INCH-POUND
MIL-DTL-24784/22(NAVY)
3 November 2007
SUPERSEDING
(See 6.3)

DETAIL SPECIFICATION SHEET

TECHNICAL CONTENT DEVELOPMENT REQUIREMENTS FOR COMBAT SYSTEM TECHNICAL OPERATIONS MANUALS (CSTOMS); HULL, MECHANICAL, AND ELECTRICAL (HM&E) SYSTEM AND EQUIPMENT MANUALS; ELECTRONIC [INCLUDING SERVICE TEST ELECTRONIC, EXPERIMENTAL ELECTRONIC AND INTERIOR COMMUNICATION (IC)] SYSTEM AND EQUIPMENT MANUALS; AND WEAPON SYSTEMS AND WEAPON EQUIPMENT MANUALS

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

The requirements for acquiring the product specified herein shall consist of this specification sheet and MIL-DTL-24784.

1. SCOPE

1.1 Scope. This specification sets forth content requirements for the preparation of technical manuals (TMs) covering description, operation, maintenance, installation, and parts support for Combat System Technical Operations Manuals (CSTOMs); Hull, Mechanical, and Electrical (HM&E) Systems and Equipment Manuals; Electronic [including Service Test Electronic, Experimental Electronic, and Interior Communications (IC)] System and Equipment Manuals; and Weapon Systems and Weapon Equipment Manuals. The requirements are applicable for the output of paper or for the display of page-oriented, linear, and non-linear TMs on an Electronic Display System (EDS).

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-24784 - Manuals, Technical: General Acquisition and Development Requirements, General Specification for

(Copies of this document are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

DEPARTMENT OF THE NAVY DOCUMENTS

OPNAVINST 4790.4 - Ships' Maintenance Material Management (3-M) System Policy

(Copies of this document are available from the Department of the Navy Issuances, SECNAV/OPNAV Directives Control Office (DNS-5), Bldg. 36, 720 Kennon Street, SE, Rm 203, Washington Navy Yard, DC 20374-5074 or online at http://doni.daps.dla.mil/default.aspx.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

NAVSEA OP 1700 - Standard Fire Control Symbols

N0002400003 - Navy Installation and Maintenance Book

NAVSEA ST000-AB-GYD-010 - Portable Electrical/Electronic Test Equipment (PEETE); Stowage Guide

(Copies of these documents are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at https://nll1.ahf.nmci.navy.mil.)

NAVAL WARFARE DEVELOPMENT COMMAND (NWDC)

Fleet Exercise Publication FXP2 - Air and AAW Exercises

Fleet Exercise Publication FXP3 - Ship Exercises

(Copies of these documents are available by emailing fleetpubs@nwdc.navy.mil or calling (401)841-1856.)

NAVAL SURFACE WARFARE CENTER (NSWC) CORONA DIVISION

NAVSEA Test, Measurement, and Diagnostic Equipment (TMDE) Index

(Copies of this document are available from NSWC Corona Division, Detachment Seal Beach, Strategic Systems Evaluation Division (MS50), Test Systems Support Branch MS532, Bldg 112, 800 Seal Beach Blvd., Seal Beach, CA 90740-5000; by calling (562)626-7959 or (DSN)873-7959; or by FAX (562)626-7831; or contact the Navy Distance Support Anchordesk at Help@AnchorDesk.Navy.Mil; by calling 1-877-418-6824; or at http://www.anchordesk.navy.mil.)

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

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS, INC. (IEEE)

IEEE 991 - Standard for Logic Circuit Diagrams (DoD adopted)

(Copies of this document are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331 or online at www.ieee.org.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, (except for related specification sheets), the text of this document takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Development. This specification provides the technical content data requirements necessary for the development of NAVSEA TMs described in 1.1 (see 6.2). This specification contains some technical content requirements that may not be applicable to all of the TMs described in 1.1. Selective application and tailoring of requirements shall be accomplished as necessary. The applicability of some requirements is also designated by one of the following statements: unless otherwise specified by the acquiring activity; or as/when specified by the acquiring activity.

3.2 Development products. Development of TM products shall be in accordance with MIL-DTL-24784 (see 6.2).

3.3 Security classification, distribution statement, and destruction notice. Security classification, distribution statement, and destruction notice shall be in accordance with MIL-DTL-24784.

3.4 Format and development instructions. The requirements for front matter, style and format, safety, tabular material, and graphics shall be in accordance with MIL-DTL-24784.

3.5 Maintenance coverage. Unless otherwise specified by the acquiring activity, each type of TM shall contain, in detail, the maintenance coverage prescribed for the applicable maintenance level(s) based on the maintenance concept or approved maintenance plan (see 6.2).

3.6 Technical content requirements. Technical content is organized into “containers” called information modules (IMs) that are grouped according to the type of information being documented. IMs consist of one or more individual information packages (IPs) that contain the actual technical content for the associated IM.

3.6.1 Information modules (IMs). IMs identify specific categories of technical content requirements grouped as follows:

a. Descriptive information (see 3.7) consists of the following IMs:
   (1) General IM (see 3.7.1).
   (2) Supporting IM (see 3.7.2).
   (3) Descriptive IM (see 3.7.3).
   (4) Functional description IMs (consisting of HM&E systems functional description IM, HM&E equipment functional description IM, weapon system functional description IM, weapon equipment functional description IM, electronic systems functional description IM and electronic equipment functional description IM) (see 3.7.4).

b. Procedural information (see 3.8) consists of the following IMs:
   (1) Operation IM (see 3.8.1).
   (2) Maintenance IM (see 3.8.2).
   (3) System/equipment installation IM (see 3.8.3).
   (4) Operational checkout and troubleshooting IM (see 3.8.4).

c. Illustrated parts breakdown (IPB) IM (see 3.9).

d. CSTOM information (see 3.10) consists of the following IMs:
   (1) Combat system introduction and description IM (see 3.10.1).
   (2) Combat system description IM (see 3.10.2).
   (3) Combat system operational description IM (see 3.10.3).
   (4) Combat system readiness assessment IM (see 3.10.4).

