12.

1 Cover stock.

3.10.12.1.1 Support volume. Cover stock shall be in accordance with MIL-P-38790, except that 100 grain 0.035 inch linear polyethelene covers may be used, when approved. Size shall be 8-1/2 x 11 inches. Cover stock for Army manuals shall be as specified (see 6. 2).

3.10.12.1.2 Troubleshooting/repair volume. Cover stock shall be 100 grain 0.035 inch linear polyethelene, California Calendar Company number CCC-84-590, or equivalent.

3.10.12.2 Colors for covers (N). Colors for covers are as follows:

Unclassified .....Blue or grey
For Official Use Only .....White with green printing
Confidential .....Green
Secret .....Yellow
Top Secret .....Pink/red

3. 10.12.3 Cover preparation. Covers information shall be prepared by silk-screen process. Information to be printed on the covers shall not be stamped in gold or any other metal foil. The covers shall be approximately 1/2-inch longer and wider than the included pages. Manuals of eight sheets (16 pages) or less need no covers, but shall be supplied in vinyl envelopes (see 5.1.6). When required, covers for Army manuals will be prepared as specified in the applicable contract. Covers for review manuscripts are not required.

3.10.12.3.1 Scoring. The front and back covers of 11 by 27 inch troubleshooting/repair volumes shall be appropriately scored vertically to permit folding into three equal portions. Covers for 11 x 17 manuals shall be scored to permit folding into two equal portions.

3.10.13 Binding.

3.10.13.1 Binding of support volumes. Binding shall be in accordance with MIL-P-38790. Manuals shall be prepared in loose-leaf form. Unless otherwise specified in the contract or order, corrosion-resistant posts and screws, polypropylene binders, or snap-ring metal prong fasteners shall be used. All metal parts shall be treated to resist corrosion. Manuals shall be punched or drilled in accordance with MIL-P-38790. Page sizes and punching or drilling for change pages shall be the same as for the original manual. Fillers shall be used to build up the binding edge to the same thickness as the right-hand edge of the manual.

3.10.13. 2 Binding of troubleshooting/repair volumes. Manuals shall be prepared in loose leaf form to facilitate the insertion of replacement pages.. Binding shall be along the long dimension. Polypropylene binding fasteners (Dustin Associates Inc., Drawing No. 0804, or equal) or commercial hinged metal rings shall be used, The fasteners shall be set on 2-1/2-inch centers, but shall not be placed where folds occur. The holes shall be not less than 1/2-inch from the binding edge and shall not be within any illustration image area. The holes shall not be larger than 1/4-inch in diameter. Manuals of two to four sheets (8 to 16 pages) shall be stapled (saddle stitched) along the binding edge, a minimum of twice between vertical folds. Binding for manuscripts or preliminary manuals shall conform to the above. When metal hinged rings are used, the binding holes in cover stock shall be of a diameter such that the hinged portion of the ring will not pass through the cover.

3.10. 13.2.1 Binding for left hand edge bound troubleshooting/repair volumes . When specified in the contract or order, binding for the troubleshooting/repair volumes shall conform to the requirements of 3. 10.13.1. Pages shall be arranged to fold out with title information visible. The binding edge and reinforcing strip (see 3.10.11) shall be along the 10-1/2 inch edge.

3.10.13.3 Binding of technician's pocket manuals. Spiral, GBC, or equivalent bindings shall be used along the 10-1/2 inch length of the manual. Polyester lamination is not required.

3.10.13.4 Special binding, When a different binding method than that specified can be considered an improvement for the manual usage, the contractor may request the procuring activity to permit a deviation. Samples and specifications for the binding method must be submitted to and authorized for use by the procuring activity.

3,11 Approval and acceptance (N). All publications shall be submitted for acceptance to the procuring activity or representatives thereof. Deliverable items listed in 3.13 shall be submitted for acceptance in sufficient time (or as scheduled in the contract) to allow an adequate review by the Government. Deliverable items will not be accepted by the Government until the contractor has complied with all conditions of approval.

3. 11.1 Publication or change number. The contractor shall request a publication or change number from the Government approving activity when the review manuscript is submitted for acceptance.

3. 11.2 Preliminary manuals. When there is insufficient time (less than approximately six months) to permit acceptance by the command or agency concerned and still provide printed final manuals with the delivered equipments, permission to supply preliminary manuals shall be requested from the procuring activity. Additional permission shall be obtained from the procuring activity prior to shipping the preliminary manual when any required data is missing. Prior to shipment with any equipment, a review copy of the preliminary manual shall be submitted to the cognizant Government representative for acceptance, The delivery of preliminary manuals does not relieve the contractor of any contractual requirements pertaining to delivery of complete, adequate, and accurate final manuals. Preliminary manuals shall be updated to represent production equipments before delivery of final manuals.

3.11.2.1 Review copies of preliminary manuals. A copy of the preliminary manual shall be submitted to the Government representative for acceptance prior to shipment of the first equipment. Simultaneously four copies of the manual shall be sent to the command or agency concerned. After acceptance, two copies of the preliminary manuals shall be packaged with each equipment.

3.11.2.2 Replacing preliminary manuals with final manuals (N). When the contractor is responsible for printing and distribution, a self-addressed contractor-furnished post card containing information equivalent to the notice shown below shall be attached to the title page of all preliminary manuals which accompany the equipment.

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

Copies of final manuals shall be forwarded by the contractor to activities that submit post cards before shipment of the final manuals to stock. When post cards are received by the contractor after shipment of the bulk stock quantity of manuals has been made, the cards shall be forwarded to the cognizant Government representative.

3.11.3 Review manuscripts for basic manuals, changes, and revisions. Unless otherwise specified in the contract or order, five validated review manuscript copies of the formal manual, changes, or revisions shall be submitted to the Government approving activity for acceptance and assignment of a publication number. Unless prior agreement has been reached, a minimum of six weeks from receipt of material shall be allowed for Government review.

3. 11.4 Certification check-off list. A signed and completed certification check-off list for preliminary, final manuals, and revisions shall be prepared in accordance with figure 33. The check-off list shall be submitted to the procuring activity with the review copies and shall indicate the degree to which the manuscript conforms to this specification. A similar list shall be prepared for permanent changes of Government furnished manuals and shall certify the extent to which the content conforms to this specification.

3. 11. 5 Rejection criteria. Failure of contractors 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) Book plan. Unless permission is obtained from the procuring activity, failure to conform with the Government accepted book plan.

(b) Technical accuracy and inconsistencies. Failure of all information to exactly represent the equipment or system being described and to be consistent with descriptive terms.

(c) Omission of data. Omission of any applicable data elements required by this specification.

(d) Validation. Failure to provide adequate evidence of validation.

(e) Workmanship. Failure to conform with the requirements of 3. 10 and MIL-M-38784.

(f) Reproducible copy, photolithographic negatives and shade screens. Failure to include changes or corrections required as conditions of acceptance.