(5) Fault detection and impact evaluation IM (see 3.10.5).

(6) Fault isolation IM (see 3.10.6).

3.6.2 Information packages (IPs). IMs consist of one or more individual IPs. The IP contains the actual technical content for the associated IM.

3.6.2.1 IP general content requirements. As applicable, each IP developed shall begin with all reference publications, special tools and test equipment, materials, and field and factory changes that apply to the technical content being developed (see 3.7.2.2 through 3.7.2.7). The following additional information about the contents of the IP shall be included as applicable:

a. Maintenance level.

b. Effectivity.

c. Personnel required.

d. Required conditions.

e. Special environmental conditions.

f. General safety instruction.

3.7 Descriptive information. Descriptive information consists of the following IMs, each of which consists of one or more IPs.

a. General IM (see 3.7.1).

b. Supporting IM (see 3.7.2).

c. Descriptive IM (see 3.7.3).

d. Functional description IM (see 3.7.4).

3.7.1 General IM <**GeneralIM**>. As applicable, the general IM shall contain the following IPs:

a. General Introduction IP (see 3.7.1.1).

b. Model differences IP (see 3.7.1.2).

The information developed shall be so that command level, supervisory personnel, and other users having a general interest in the equipment can easily and rapidly determine the purpose, physical and functional characteristics, interface requirements, and the operational capabilities of the system/equipment.

3.7.1.1 General Introduction IP <**GeneralIntroIP**>. An introduction shall be developed for all TMs. The primary purpose of the introduction is to provide information necessary to use the data provided in the TM and respective IPs as effectively as possible. The introduction IP shall include the following information:

a. Purpose and scope. The purpose and scope of the manual, including the subject matter being covered and any superseding data, if applicable.

b. Description and designated nomenclature. The designated nomenclature and a brief description of the end item. The introduction may include an illustration (frontispiece) (see 3.7.8.2.1 of MIL-DTL-24784) of the equipment. Applicability (including ship and shore) of the TM, including capabilities, subsystem or equipment mission, subsystem or equipment interface description, models, serial numbers, and configuration covered shall also be included. As applicable, a consolidated list of the ship hull numbers (by ship class, if applicable), model numbers, serial numbers and part numbers, covered by the TM shall be included and identified as the configuration identification list <**ConfigurationIDList**>.

c. Effectivities. If applicable, an explanation of the effectivities used throughout the TM.

d. Multi-volume TMs. The first volume of a multi-volume TM shall contain general information and reporting requirements regarding all volumes and specific information applicable to Volume 1, as required.

e. Technical manual deficiency/evaluation report (TMDER). The following submittal and routing instructions for TM improvement reports shall be included:

"Ships, training activities, supply points, depots, Naval Shipyards and Supervisors of Shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA technical manuals (TMs). All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA TMs shall be submitted as a Technical Manual Deficiency/Evaluation Report (TMDER). All feedback comments shall be thoroughly investigated and originators will be advised of action resulting there from.

(Use this statement for printed hard copy TMs)
Three copies of the NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report form, NAVSEA 4160/1 are included at the end of each separately bound hardcopy TM.

(Use this statement for a TM on CD-ROM)
The NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report form, NAVSEA 4160/1 is included as the last page of the TM.

(Include this statement for all TMs)
Copies of form NAVSEA 4160/1 may also be downloaded from:

https://nsdsa2.phdnswc.navy.mil/tmmp/forms/TMDER_BLANK_REV_7-2003.doc.

The following methods are available for generation and submission of TMDERs:

- The most expedient and preferred method of TMDER generation and submission is via the Technical Data Management Information System (TDMIS) website at: https://mercury.tdmis.navy.mil. TDMIS accounts can be requested at https://nsdsa2.phdnswc.navy.mil/.
- Generate and submit TMDER via the Naval Systems Data Support Activity (NSDSA) website at: https://nsdsa2.phdnswc.navy.mil/tmder/tmder-generate.asp?lvl=1.
- When internet access is not available, submit TMDER via hardcopy to:

  COMMANDER
  CODE 310 TMDERs
  NAVSURFWARCENDIV NSDSA
  4363 MISSILE WAY, BLDG 1388
  PORT HUENEME, CA 93043-4307

- TMDERs against classified TMs must be submitted using the hardcopy method cited above.
- Urgent priority TM deficiencies shall be reported by Naval message with transmission to Port Hueneme Division, Naval Surface Warfare Center (Code 310), Port Hueneme, CA. Local message handling procedures shall be used. The message shall identify each TM deficiency by TM identification number and title. This method shall be used in those instances where a TM deficiency constitutes an urgent problem, (i.e., involves a condition, which if not corrected, could result in injury to personnel, damage to the equipment or, jeopardy to the safety or success of the mission).

Complete instructions for TMDER generation and submission are detailed on the NSDSA website at: https://nsdsa2.phdnswc.navy.mil/tmder/tmder.asp?lvl=1."

f. Distance support information. Provide current information on contacting Navy Distance Support (Anchor Desk) via the web (http://www.anchordesk.navy.mil/) and via the toll free number (1-877-4-1-TOUCH [86824]).

g. Warranty information. As applicable, warranty and guarantee information shall be included as stated in the contract and shall be in accordance with the Federal Acquisition Regulations (FAR), including hardware modifications (such as ship alterations, engineering change proposals, machinery alterations, ordnance alterations, field changes, and so forth) (see 6.2).

h. Other specific introductory information. Additional introductory information related to a specific type of TM shall be included, such as the interface relationship of the TM to other referenced publications and the relationship of the equipment to referenced systems or other equipment.

3.7.1.2 Model differences IP <**ModelDiffIP**>. When applicable, the differences between models of the equipment shall be briefly delineated in this IP. Descriptions of major physical differences shall be supported by reference to appropriate illustrations. These major differences shall also be reflected in the operating instructions, maintenance instructions, and parts list. Multiple model differences that involve a number of equipment sections or subsections shall be presented in tabular form. The method for handling differences between models in other portions of the TM shall be defined here.

3.7.2 Supporting IM <**SupportingIM**>. The supporting IM shall contain the following IPs, as applicable:

a. Safety precaution IP (see 3.7.2.1).
b. Reference publications IP (see 3.7.2.2).
c. Special tools and test equipment IP (see 3.7.2.3).
d. Materials required IP (see 3.7.2.4).
e. Equipment modification IP (see 3.7.2.5).
f. Equipment, accessories, and documents supplied IP (see 3.7.2.6).
g. Equipment, accessories, and documents not supplied IP (see 3.7.2.7).

3.7.2.1 Safety precaution IP <**SafetyPrecautionIP**>. All TMs containing dangers, warnings, or cautions shall have a safety precaution IP. See 3.7.5 of MIL-DTL-24784 for safety and health requirements. General safety precautions and the complete warnings applicable to hazardous materials and related information shall be contained in the safety precaution IP in accordance with 3.7.5.10 of MIL-DTL-24784. Hazardous material warnings used throughout the TM shall be referenced to the safety precaution IP to provide the user with the applicable hazardous material icons and the complete warning text. This IP shall describe all safety precautions necessary for the protection of personnel and the ship including the hazards associated with system operation and maintenance. This IP shall include the following information, as applicable.

3.7.2.1.1 Introduction <**intro**>. This description shall orient 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.

3.7.2.1.2 Electromagnetic radiation hazards and precautions <**RadiationHazard**>. If applicable, describe the radiation hazards to topside personnel and the precautions to be taken. The description shall include discussions of the following:

a. Locations of topside and in-board 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, and so forth.

3.7.2.1.3 Hazards to divers <**DiverHazard**>. 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.

3.7.2.1.4 System hazards and precautions <**SystemHazard**>. Descriptions of system hazards and precautions shall be included, addressed to system personnel and referenced to particular system equipment. 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.

3.7.2.1.5 Operational safety summary <**OperationalHazard**>. A summary shall be included which emphasizes the proper use of equipment controls, describes the hazards to operators, or as applicable, the hazards to persons in areas remote from the operation, and recommend precautions.

3.7.2.1.6 Maintenance safety summary <**SafetySummary**>. A maintenance safety summary shall emphasize the proper use of controls, describe the hazards to maintenance personnel, potential damage to the equipment, and recommend precautions.

3.7.2.1.7 Hazardous components <**HazardComp**>. 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 charges.

3.7.2.2 Reference publications IP <**RefPubIP**>. A list of the manuals that pertain to system and subsystem equipment, and other documents of interest or use to operating or maintenance personnel, such as basic training manuals, special directives, NAVSEA OP 1700, and manuals for associated systems equipment shall be included in this IP. The list of publications shall include the title and publication number of the referenced publications.

3.7.2.3 Special tools and test equipment IP <**StteIP**>. All special tools, tool kits, test equipment, miscellaneous parts, and Government-furnished items that form a part of, or are supplied (or not supplied) with, the system or equipment shall be included in this IP. Items included in the table (<**SpecialToolsList**>**)** shall be listed alphabetically by their official name or nomenclature. Notes explaining the use of the tables and stock code numbering system shall precede the first table for which a particular note is applicable. For each listed item, the table shall include:

a. Item name consisting of the official name or nomenclature of the listed item.

b. If applicable, a description of its general use and a reference to the illustration contained in the IPB.

c. Quantity of the items required for maintenance of the equipment.

d. Manufacturer’s part number consisting of the manufacturer’s or the contracting activity’s assigned part number as it appears on the item.

e. The Commercial and Government Entity (CAGE) code consisting of the assigned CAGE code of the manufacturer or contracting activity of the listed item.

f. The stock code number consisting of an assigned number which indicates the procurement status of the listed item as follows:

   (1) Item is supplied with the equipment.

   (2) Item is supplied by the manufacturer.

   (3) Item is available from the manufacturer.

3.7.2.3.1 Equipment and publications required but not supplied IP (electronic systems and equipment only). A tabular listing of all test equipment and publications required but not supplied with the equipment or system shall be included in this IP. The NAVSEA Test, Measurement, and Diagnostic Equipment (TMDE) Index shall be used as a guide for the selection and application of test equipment required for shipboard use. If a measurement requirement is established which cannot be satisfied by the subcategory (SCAT) codes listed in this guide, or alternate test procedures cannot be developed utilizing the listed SCAT request for assistance should be directed to:

Commander
Naval Sea Systems Command
ATTN: SEA 05M3
1333 Isaac Hull Avenue, SE
Stop 5160
Washington Navy Yard DC 20376-5160

The listing shall contain:

a. SCAT code. When applicable, this column shall contain the four digit group of numbers, which is included in the NAVSEA TMDE Index, used to identify a measurement requirement.

b. Test equipment category. This column shall contain the item name of each item of equipment required.

c. Representative test equipment model number. This column shall contain the model number of the standard or substitute standard general purpose electronic test equipment, listed in the NAVSEA TMDE Index, as applicable, which can be used to satisfy the measurement parameters.

d. Equipment test parameters. This column shall specify the range of test parameters, which shall be satisfied by this test equipment item (it shall not define the ranges of the test equipment model).

e. Application. This column shall indicate the intended use of the test equipment (for example, troubleshooting, maintenance, or installation).

f. Publication number and title. This column shall specify the publication by number and title.