3. 12 Quantity and distribution.

3.12.1 Final manuals. The quantity of manuals shall be as specified (see 6. 2). Unless otherwise specified in the contract or order, the contractor shall be responsible for the distribution of all manuals procured on the contract or order. If final manuals are available, two copies of the manuals shall be shipped with each equipment, and bulk quantities shall be distributed at time of first equipment shipment. If final manuals are not available with first equipment shipment, then preliminary manuals shall be delivered in accordance with 3.12.2, and the final manuals shall be distributed within 90 days after receipt of acceptance.

3.12. 2 Preliminary manuals. Unless otherwise specified in the contract or order, the quantity shall be two delivered with each equipment. For type I manuals, a bulk quantity up to the bulk required for final manuals, but no less than 25 copies shall be supplied. (The total quantity of preliminary manuals to be supplied will depend upon the need at the time and the expected delay in production of final manuals. Distribution will be as directed.) Distribution of bulk quantities shall not be later than 30 days after the shipment of the first equipment.

3.12.3 Changes and revisions. The quantity of copies of changes and revisions shall be as specified in the contract or order. The distribution of such material shall be to all activities receiving the original manual and in the same quantity or as directed by the command or agency concerned.

3. 13 Deliverable data items. The deliverable data items of the FOMM manual shall be as specified (see 6. 2), and shall conform with the requirements specified herein. Data items shall include the following, as applicable.

(a) Book plan (dummy manual).
(b) Quality program.
(c) Manuscript for review.
(d) Preliminary manual.
(e) Basic (final) manual.
(f) Supplement.
(g) Change.
(h) Revision.
(1) Camera-ready reproducible copy.
(j) Photolithographic negatives.
(k) Replenishment material.
(l) Status reports.
(m) Certification check off list.
(n) User activity comment sheet.
(o) Microfilm copy.
(p) Technician's pocket manual.

3.13.1 Book plan (dummy manual). Two copies of the book plan (dummy manual) (each volume) shall be prepared for review and acceptance by the procuring activity, prior to development of the review manuscript. The dummy manual shall outline the planned manual coverage by proposed volume, division, etc., in accordance with the content and format requirements of this specification. Each page of the troubleshooting/repair volume shall be represented in the dummy manual. Pages containing more than one data Item (for example, schematic, text, and MDC) shall show the relative location of each data item on the dummy manual page. Each page in the dummy manual shall indicate page title and page number.

3.13.2 Quality program. A quality program, including proposed procedures and methods for validation and verification shall be maintained in accordance with 4. 2. Two copies of the quality program shall be submitted for review by the contracting agency prior to preparation of the review manuscript.

3.13.3 Manuscript for review. Unless otherwise specified in the contract or order, five validated copies of review manuscripts shall be prepared and submitted to the designated activity for acceptance prior to the preparation of the reproducible copy. Review manuscripts shall be submitted in accordance with contractor/Government approved milestone plan or not later than six months prior to delivery of the first equipment. The review manuscript shall contain all front matter, text, tables, and illustrations necessary to meet the content requirements of this specification. The manuscript shall be proofread, edited, validated, and collated in the same manner as the final manual prior to submittal. Production and delivery of the manuscript shall be in accordance with this specification and the contract.

(a) Each page of the manuscript shall be presented on one side of the paper and shall contain the exact wording and content intended for the reproducible copy. The production method may be the most economical method at the option of the contractor.

(b) Reproduction of penciled illustrations are acceptable, if their technical content, clarity, correctness, and adequacy meet specification requirements. Illustrations submitted for review purposes shall be legible. Submitted manuscripts shall be in accordance with 3.10.5.3.

(c) Color coding is not required in review manuscripts but blue boundaries shall be illustrated by dotted lines. Hardware boundaries shall be indicated by dot and dash lines with the number of dots corresponding to the level of containment (first level, second level, etc.).

3.13.4 Preliminary manual. The preliminary manual shall include all data required for the basic (final) manual, and shall be validated in accordance with 4.2.2(d). The preliminary manual shall reflect the review manuscript with all valid Government review comments incorporated and shall be superseded by a basic (final) manual. Unless preliminary manuals are required as a deliverable item by the contract or order, preliminary manuals are only produced to fulfill the need specified in 3.11.2.

3.13.5 Basic (final) manual. The basic (final) manual shall be prepared in full conformance with this specification and the requirements of the applicable contract or order. The production requirements shall be in accordance with this specification (see 3. 10) and the applicable contract.

3.13.6 Supplements. Supplements to the manual shall be prepared in accordance with this specification (see 3.1.4.3) and MIL-M-38784.

3. 13.7 Changes. Changes and instructions shall be prepared in accordance with this specification (see 3. 9. 1) and MIL-M-38784.

3.13. 8 Revisions. Revisions shall be prepared in accordance with the requirements of this specification (see 3. 9.2) and MIL-M-38784.

3.13.8.1 Updated revisions. Updated revisions shall be provided as corrections to the manual to reflect a modification to an equipment or to correct detected errors or deficiencies and shall incorporate all temporary changes.

3.13.8.2 Complete revisions. Complete revisions shall be prepared in full conformance to this specification and the entire manual shall be accurate, and be validated in accordance with 4.2.2(d).

3.13.9 Camera-ready reproducible copy. Final camera-ready reproducible copy, including original artwork, color-shading masks (see 3.10.6), complete in all respects for photographic reproduction, shall be prepared in accordance with this specification. All artwork prepared for manuals under the contract or order shall be the property of the procuring activity and shall be delivered as the procuring activity directs.

3.13.9.1 Text. Text pages may be typed, reproduced mechanically or by a computer typesetting system. Unless otherwise specified by the procuring activity, the text shall be double column, justified left column format. If a computer typesetting system is used, text may be justified left and right margin format.

3.13.9.1.1 Spacing and lettering. Spacing and lettering shall conserve space without lessening usability or clarity of material. Letters, lines, symbols shall be of a uniform contrast throughout the text material. Lettering and spacing shall be such as to meet the reproduction requirements by 24X microfilm (see 3.10.1.2) and will maintain legibility when reproduced by microfilm reader/printer.

3.13. 9.1.2 Arrangement. All text pages, including text in a single volume manual and in the troubleshooting/ repair volume shall be formatted to fall within a single 8 by 10 1/2 inch page when reduced and within a single frame of 24X microfilm/ microfische.

3.13.9.2 Artwork. Artwork shall be capable of reproduction on 24X microfilm, resulting in clear, adequate, and legible reproduction on a microfilm reader/printer. Shades of blue shall. reproduce in grey. Shading shall hold in to the degree of defined identification. Line drawings and illustrations rather than photographs shall be used, except when halftones will result in a savings to the Government and they will be limited in use to those that will meet the requirements of reproduction by 24X microfilm.

3.13.9.2.1 Line density. The line density for graphic material and background area shall be uniform to achieve the highest possible contrast for better readability and reducibility. Parallel lines on wiring and schematic diagrams shall in no case be less than 1/16 inch apart when reduced to printed size.

3.13. 9.2.2 Spacing. The density of information presented shall be such that the spacing between lines of characters shall be not less than one-half the character height used.

3.13.9.2.3 Arrangement. Artwork in the troubleshooting/repair volume, shall be arranged to fall within two (11 by 17 inch final size) or three (11 by 27 inch final size) consecutive frames of 24X microfilm. Insofar as possible, the layout should be such that only connecting lines (without symbols or printing) exist at the theoretical interface points between frame areas,

3.13. 10 Photolithographic negatives. When required by the applicable contract or order, photolithographic negatives shall be prepared in accordance with this specification (see 3.10.3).

3.13.11 Replenishment material. Replenishment material consisting of one copy of the final manual, the photo-lithographic negatives including the line negative, the grey screen negatives, the blue screen negatives, and the printers assembly instructions that were used for the printing of the manual, shall be supplied.

3.13.12 Status reports. When required by the contract or order, the contractor shall supply a status report on a monthly basis starting 60 days after contract award and continuing until all deliverable items have been accepted. The status report shall indicate the degree of progress, any problems encountered, and any delays which may effect the development and timely delivery of the deliverable data items. The status report shall include a table that lists each element in the proposed manual and indicates the degree of completeness of each element. When another monthly report is required as part of the contract, this information may be combined with the other report provided that distribution is as specified.

3.13. 13 Certification check-off list. A signed and completed check-off list shall be prepared in accordance with figure 33 for preliminary, final manuals and revisions. The check-off list shall be submitted to the procuring activity with the review copies and shall indicate the degree to which the manuscript conforms with this specification. A similar list shall be prepared for all permanent changes to the manual and shall certify the extent to which the content requirements conform to this specification.

3. 13. 14 User activity comment sheet. Three copies of user activity comment sheet similar to figure 34 shall be included after the last page of the support volume.

3. 13.15 Technicians pocket manual. When required by the contract or order, an approximate 4-1/8 by 10-1 /2 inch page size reprinting of the troubleshooting/repair volume shall be provided. A unique publication number shall appear on the cover and title page only. All other pages shall be a reduced size copy of the troubleshooting/repair volume, see figure 19.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Quality program requirements (CG, MC, N). The supplier shall document and maintain a written quality program as required to assure that the manual will accurately and adequately reflect the equipment or system covered and will include the necessary installation, operation, maintenance, repair, and parts support procedures necessary for satisfactory equipment performance. Acceptance of the program (see 4.4) shall be obtained from the procuring activity or its designated representative prior to development of any part of the manuscript. The program shall assure the comprehensive control of the development validation and evaluation of the manual.

4.2.1 Quality program (general). The quality program shall be in accordance with the following:

(a) Organization. Effective management for quality shall be clearly prescribed by the supplier. Personnel performing quality functions shall have well defined responsibility and authority and the organizational freedom to identify problems and to initiate, recommend, and provide solutions. Management shall review the status and adequacy of the program on a regularly scheduled basis.

(b) Initial quality planning. The supplier, during the earliest practical phase of contract performance, shall conduct a complete review of the contract requirements to identify and make timely provision for any special controls, processes, tests, and skills, that may be required. This initial planning shall include the development, maintenance, and implementation of methods and procedures to assure the quality of the manual review and actions to assure compatibility of preparation, inspection, validation, and documentation.

(c) Manual (manuscript or preliminary) inspection and validation. The quality program shall assure that there is a system for inspection, validation (see 6.4. 59) and correction of the manuals, in parallel with the design. and manufacture of the equipment or system. Validation shall provide a measure of the overall quality of the manual and shall be performed in accordance with 4.2.2(d). When revisions or corrections are required, after any inspection, validation, or review, there shall be reinspection, revalidation, or re-review of all characteristics affected.

(d) Subcontracting. A subcontractor quality program is required if the subcontractors prepare, inspect, or validate the manuals.

(1) Responsibilities. The supplier shall be responsible for assuring that all manuals procured from the subcontractors conform to the contract and specification requirements. The extent of control invoked and exercised by the supplier shall be identified in the quality program. When the Government performs an inspection(s) at a subcontractors plant, such inspections) shall not be used by the supplier as evidence of effective control of quality by such subcontractors. The effectiveness of subcontractor quality control shall be reviewed by the supplier at regular intervals. The supplier shall inspect manuals upon receipt from the subcontractor to assure conformance with requirements. All deficiencies shall be promptly corrected by the supplier.

(2) Purchase orders. The supplier's quality program shall not be deemed acceptable to the Government unless the supplier requires from his subcontractor an equivalent quality control program, or equivalent control over the subcontractor. The supplier shall assure that applicable requirements are included or referenced in all purchase orders. The purchase order shall contain a complete description of the manuals and materials ordered including, by statement or reference, applicable requirements for preparation, inspecting, validating, packaging, packing and any requirements for Government or supplier inspection, certifications, acceptance or approvals. The description of manuals shall include a requirement for supplier inspection at the subcontractors, when necessary to assure that his quality program effectively implements his responsibility for quality assurance. The purchase order shall contain a requirement for subcontractors to notify and obtain authorization from the supplier for changes in design or content of the manual. Instructions shall be provided when direct shipment from the subcontractor to Government activities is authorized.

(3) Government inspection, verification, acceptance of manuscripts at subcontractor facilities. Government inspection, verification (see 6.4.60), and acceptance of review manuscript shall not constitute Government acceptance and shall not in any way replace supplier inspection/validation or otherwise relieve the supplier of his responsibility: to furnish an acceptable manual. When the procuring activity requires inspection or verification at the subcontractor location, the supplier shall include in the purchasing document a statement equivalent to the following:
"Government inspection/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/verification may be planned. If the Government representative cannot be identified, the prime contractor shall be notified immediately."

The supplier shall report to his Government representative any nonconformances of Government source inspected' verified manuals and shall require the subcontractor to coordinate corrective action with his Government representative.

4.2.2 Quality program (specifics). The quality program shall include, but not be limited to the following:

(a) Designation of authority, functions, and duties of those personnel responsible for preparation, inspection, and validation of the manuals.

(b) Coordination with equipment or system design and production activities to assure the use of the latest technical data and information (e.g. , operation and maintenance procedures, drawings, illustrations, etc.) for the preparation of the manual(s) and that authorized changes to the equipment or system are promptly incorporated in the manual(s).

(c) Establishment of in-process inspection points and development, maintenance and implementation of inspection criteria to control the adequacy and accuracy during the development stages of the manual(s).

(d) Validation (see 6.4.59) by comparison or performance of descriptions in the manual-against or on the physical equipment or system. Performance of the instructions or: procedures within the manual shall be accomplished by the supplier or subcontractor personnel at the level for which the manual is written, using equipment normally available at the installation site.