3.7.2.4 Materials required IP <**MatReqIP**>. When applicable, this IP shall provide a list of all materials (consumable materials and/or expendable items) required to perform maintenance type procedures. Items shall be listed in alphabetical sequence by noun nomenclature. The materials required list (<**MaterialsList**>) shall be prepared in accordance with the following guidelines:

a. Each material entry in the list shall be identified by "Nomenclature <**Nomenclature**>," and "Specification <**SpecNumber**>, Part Number <**PartNumber**>, or Not Specified <**NotSpecified**>" as applicable. If the materials are authorized for use at only certain maintenance level(s), the restriction shall be indicated by the use of an O, I, and/or D.

b. Unless alternate identification is approved by the acquiring activity, materials shall be listed by Government specification in parentheses following the item nomenclature.

c. When more than one of the same item is required, the quantity shall follow the nomenclature in parentheses.

d. Parts that require mandatory replacement in the procedure, such as preformed packing, shall be listed.

3.7.2.5 Equipment modification IP <**EquipModIP**>. An IP shall be developed to include all equipment modification change data (<**EquipModTable**>) for the system/equipment covered by the TM. Field changes, factory changes, engineering changes or notices, modifications, and so forth (<**FieldFactoryChangeList**>) shall be identified and included as follows:

a. Change number <**ChangeNumber**>. This column shall list the change number for each field and factory change considered and included in the preparation of the TM.

b. Nomenclature <**Nomenclature**>. This column shall list the equipment nomenclature and Government serial numbers of equipment affected by the change.

c. Description <**desc**>. This column shall contain a brief statement identifying the change and its purpose.

3.7.2.6 Equipment, accessories and documents supplied IP <**EquipDocSuppIP**>. As applicable, an IP containing a tabular listing of all equipment, accessories, and other documents supplied (<**EquipDocSuppTable**>) shall be provided. List the equipment (other than test equipment), its units, and its accessories. The table shall include the following:

a. Quantity <**Quantity**>. This column shall contain the quantity of each unit and accessories supplied with the equipment.

b. Item name or nomenclature <**name**>. This column shall contain the official name (for example, pump, winch) or nomenclature (name and designation) of each component, unit or accessory. For documents, list the document title.

c. PIN number <**PINNumber**>, RIC number <**RICNumber**>, or unit number <**UnitNumber**>. This column shall contain the part identification number (PIN) or component identification number (CID), repairable identification code (RIC), or unit number of each equipment unit or accessory. For documents, list the document identification number.

d. Overall dimensions <**Dimensions**>. This column shall contain the crated (if available) and uncrated height, width, and depth in inches (or inches and centimeters) of each unit, accessory, or document.

e. Weight and volume <**WeightVolume**>. This column shall contain the crated (if available) and uncrated weight and volume in cubic feet of each unit, accessory, and document.

3.7.2.7 Equipment, accessories, and documents not supplied IP <**EquipDocNotSuppIP**>. As applicable, an IP shall be provided describing equipment and accessories (such as controls, foundations mounts, couplings, and accessories) and related publications, which are not furnished with the basic equipment covered by the TM, but which attach or relate importantly to the basic equipment. The data shall be in sufficient detail to establish the correlation of the equipment with respect to physical and functional interfaces. If applicable, a reference should be made to the shipbuilder's power plant technical manual if it contains additional applicable information.

3.7.3 Descriptive IM <**DescriptiveIM**>. Descriptive IMs shall be developed and be divided into IPs as described in 3.7.3.1 through 3.7.3.4, as applicable.

3.7.3.1 Physical arrangement IP (HM&E systems, weapon systems, and electronic systems and equipment only) <**PhysicalArrangeIP**>. For systems, all system areas and compartments shall be described and the system equipment and units contained in the areas shall be listed in this IP. The physical arrangement description shall be supported by the following illustrations:

a. An inboard profile drawing of the ship or stations showing compartment locations and identifying topside equipment and equipment units comprising the system (see figure 1).

b. Separate illustrations of each compartment and area, identifying the listed system equipment (see figure 2). 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.

3.7.3.2 System description IP <**SystemDescriptionIP**>. System description IPs shall describe the system and its relationship to associated systems, subsystems, and equipment. For other than weapon systems and subsystems or weapon equipment, the descriptions shall combine the physical and general aspects of the system and associated systems contained therein and their interdependencies and interactions. Each of the equipment comprising the system shall be identified and described. Descriptions of operator-attended equipment shall include general statements as to the nature and purpose of units and indicators. The text shall be supported by illustrations. All equipment shall be shown, whenever possible, in relative-scale proportion. Equipment may be separately illustrated with significant features called out, if such details are necessary for proper support of the text. When required, descriptions and illustrations of associated system equipment shall be limited to the major units thereof. The descriptions of associated system equipment shall be more condensed than those of the subject system equipment; otherwise, the same requirements are applicable. In the descriptions, emphasis shall be placed on those associated system equipment that constitute operational or functional interfaces with the subject system and shall be included in the illustrations.

a. For **weapon systems** and subsystems, the general description shall identify each subsystem group of weapon system equipment and each unit equipment in a group by composite illustrations of the subsystem group of the first ship of the class, for example, the fire control subsystem. The text shall only describe significant features of a particular component of an equipment in a group. Significant features would comprise such items as console panels, sub-panels, and control and indicator groups. Each component of an equipment in a group shall be called out as shown in figure 3. Associated systems equipment shall be shown in separate group operational and functional interfaces with the weapon system. Examples of such components include search radar distribution switchboard and radar order switches that control the availability of weapon system planned-position indicator (PPI) displays, and units of the naval tactical data system that control the transmission of target data to and from the weapon system.

b. For **weapon equipment**, if the equipment operates as part of a system, a system description shall be included. This shall be a non-technical orientation of the subject equipment with other equipment in the system. The system description shall discuss only those components of the system necessary to introduce the subject equipment's system-contributing capabilities. An illustration shall be used to clarify the relationships. Figure 4 is a typical equipment/system integration illustration.