(1) The demonstration by actual performance of instructions and procedures in each manual relating to operation, assembly, disassembly, maintenance, troubleshooting, etc., shall be performed by the supplier or his subcontractor at the equipment installation site to the extent technically practical. Checks may be conducted concurrently with normal assembly, test, and disassembly inspections, when applicable. Written information and drawings in each manual shall be compared against actual equipment to ensure chat the information and drawings match the actual equipment in all details. Installation drawings and engineering drawings that have been reproduced for use in the manual and have been validated in accordance with MIL-D-1000, do not require further validation. Where appropriate, descriptive material may be checked against validated drawings.

(2) All procedures, and instructions, except those which will damage the item or incur extraordinary costs shall be demonstrated by review of performance. Procedures that would damage the item shall be demonstrated by review of drawings. Examples are:

a. Destruction of material, such as unsoldering/soldering on electronic subassemblies, parts, etc.

b. Boring, grinding, and other shaping repair procedures.

c. Removal of distilling plant tube nets, shafting, crankshafts, inner tubes from periscopes, or other parts when accessibility can be determined by measurement, observation, and reference to drawings.

d. Emergency or damage control operating procedures which would endanger material or personnel.

e. Operating procedures which would entail excessive costs not encountered in the normal operating mode. (Excessive costs can be defined to include the provision of special equipment, aircraft, ships, facilities, etc., for testing, unless furnished by the Government.)

(e) Detailed review of camera-ready copy/photolithographic negatives, masks, as applicable, with a representative of the public printer to ensure that this material is identical to the authorized, validated, verified, corrected, and accepted manuscript, and complies with the legibility and reproducibility requirements.

(f) Inspection of the final Government printed manuals (upon receipt from the Government) to ensure the proper page count, that no damage exists, and through the use of an acceptable sampling plan (as a minimum) that the printed manuals represent the camera-ready copy or photolithographic negatives, as applicable. (NOTE: Printing by the Government shall not relieve the supplier from providing adequate and accurate content in the manual(s)).

4.3 Validation/verification (A). For Army manuals validation/verification and the requirements thereof shall be in accordance with MIL-M-63000 and MIL-M-63001.

4.4 Quality program acceptance. Acceptance of the supplier's quality program by the Government in no way relieves the supplier of the final responsibility to furnish manuals as specified. Acceptance shall not preclude additions, refinements, or changes by the supplier, to the quality program where evidence indicates that the program is 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 supplier, acceptance shall be obtained from the cognizant Government activity prior to implementation.

4.5 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5.0 PREPARATION FOR DELIVERY

5. 1 Packaging and packing. Unless otherwise specified in the contract or order, the packaging and packing requirements for delivery of book plans, manuscript copies, reproducible copy, technical manuals, and replenishment material shall be in accordance with this specification.

5.1.1 Classified material. All classified material shall be packaged and marked in accordance with the requirements of DOD Instruction 5220. 22-M (see 6. 3).

5.1.2 Manuscript copy for review. Manuscript copy (see 3. 11.3) shall be packaged flat in the most appropriate containers. (See 5.1.9 and 5.1.10 for container and marking requirements.)

5.1.3 Original artwork. When original art is mounted on illustration boards it shall have a protective flap. As specified by the contract or order, the illustration boards shall have instructions, and registration marks, etc. 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 art.

5. 1.4 Photolithographic negatives and masks. Photolithographic negatives and masks shall be packed flat (never folded or rolled) and double packaged. The interior material shall be waterproof and free of any chemical substance that would discolor or otherwise degrade the negatives. The exterior package shall be a standard commercial carton at least equal to Interstate Commerce standards and of sufficient strength to protect the negatives against the forms of damage that frequently occur during shipping. (See 5. 1 for marking requirements.)

5.1.5 Single and multivolume manuals. Single copies and multivolume technical manuals shall be packed to preclude damage in transit. Multivolume technical manuals shall be furnished as complete sets except for bulk manuals shipped for stock. Stock copies of identical volumes shall be packed and shipped in common containers.

5.1.6 Manuals of four pages or less. Manuals consisting of four pages or less shall be enclosed in a clear durable vinyl envelope not exceeding 15-1/2 by 13 inches. 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.

5.1.7 Technical manuals shipped with equipment. Technical manuals that accompany shipments of equipment that are packed levels A or B (see MIL-E-17555), shall be packaged in transparent plastic bags, minimum four mil thick. Closure shall be by heat sealing. Technical manuals shall not be placed within any sealed flexible barrier material used to enclose the equipments. Army technical manuals shall be packaged in accordance with method IC-1 of MIL-P-116.

5.1.8 Bulk shipments. Except as set forth in 5.1.6, technical manuals, when shipped in bulk quantities for stock shall not be individually wrapped (see 5.1.1). Containers shall comply with the Uniform Freight Classification Rules or other carrier regulations, as applicable to the mode of transportation. All containers shall be marked FOR STOCK". (See 5. 1. 10 for container information.)

5.1.8.1 Correction material and field change bulletins (N). For bulk shipment, correction material (changes or temporary corrections) and field change bulletins (see MIL-F-17655) shall be packaged separately as separate line items.

5.1.9 Shipments in multiple containers. For equipments shipped in multiple shipping containers, the technical manual(s) shall be placed in the container housing of the main unit of equipment. Packing lists, invoices, or bills of lading shall indicate the number of the container that encloses the technical manuals, the publication identifying number, nomenclature, etc. (see 5.1.10). For ease of removability, the location of the manual(s) shall be such that they are readily accessible when the container is opened. The shipping container housing the manuals shall be marked "MANUALS ENCLOSED".

5.1.10 Container marking information. In addition to sender and addressee information, the exterior of each container shall show the following, as applicable:

(a) Publication identifying number.
(b) Nomenclature of equipment.
(c) Manuscript copy.
(d) Reproducible copy.
(e) For storage.
(f) For stock.
(g) Manual:, enclosed.
(h) Number of containers in shipment.
(i) Replenishment material.
(j) Original artwork.

5.1.11 Packing list. A copy of the letter of transmittal, the packing list, or bill of lading shall be placed inside of the carton or 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.

5. 1.12 Replenishment material (N). The replenishment material shall be packaged in accordance with 5.1.4. The container shall be identified (see 5.1.10) and marked "FOR STORAGE". The container with a transmittal letter shall be forwarded to:

Director
Naval Publications and Printing Service, Eastern Division Building 4, Section D
700 Robbins Avenue
Philadelphia, Pa. 19111

NOTES

6.1 Intended use. FOMM manuals prepared to this specification are used to support equipment and system installation, operation, maintenance, repair, and parts provisioning. The manuals are also used as sources for on the job training and classroom instructional material. The arrangement of the data is specifically tailored to be of maximum benefit for the user in gaining an understanding of equipments on which he has had little formal training, and for troubleshooting and repair of the equipment or system covered.

6.1.1 Type I. Type I, IS, or IX manuals are required for equipments (see 6.4. 10).

6.1.2 Type II. Type II, BS, or IIX manuals are required for systems (see 6.4. 53).

6. 2 Ordering data. Procurement documents (including the Contract Data Requirements List, Form DD 1423) should specify the following:

(a) Title, number, and date of this specification.

(b) Type of manual required (see 1.3).

(c) Deliverable data items (see 1.4).

(d) A technician's pocket manual shall be ordered as an additional item when a need is anticipated for a reduced size copy of the troubleshooting/repair volume. The technician's pocket manual shall not be ordered in lieu of the troubleshooting/repair volume (see 3.1.4.1.1).

(e) Service test or experimental (N). If the equipment/ system is considered as experimental but is intended for service test, the manuals) shall be specified as service test.

(f) Two volume or single volume manual. When the final manual will not require more than 10 sheets (20 pages) (11 x 27 inches) to accomplish the requirements of the support volume, a single volume should be procured which contains the full subject matter of both the support volume and the troubleshooting/repair volume. A supplement may also be ordered as a single volume.

(g) Requirements for blue shades may be waived for manuals that will not be used in training situations or manuals that will not be produced in hard copy, or for manuals in which blue shades will provide minimal benefit.

(h) Requirements for appendixes, as applicable.

(i) Requirements for installation data (type I (see 3.3.1.5), type II (see 3.4.1.7)). Installation data should be required when separate installation data is not procured under the equipment contract and if installation is to be per-formed by operator or maintenance personnel, rather than by installation facilities (e. g. , yards, depots, factories, etc.).

(j) Requirements for complete separate parts list (see 3.3.1.6).

(k) Applicable distribution statement.

(1) Type II should be procured for a specific type of system installation, (e.g., aircraft, ship) or subsystem (e. g. , NTDS, fire control, IFF) rather than for a broad group of dissimilar installations when the individual equipment manuals do not provide the necessary integrating information.

(m) Designated level of repair and volumnization (see 3.8.2.2).

(n) New manual, permanent change (see 3.9.1.2), interim change (see 3.9.1.1), revision (see 3.9.2.1 and 3.9.2 2), supplement (see 3.9.4).

NOTE: Where the extent of change to the basic; manual is less than 25 percent, a permanent change should be procured. When the extent of a change is over 25 percent, an updated revision (see 3.9.2.1) of the manual shall be procured. When the basic manual has been changed to the extent that it is wholly inadequate because of its arrangement, or other reason detrimental to the user, a complete revision (see 3.9.2.2) of the manual shall be procured.

(o) Cover stock for Army manuals (see 3.10.12.1.1).
(p) Quantity and delivery data of deliverable items (see 3.12 and 3.13).
(q) Microfilm requirements; prepare as a separate item on DD Form 1423 and reference DID or governing specification.

6. 3 Management control system document. The following management control system document should be included on DD Form 1660:

(a) 5220. 22M (see 3. 1. 3 and 5.1.1).

6.4 Definitions.

6.4.1 Blocked schematic. A blocked schematic is a diagrammatic presentation in which the circuit elements have been grouped (blocked) into functional entities in order to present a clearer picture of the operation of the assembly.

6.4.2 Blue. Refers to the color of functional areas in final manuals. The specified color is actually blue/green in order to enhance microfilming.

6.4.3 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.

(l) 6.4.4 Circuit elements. Circuit elements are those electrical, electronic, or mechanical piece parts not subject to disassembly withou destruction of its designed use such as electronic tubes, resistors, capacitors, transformer, valves, etc.

6.4.5 Component. A composite fabricated unit, generally complete within itself, that is designed to perform a stated service when installed in its proper position within a ship or station (e. g. , boiler, winch, motor, power voltage regulator, etc.).

6.4.5.1 Component identification number (CID). Component identification number is a design identifier which gives the manufacturer's name and the characteristics for a particular piece of equipment. For the purposes of this specification, the procuring activity will specify the significant component identification to be used.

6.4.6 Composite entity. A group of functional entities that work together to perform a larger function, such as a series of flip-flops connected as a "ripple counter".

6.4.7 Dependency chart. (See 6.4. 28).

6.4.8 Discrete parts. Individually distinct parts as opposed to integrated circuits. Examples are resistors, transistors, capacitors, etc.

6.4.9 Distribution statement. A statement used in marking a technical document to denote the conditions of its availability for distribution, release, or disclosure. This statement will be provided by the approving activity upon request.

6.4.10 Equipment. One or more assemblies capable of performing a complete function (see 6.4.15).

6. 4. 11 Event. An action, or the presence of a voltage, signal, pressure, or other data at a defined observation or measurement point, that results from a turn-on, operational, or check-out procedure, or the presence of an initiating signal, data, etc.

6.4.12 Experimental equipment. An equipment designed to prove feasibility of concept.

6.4. 13 Final manual. A completed book accepted by the procuring activity which complies with all requirements, including production requirements of this specification and has been validated and verified to be adequate for its intended use.

6.4. 14 FOMM - Functionally Oriented Maintenance Manual. Acronym for manuals prepared to this specification.

6.4. 15 Function. A group of functional entities and functional devices or circuit elements that work together to accomplish a portion of a system or an equipment assigned objective. For example: transmit, receive, display, hoist, train, generate power, and control actions.

6.4. 16 Functional devices. One or more parts which perform a functional operation. Also, the fewest number of parts that can perform a functional operation.

6.4. 17 Functional entity. A grouping of parts connected together to perform a basic function (for example, amplify, oscillate, filter, voltage divide, etc.) and in event of a malfunction provide a recognizable (visual, audible, etc., or by means of measurement) symptom.

6.4.18 Functional entity identifier code. A group of letters and a number which identify a particular functional entity. The first letter defines a general (physical) characteristic, the following letters defines the purpose of the entity, and a number(s) differentiates between identically defined entities in one assembly.

6.4.19 Hardware. Actual equipment, such as a unit, assembly, subassembly, etc.

6.4.20 Hardware information. The most detailed information contained in the troubleshooting/repair volume. Hardware information consists of blocked schematics, keyed text, MDC, alignment and repair data, and parts data.

6.4.21 Hierarchical data. An arrangement of information into levels from the most general to the most derailed. The troubleshooting/repair volume uses this arrangement to illustrate the functional and physical packaging of an equipment. The basic levels are:

(a) Overall information.
(b) Major function information.
(c) Hardware information.

6.4.22 Integrated blocked schematic. Integrated blocked schematics are diagrammatic presentations which show all circuit elements (electrical, electronic, mechanical, or otherwise) encompassed within two or more assemblies. Such a schematic shows the complete interconnections between functional devices, circuit elements, subassemblies, and assemblies included.

6.4.23 Interim change. An expeditious method of promulgating a minor manual change by means of replacement pages or pen and ink corrections. (Interim changes are often referred to as temporary changes.)