3.7.3.2.1 Equipment and component description. The IPs shall identify and describe the equipment and components. The description shall include the intended use (why, where, when, how, and with what), capabilities, and limitations of the equipment. Descriptions of operator-attended equipment shall include general statements as to the nature and purpose of units and indicators. The text shall be supported by illustrations. Text covering physical description or structural arrangement shall be brief, with special attention given to avoiding unnecessary or repetitious details that are easily illustrated. All equipment shall be shown, whenever possible, in relative-scale proportion. Equipment may be separately illustrated with significant features called out, if such details are necessary for proper support of the text. Assembly and detail drawings as appropriate may be referenced. If the TM covers more than one equipment configuration, a table defining the differences shall be included.

3.7.3.3 Software description IP <**SoftwareDescriptionIP**>. This IP shall be developed to provide descriptive information for programming software used for systems, equipment, and test equipment, when applicable. Block diagrams, test setup diagrams, and pictorials of display readouts shall be included when necessary to support the descriptive text.

3.7.3.4 System/equipment characteristics/capabilities IP <**SystemCharIP**>. When required, an IP shall be prepared containing the leading particulars or technical characteristics (reference data) to present the physical, mechanical and electrical characteristics of the system, subsystem, equipment, or major functional components. The following shall be included:

a. Official nameplate designations and nomenclature of all equipment [manufacturer, type, model, and component identification number (CID)] or, for **HM&E equipment** a part number, repairable identification code (RIC), and allowance parts list (APL), joint electronics type designation (when applicable) major units, and support equipment. This list shall include common names and quantities required per unit, if available.

b. Detailed operating characteristics, and significant equipment capabilities and limitations such as: pounds of thrust, knots, turning radius, minimum and maximum ranges, degree of coverage, resolution, accuracy, wattages, voltages, horsepower, gallons per minute, input and output signals, load limits, frequency, testable items, resolution, memory capacity, reaction time, transfers per hour, boom capacity, data handling capability, and number of channels.

c. Power input requirements and other externally supplied inputs (such as data and control signals, pressurized air, and coolant water) shall be listed, along with identity of the source of each, such as: ships supply, specific associated equipment, gyrocompass, power requirements, horsepower, pressure, capacity, modes of operation, power output, frequency, pulse characteristics, sensitivity, selectivity, including tolerances, where applicable.

d. Environmental characteristics, such as: ambient temperatures, heat dissipation per unit, humidity limits, coolants (airflow, water or oil flow rate, chilled and demineralized seawater). Measurements provided shall match the installed equipment.

e. In addition, for **weapon systems**, a description of the system capabilities and how these enable the ship to perform the primary mission. Subsystem and equipment capabilities shall be described only to the extent necessary to describe system capabilities. Capabilities of associated systems shall be described as applicable. Data such as search radar detection ranges, fire control radar acquisition and tracking ranges, number of targets that can be simultaneously evaluated, number of targets that can be simultaneously engaged, and minimum and maximum effective ranges of missiles and guns shall be included. Envelope drawing(s) shall be developed to illustrate system capabilities (see figure 5). Such drawing(s) shall meet the requirements for training documents and shall be technically accurate for use as a guide for system evaluation training exercises.

3.7.4 Functional description IMs. Functional description IMs shall be developed and divided into IPs as described in 3.7.4.1 through 3.7.4.6, as applicable.

3.7.4.1 HM&E systems functional description IM <**HMESysFunctionalDescIM**>. Functional description for HM&E systems shall describe how the components or equipment comprising the system jointly perform major operations and functions, and how associated systems contribute to the performance of these major functions. The description of the entire system shall be supported by a basic block diagram of the system (see figure 6). Each major function shall then be discussed separately at progressively increasing levels of detail supported with overall and functional block diagrams. Where information can be better presented pictorially than by text, additional diagrams and other illustrations shall be used. Reference may be made to diagrams provided for troubleshooting. Equipment or associated system interfaces shall be described only as necessary to identify the sources or destinations of system inputs and outputs. Functional description data may be divided into as many IPs as necessary to facilitate usability of the information.

3.7.4.1.1 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in the functional description. The introduction shall also describe briefly the interrelationship between the system and associated systems.

3.7.4.1.2 System function directory IP <**SysFuncDirIP**>. This IP shall include a system function directory tabulating the operation control functions and the signal data described in the detailed level of functional description (see 3.7.4.1.4). The tabulation shall include the following information, as applicable:

a. Official name of the function, common name, and symbol.

b. Type of control or signal (alternating current frequency and voltage, direct current polarity and voltage, hydraulic pressure, mechanical motion, synchro, and so forth).

c. The origin and termination of the control or signal.

d. Identify equipment (relay transmitters, coordinate converters, distribution boxes, switches, and the like) between the origin and termination of the output control or signal.

e. A reference to supporting illustrations.

3.7.4.1.3 Simplified functional description IPs <**SimplFuncDescIP**>. The IPs shall be developed for system simplified functional descriptions. The simplified functional description shall be confined to data such as origin of the major functions at an equipment control or sensor; transmission of the signal via intermediate equipment such as switchboards, relay transmitters, coordinate converters, and distribution boxes; and presentation of the function at terminal equipment. Control functions essential to the development of a signal shall be introduced and briefly described in their relationship to the signal. The description shall be supported by electronic, electrical, and mechanical system type block diagrams, as applicable (see MIL-DTL-24784 for examples of block diagrams). Functions involving computations may be explained in mathematical terms, but at a level no higher than high school mathematics; that is, algebra, plane geometry, and trigonometry (through sine, cosine, and tangent).