6.4.24 Interior communications equipment (N). Equipment normally used for shipboard interior communication. These include navigation or related equipment designated Interior Communications (IC) equipment such as the following:

(a) Plotting tables.
(b) Dead reckoning indicators.
(c) Gyros and gyro amplifiers.

6.4.25 Intermediate function diagram. A block diagram constructed to the same rules as the overall function diagram which fits into the hierarchical structure between the overall function diagram and the major function diagrams. It is only used when the number of major functions is too great to be presented on the overall function diagrams.

6.4.26 Keyed text. Descriptive text for each functional blocked area (blue shaded area) on a particular diagram. Encircled numbers key blue shaded areas on the diagram to the appropriate text. Keyed text is prepared in columnar format for each diagram in the troubleshooting/repair volume and always appears on the same or facing page.

6.4.27 Mainframe, A mainframe is the enclosure and attached circuit elements or functional devices that remain after removal of such assemblies as chassis, printed circuit boards, and trays, pistons, gears, connecting rods, shafts, etc. A typical mainframe might be an electronic cabinet enclosure with wire harnesses, etc. remaining in place after removal of replaceable assemblies.

6.4.28 Maintenance dependency chart (MDC). An MDC. is a diagram showing the processing of energy/information through the functional grouping depicted on the related blocked schematic or on a functional block diagram.

6.4. 29 Maintenance requirements cards (MRC). A series of cards, which are part of the planned maintenance subsystem, used by technicians for performing scheduled tests and preventive maintenance for given equipments and systems. When the planned maintenance subsystem is installed, the procedures on the maintenance requirements cards supersede the scheduled maintenance procedures in the technical manual.

6.4.30 Major function. Functional sub-division of an equipment or system. Normally includes portions of several assemblies within the equipment. Examples are: transmit, receive, synchronization control, etc. In systems manuals, major function may be based on the mode of operation.

6.4.31 Major function diagram. A detailed block diagram of a major function of the equipment or system. The diagram illustrates the interrelationships of all functional entities and devices and the hardware levels of containment.

6.4.32 Major function information. Data necessary to illustrate, describe and troubleshoot a major function. Normally consists of a major function diagram, keyed text and an MDC

6.4.33 Manuscript for review. A draft copy of the manual (or changes) which is submitted for review and acceptance prior to preparation of preliminary and final manuals.

6.4. 34 Microfilm. A high resolution fine grain photographic film used to photograph data at a greatly reduced size in order to reduce storage requirements. Microfilm may be supplied users in lieu of printed-copy. A microfilm reader allows the user to read the microfilm from a screen; a reader/printer allows a user to both read the copy and duplicate the data on paper (hard copy). All reference to microfilm in this specification refers to Silver Halide, negative type, clear line image.

6.4. 34.1 35mm Microfilm. Film images roughly 1.25 by 1.75 inches, in roll film or mounted in aperture cards.

6.4.34.2 24X Microfilm. Microfilm with a maximum reduction ratio of 24:1 on 16mm roll film, roll cartridge, or microfiche. Image area per frame is approximately 10mm by 12. 5mm.

6.4. 34.3 Microfiche. A sheet of film containing micro images, and usually a title that can be read with the naked eye. For purposes of this specification, a microfiche is approximately 106 by 148. 75mm having 7 rows and 14 columns (98 frames approximately 10 by 12 1/2mm per frame).

6.4.35 Objective quality evidence. (See MIL-STD-109.) Examples of verifiable evidence are validation reports, inspection records, certificates, and any other evidence relating to the accomplishment of control of quality.

6.4.36 Overall function diagram. A block diagram that depicts and identifies all interfaces between the major functions. In final manuals it is a two color diagram with the equipment represented by grey shades and the major functions represented by blue shades.

6.4.37 PABD - Precise access block diagram. Same as a major function diagram.

6. 4.38 Part. One piece, or two or more pieces joined together, which are not normally subject to disassembly without destruction.

6.4.39 Planned maintenance system. Aspects of the D.O.D. maintenance and material management system (see 3.4.1.5).

6.4.40 Preliminary manuals. A preliminary manual is a manual which includes all data required for the final manual but has not received final acceptance and may not comply with the production requirements for a final manual. Preliminary manuals are superseded by final manuals.

6.4.41 Repair. Action required to restore a repairable part, subassembly or assembly to a specified condition, but not necessarily to make it like new in physical appearance.

6.4.42 Replenishment material. Replenishment material consists of one copy of the final manual and the photolithographic negatives, masks, and instructions used for printing the manual.

6.4.43 Review manuscript. Manuscripts submitted to the procuring activity for acceptance prior to preparation of final reproducible copy (see 3.13.3).

6. 4.44 Revision. A second or subsequent edition of a manual which supersedes the preceding edition. An updated revision is required when the current manual does not accurately or adequately cover the equipment (because of errors, production changes, or field changes made to the equipment) and when the extent of required page changes to the technical manual is greater than 25 percent. A complete revision is made when the basic manual is wholly inadequate because of obsolescence, gross inaccuracies, etc.

6.4.45 Roadmap type manual. Technical manual fully contained on one sheet of paper. Blocked schematic and keyed text appear on one side of the sheet. Parts data, operation and maintenance data are on the opposite side. The sheet is folded like a roadmap to fit inside the equipment cover, in a pocket, etc.

6.4.46 Schematics (see 6.4.1).

6.4.47 Service test equipment. An equipment used for test under service condition for evaluation of suitability and performance. It closely approximates the final design, has the required form, and employs approved parts or their interchangeable equivalents.

6.4.48 Set. A unit or units and necessary assemblies, subassemblies, and basic parts connected or associated together to perform an operational function. In the case of electronics equipment, an AN nomenclature is assigned. Refer to ANSI Y32. 16 for a detailed description (see 6.4. 10).

6.4.49 Signals. The information/energy which may be sensed or measured at defined points within the equipment. Signal connotes different types of information depending upon the equipment involved. Examples are pressure, speed, temperature, voltage, etc.

6,4.50 Signal designator. The. signal name, an abbreviation of the signal name, a code, a cipher, or any combination thereof which is used to identify inputs and outputs of functional devices.

6.4. 51 Signal flow. The ordering of information/energy transfer through a system as shown by drawing layout, use of arrowheads and descriptions in text. Signal flow does not automatically imply electrical current flow or physical motion.

6.4.52 SIMM - Symbolic Integrated Maintenance Manual. Acronym for manuals prepared to MIL-M-24100A (SHIPS), the predecessor of FOMM manuals prepared to this specification.

6.4. 53 Supplement manual (complementary manual). A separate publication which augments a technical manual so that both jointly describe the configuration of the equipment and all necessary information for operation, maintenance, and repair.

6.4.54 Support volume. The first volume of a two volume FOMM manual. This volume contains all information not generally required for troubleshooting and corrective maintenance.