3.7.4.1.4 Detailed functional description IPs <**DetlFuncDescIP**>. The IPs shall be developed for system detailed functional descriptions. The detailed-level description shall explain the system major functions in terms directly related to the diagrams provided for troubleshooting. Data and control functions shall be described down to the level of an equipment or an equipment group.

3.7.4.2 HM&E equipment functional description IM <**HMEEquipFunctionalDescIM**>. Functional description IPs for HM&E equipment describing how the equipment operates shall be provided. Major assemblies of the equipment and interaction on major subassemblies shall be described. Detailed mechanical and electrical functional description, including descriptions of power distribution, power supplies, and regulators, shall be provided. Simplified electrical and electronic schematic diagrams, piping diagrams, mechanical schematic diagrams, as applicable shall support the text. The functional description of digital equipment shall be similar to that for conventional equipment. However, the functional and hardware makeup of digital equipment requires a variation in the method of presentation and descriptive requirements. An overall description of the functional relationship of the logic sections, units, and assemblies comprising the equipment shall be provided. The functional description IPs shall be presented in successive levels of increasing detail as described in 3.7.4.2.2 through 3.7.4.2.4.

3.7.4.2.1 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in the functional description. The introduction shall also describe briefly the interrelationship between the equipment and associated components.

3.7.4.2.2 Simplified functional description IP <**SimplFuncDescIP**>. This IP shall provide narrative text that supports and refers to the overall functional block diagram. All major functions such as transmit, receive, control, display, power distribution, cooling, and so forth shall be described at this level.

3.7.4.2.3 Detailed functional description IP <**DetlFuncDescIP**>. This IP shall describe the development of each major function at the level of detail shown on its related signal flow diagram, logic diagram, or other diagram provided in troubleshooting. The text shall support and refer directly to the diagrams. The following shall be included, as applicable.

a. An introduction to, and description of, the signal characteristics:
   (1) Signal levels or bi-stable states utilized by the equipment; that is, true (1) and false (0), and their relative voltage levels.
   (2) Interpretation of the word-code bit structure; that is, address, instruction, or data bit codes.
   (3) Signals, identified by their operational accomplishment.
b. Overall and functional block diagrams (FBDs), and associated descriptions.
c. Logic principles shall be described beginning with an introduction to the basic digital logic symbology used in the manual. Each logic function shall be described and supported by Boolean equations, truth tables, simplified logic diagrams, and timing diagrams.
d. Functional description of power distribution, power supplies, and regulators.

3.7.4.2.4 Integrated circuits and micro-miniature capsules IP <**IntegratedCircuitIP**>. This IP shall provide a brief description of the overall functional operation for circuits within different types of non-repairable integrated circuits and micro-miniature capsules. Non-repairable circuits are not required for functional understandings of theory of operation. Simplified schematics in accordance with SE000-01-IMB-010 or logic diagrams showing input and output connections, truth tables, and waveforms as applicable shall support the text.

3.7.4.3 Weapon systems functional description IM <**WeaponSysFunctionalDescIM**>. Major weapon system functions shall be identified and described in functional description IPs. The highest threat level shall be considered the primary mode of weapon system operation. Other modes shall be treated as secondary and, insofar as feasible, as modifications of the primary mode. Thus, functions that are common to all modes shall be described under the primary mode and referred to under the secondary mode, with such modifications as may be necessary. Each function shall be analyzed by describing the origin of the function and by stating how each pertinent equipment contributes to the purpose of the overall system function. Functions shall be covered in terms directly related to the system troubleshooting procedures and diagrams. Each functional analysis shall be presented in two levels, simplified and detailed, so that personnel training based on this approach can adequately support the concept. Descriptions shall be supported by illustrations, which may include block diagrams, geometrical diagrams, and functional block diagrams.

3.7.4.3.1 Introduction IP <**IntroductionIP**>. This IP shall briefly describe the system interfaces and explain interrelationships between the subject system and associated systems and equipment. The major system functions shall be introduced briefly, and the general approach used in the description and analysis of the major function shall be explained. The introduction shall introduce all major system functions and physical interfaces. Subsequent IPs shall contain a description and analysis of major system functions. The introduction shall inform the reader that each major function is separately analyzed in two levels: simplified and detailed.

3.7.4.3.2 Weapon system interfaces IP <**WeaponSysInterIP**>. This IP shall include descriptions of weapon system interface relationships to associated systems and equipment and shall be supported by interface functional block diagrams that illustrate system integration (see figure 7).

3.7.4.3.3 Major system functions IPs <**SysFuncDescIP**>. All major system functions shall be listed and defined and included in individual IPs. Major functions shall reflect the operational phases or events of the primary mode of system operation. Secondary system modes, integration with associated systems, multiple-radar synchronizing systems, evaluation instrumentation systems, and other such miscellaneous but primary subjects, shall be treated separately as related functions. Each major function shall be thoroughly analyzed from generation to output on the basis of concurrent or sequential sub-functions such as data and control functions. The analytic levels in order of increasing complexity are from simplified to detailed. The detailed level shall be an expansion of, and correlate to, concepts introduced at the simplified level. Each level shall be complete within itself. The selected levels of presentation shall be adequate to indoctrinate the reader in weapon system technology.

a. Simplified. The objective of the simplified level shall be to describe the major functions in terms understandable by a person possessing fundamental technical knowledge, and thus provide this person with a basis for better understanding of the detailed analysis. The simplified functional analysis shall explain the generation, transformation, interrelation, and use of the data and control functions that constitute the major function. The analysis shall cover essentials such as origin of the function at an equipment control or sensor; transmission of the function via intermediate equipment such as switchboards, relay transmitters, coordinate converters, and distribution boxes; and manifestation of the function at the terminal equipment. Data and control circuitry that are essential and contribute to the operation of a major function shall be introduced and briefly described. Primary emphasis shall be placed on the development of functional concepts in the geometrical reference frame provided by NAVSEA OP 1700 or other manuals provided by the acquiring activity. Only secondary consideration need be given to the mechanization of functions. Functions involving computations may be explained in mathematical terms, but at a level no higher than high school mathematics; that is, algebra, plane geometry, and trigonometry (through sine, cosine, and tangent). Explanations requiring advanced mathematics higher than that expressed on a high school level shall not be presented. The simplified analysis shall be supported by one or more simplified functional diagrams, as appropriate, for the nature and complexity of the function (see figures 8 and 9).

b. Detailed. The objective of the detailed level shall be to describe the major functions in terms directly related to the system troubleshooting procedures and diagrams in the operational checkout and troubleshooting portion of the TM. Accordingly, a detailed functional analysis shall examine the mechanization of data and control functions down to the level of particular and essential circuit components or functional modules. Essential circuit components and functional modules are those that transform data or control the transmission of data and orders. Nonessential circuit components, such as in-line amplifiers, are a practical necessity but do not require detail analysis. Illustration support shall be provided by reference to system functional block diagrams (FBDs).

3.7.4.4 Weapon equipment functional description IM <**WeaponEquipFunctionalDescIM**>. Functional description IPs shall provide a detailed analysis of the principles of operations of the overall equipment and its functions. The development of the equipment functions in every mode of operation shall be described. The structure and organization of this data shall parallel the troubleshooting data contained in the TM. The text shall refer to and support the troubleshooting. Simplified and detailed principles of operation shall be provided. The continuity of the simplified and detailed principles of operation shall be such that summarizing is not required for understanding combined functions of the equipment as operated in the intended weapon system application. In instances where the various functional units may, by multiple switching, assume a variety of configurations, coverage shall be accomplished by assuming each of the various possible conditions and describing only the modified portion of the signal path, action, or information flow. Illustrations of alternate configurations shall be limited to that required to integrate signal modification and control.

3.7.4.4.1 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in the functional description. The introduction shall also describe briefly the interrelationship between the equipment and associated components.

3.7.4.4.2 Simplified functional description IPs <**SimplFuncDescIP**>. Simplified functional description IPs shall provide an overall explanation of the functional operation of the equipment in relationship to the system of which it is a part. This explanation shall provide an understanding of the way in which the equipment performs functions by modes of operation, placing emphasis on the primary modes, without going into mechanical or electrical circuit details. To ensure continuity, this description shall bridge the gap between the introductory description and the more detailed descriptions to follow. First order equipment-to-system interfaces, such as, target data accumulation, processing and display, target designation, types of guidance, launcher assignment, and pointing characteristics, shall be described. The description shall be supported by a functional block diagram of equipment-to-system interface showing only main data flow from the equipment to related equipment within the system. Figure 10 depicts a typical relationship between equipment and system.

3.7.4.4.2.1 Simplified functional description data flow. The simplified functional description data flow shall be described in groups of signals between major components within the equipment. Text for subordinate modes of operation shall reference applicable portions of normal mode description. Unique or not commonly known features, engineering concepts, or specialized applications of existing concepts shall be explained only when necessary for an understanding of the functional operation of the equipment. This provision shall apply, for example, to unique features and concepts of self-checking and automatic test programming features of equipment. The text shall be supported with block diagrams. The number of diagrams required for clarity depends upon the variety of outputs and the changes imposed by different operational modes. To avoid redundancy, appropriate references shall be made to diagrams provided for troubleshooting.

3.7.4.4.3 Detailed functional description IPs <**DetlFuncDescIP**>. The detailed functional description IPs shall begin with a detailed block diagram presentation of each major functional block presented in the general functional description. The presentation shall clearly indicate what group of signals covered in the general functional description is being expanded in the detailed functional description. For example, data flow on the simplified functional block diagram shall be expanded into individual signals and the generation path of the individual signals further expanded into a detailed block diagram (see MIL-DTL-24784). Outputs shall be identified by names or fire control symbols. Diagrams that are redundant, in total or in part, with troubleshooting diagrams contained in the manual shall not be included. The troubleshooting diagrams in the manual shall be referenced to the detailed functional description as the basic supporting illustrations. Diagram titles shall be synonymous with the heading titles.

a. The description shall first briefly describe the composition of the output by tracing the output back to its origin. This shall illustrate functional dependency of the circuits or mechanisms and shall familiarize the technician with the way in which the signal flow diagrams, when required, are to be used for fault-isolation. It also provides the technician with a summary of the total generation path as background for the more detailed description that shall follow.

b. Next, the text shall, in effect, “talk through” each of the signal flow diagrams from source to output. These presentations shall be supplemented, as required for completeness, by reference to second-order supporting diagrams contained in the manual. As required for clarity, additional supporting illustrations shall be provided. These may include timing diagrams or a block diagram giving a more condensed view of a particularly complex signal flow diagram (see MIL-DTL-24784). Such additional illustrations shall be consistent with the troubleshooting diagrams with respect to nomenclature, symbology, and reference designations. These diagrams shall clearly label and define source and destination input and output signals and mechanical occurrences, and the time and phase relationships.

c. A detailed analysis shall be provided for areas of new, unusual, or complex design. Descriptions of conventional circuits or devices that are covered in Navy Class A training shall be included only to the depth required to integrate them into the overall analysis. Detailed analysis text shall be supported as appropriate by detailed logic diagrams and partial electrical, electronic, pneumatic, hydraulic, and mechanical schematics (see MIL-DTL-24784). Detailed logic diagrams shall include the level of detail specified in IEEE 991. Detailed mechanical analysis descriptions shall be supported as appropriate by mechanical schematics, gearing, and linkage diagrams. Cutaway views shall show internal parts of complex mechanisms in the detail necessary to ensure comprehension of a detailed mechanical analysis. Callouts shall be used to locate each functionally significant part.

d. Mathematical analysis shall be provided for equipment elements that perform mathematical functions, such as fire control, guidance, and computer equipment, in sufficient detail that shall provide the technician or trainee with a complete understanding of the mechanics of the equipment performing the function. Mathematics shall be limited to the level of high school algebra, geometry, and trigonometry. However if a higher level of mathematics is required for a valid definition, it shall be presented in the simplest possible terms, preferably including an approximate equivalent expressed in a simpler form. Mathematics shall not be used to justify design or to describe basic circuit elements.