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

(a) An electronic system (or subsystem) can be identified as IFF system, ECM system, AEW system, ASW system, TDS system, etc.

(b) An electromechanical system can be identified as a propulsion system, replenishment system, degaussing system, etc.

6.4.56 Technician's pocket manual. A reduced-size copy of the troubleshooting/repair volume. It is issued for use where the convenience of small size exceeds the disadvantages of marginal legibility. It is intended that the technician reference the standard size manual when he must verify data.

6.4.57 Troubleshooting/repair volume. The second volume of a FOMM manual. It contains the drawings and troubleshooting data necessary for a qualified technician to locate and correct a fault in an equipment or system without reference, except for performance test procedures, to other documents.

6.4.58 Unit. A major building block for a set or system, consisting of a collection of basic parts, subassemblies, and assemblies packaged together as a physically independent entity.

6.4. 59 Validation. The process by which the contractor asures that the manual represents the latest equipment configuration, that it is accurate and adequate for its intended purpose. Validation is performed by actual tests on the hardware.

6.4. 60 Verification. The process by which the Government assures the accuracy of the manual(s) by actual comparison with hardware. This includes Government action to assure proper execution of validation by the contractor.

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

Preparing activity:
Navy - SH
(Project TMSS-0207)

Custodians:
Army - TM
Navy - SH

Review activities:
Army - AT, AV, CE, EL, ME, MI, MU, SC, SL, WC Navy -
CG, EC, MC

User activities:
Army -
Navy - OS, YD

SECURITY CLASSIFICATION

Publication Number **VOLUME 1, PART 2**

FOMM

TECHNICAL MANUAL

SUPPORT VOLUME
for

NOMENCLATURE OF EQUIPMENT

TYPE, MODEL, PART NUMBER

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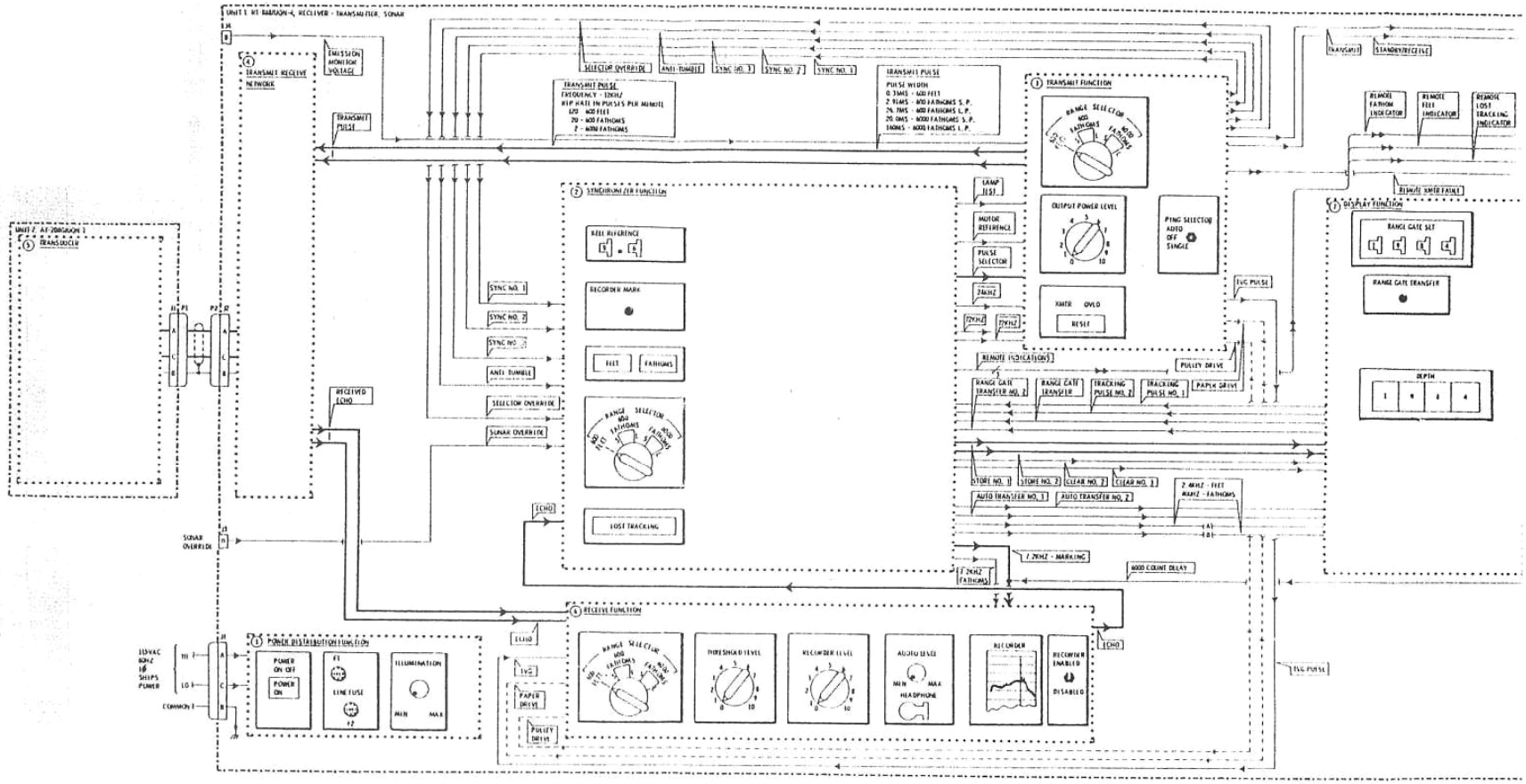
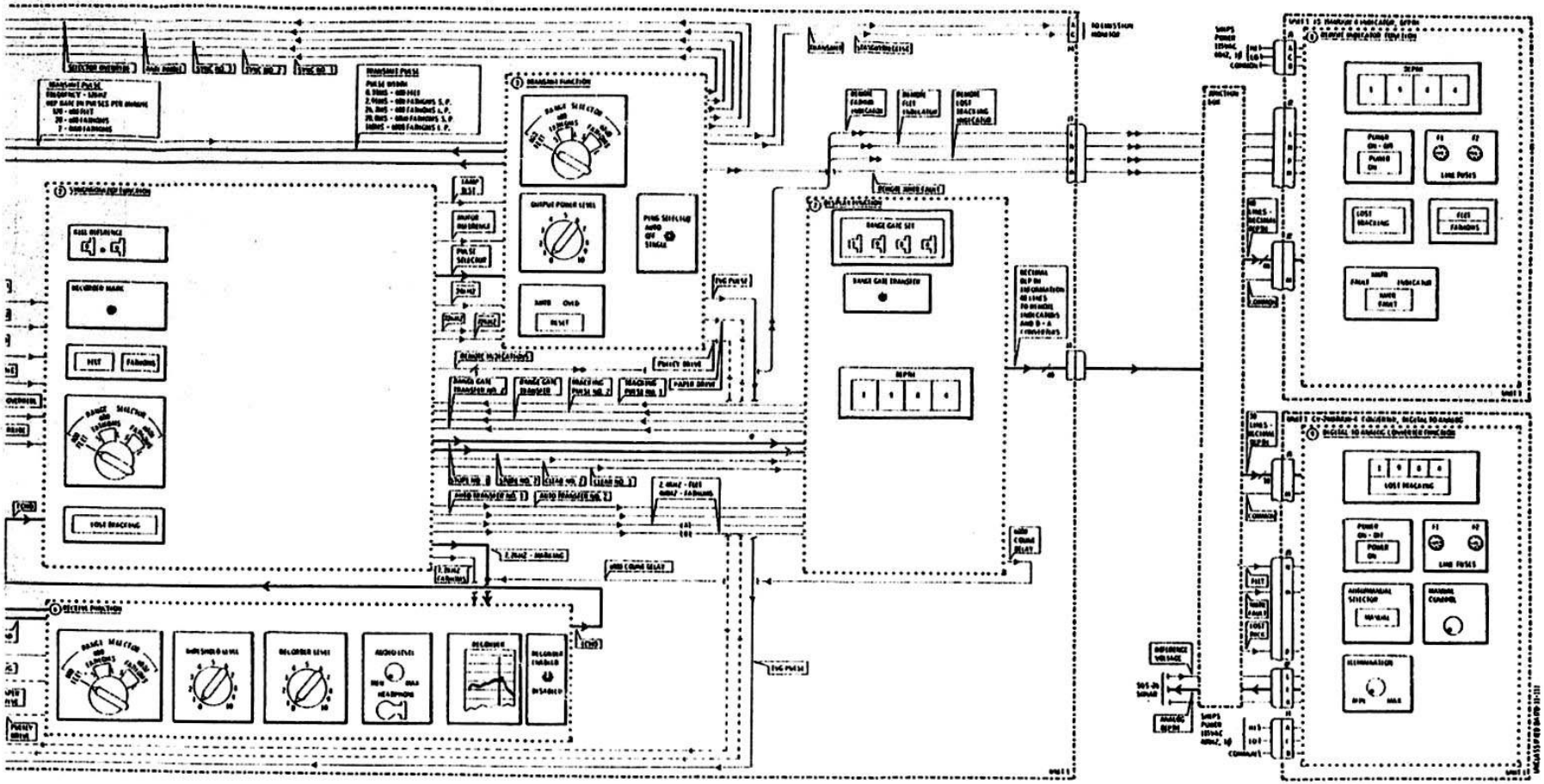
Figure 1. Cover (Support Volume).



Sample arrangement only. Layout does not conform to microfilm requirements.



Sample arrangement only. Layout does not conform to microfilm requirements.

Figure 11. Overall Function Diagram (Review Manuscript). 73/(74 blank)

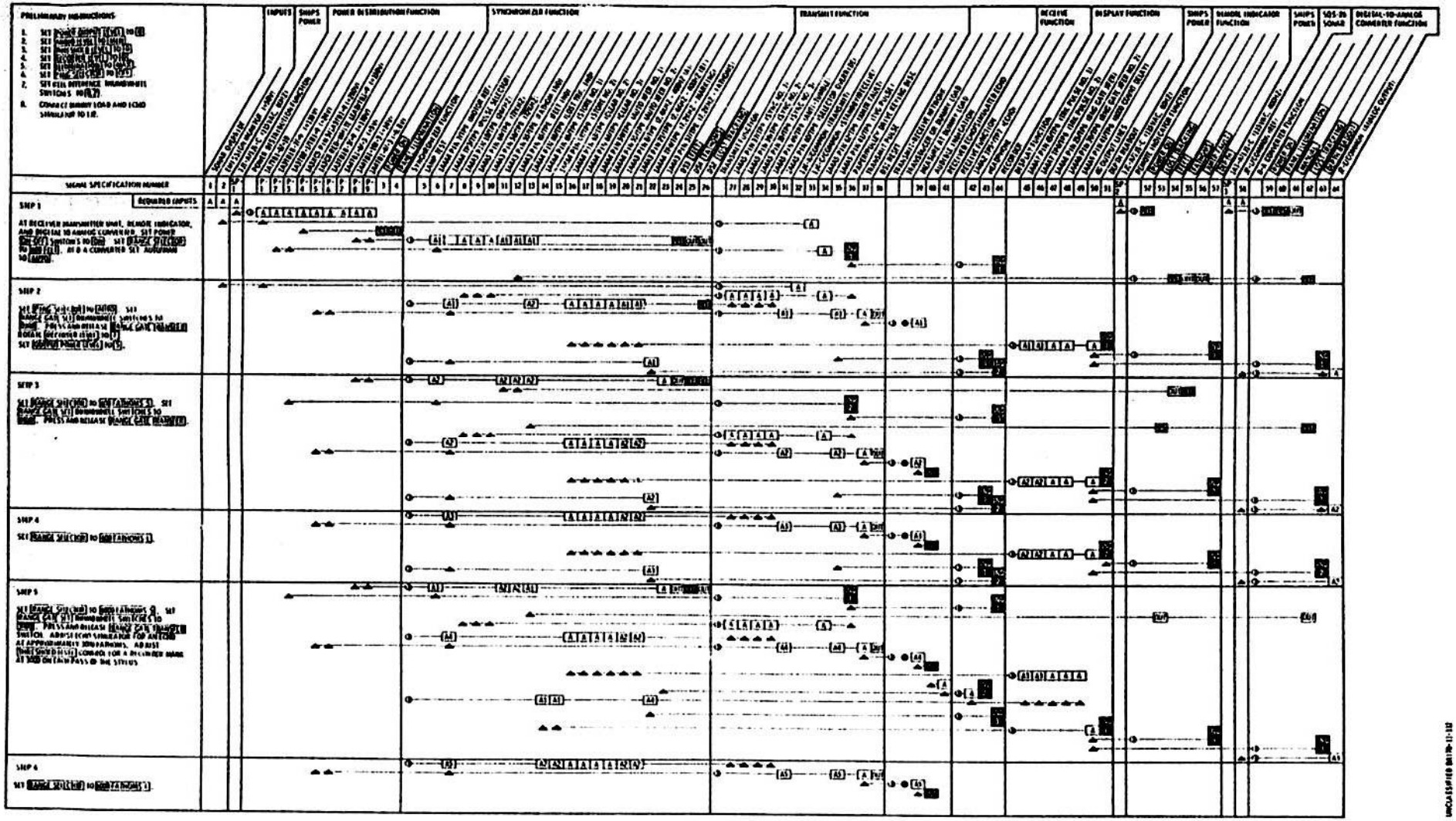


Figure 12. Overall MDC. 75/(76 blank)