3.7.4.4.4 Functional elements IP <**FuncEleDescIP**>. This IP shall describe the functional elements consisting of electrical, electronic, pneumatic, hydraulic, mechanical, and optical units. The elements shall be described in sufficient detail to provide the technician with a complete understanding of how these elements accomplish their functions. Descriptions of conventional circuits or devices that are covered in Navy Class A training generally shall not be extended below the level of single function stages or individual active elements; for example, amplifier stage, rectifier, synchro, motor transducer, and digital logic block. However, the learning objectives of the Class A training should be the determining factor for the depth of coverage.

3.7.4.4.4.1 Detailed functional elements. Depth of coverage, which may be defined as detailed circuit analysis or mechanical analysis, shall be restricted to areas of new or unusual design. When functional elements are new, unusual, or complex in design and therefore require more detailed coverage, such coverage may be presented at one time, in an IP, and not in a straightforward sequence with respect to each individual signal flow diagram. In such instances, specific paragraph references shall be provided in logical functional sequence with respect to each individual signal flow diagram. In such instances, specific paragraph references shall be provided in logical functional sequence for all out-of-sequence text material. Typical examples are as follows:

a. Unusually lengthy descriptions of complex functional elements (circuitry or mechanism) should be deferred as amplifying information if such descriptions would tend to obscure the continuity of an overall description.

b. Complex functional elements having identical multiple applications, or one application contributing to two or more output functions, shall be fully described only once and otherwise covered by references to that point in the text.

3.7.4.5 Electronic systems functional description IM <**ElectronicSysFunctionalDescIM**>. Functional description for electronic systems shall describe how the components or equipment comprising the system jointly perform major operations and functions, and how associated systems contribute to the performance of these major functions. The description of the entire system shall be supported by a basic block diagram of the system (see figure 6). Each major function shall then be discussed separately at progressively increasing levels of detail supported with overall and functional block diagrams. Where information can be better presented pictorially than by text, additional diagrams and other illustrations shall be used. Reference may be made to troubleshooting diagrams. Equipment or associated system interfaces shall be described only as necessary to identify the sources or destinations of system inputs and outputs.

3.7.4.5.1 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in the functional description. The introduction shall also describe briefly the interrelationship between the system and associated systems.

3.7.4.5.2 System function directory IP <**SysFuncDirIP**>. This IP shall include a system function directory tabulating the operation control functions and the signal data described in the detailed level of functional description. The tabulation shall include the following information, as applicable:

a. Official name of the function, common name, and symbol.

b. Type of control or signal (AC frequency and voltage, DC polarity and voltage, hydraulic pressure, mechanical motion, synchro, and so forth).

c The origin and termination of the control or signal.

d. Identify equipment (relay transmitters, coordinate converters, distribution boxes, switches, and the like) between the origin and termination of the output control or signal.

e. A reference to where the function is illustrated, including the troubleshooting diagrams.

3.7.4.5.3 Simplified functional description IP <**SimplFuncDescIP**>. The simplified functional description IP shall be confined to data, such as, origin of the function at an equipment control or sensor; transmission of the signal via intermediate equipment such as switchboards, relay transmitters, coordinate converters, and distribution boxes; and presentation of the function at terminal equipment. Control functions essential to the development of a signal shall be introduced and briefly described in their relationship to the signal. The description shall be supported by a FBD. Functions involving computations may be explained in mathematical terms, but at a level no higher than high school mathematics.

3.7.4.5.4 Detailed functional description IP <**DetlFuncDescIP**>. The detailed functional description IP shall explain the system major functions in terms directly related to the diagrams developed for troubleshooting. Data and control functions shall be described down to the level of an equipment or an equipment group.

3.7.4.6 Electronic equipment functional description IM <**ElectronicEquipFunctionalDescIM**>. IPs describing the detailed analysis of the functional descriptions of the overall equipment and its functions shall be provided. The development of the equipment functions in every mode of operation shall be described and supported with FBDs. The text shall support and reference the functional troubleshooting diagrams. The functional description of digital equipment shall be similar to that for conventional equipment. However, the functional and hardware makeup of digital equipment requires a variation in the method of presentation and descriptive requirements. An overall description of the functional relationship of the logic sections, units, and assemblies comprising the equipment shall be provided. The functional description IPs shall be presented in successive levels of increasing detail as described in 3.7.4.6.2 and 3.7.4.6.3.

3.7.4.6.1 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in the functional description. The introduction shall also describe briefly the interrelationship between the equipment and associated components.

3.7.4.6.2 Simplified functional description IP <**SimplFuncDescIP**>. This IP shall provide narrative text that supports and refers to the overall functional block diagram. All major functions such as transmit, receive, control, display, power distribution, cooling, and so forth shall be described at this level

3.7.4.6.3 Detailed functional description IP <**DetlFuncDescIP**>. This IP shall describe the development of each major function at the level of detail shown on its related signal flow diagram, logic diagram, or other diagram provided in troubleshooting. The text shall support and refer directly to the diagrams. The following shall be included, as applicable.

a. An introduction to, and description of, the signal characteristics:

   (1) Signal levels or bi-stable states utilized by the equipment; that is, true (1) and false (0), and their relative voltage levels.

   (2) Interpretation of the word-code bit structure; that is, address, instruction, or data bit codes.

   (3) Signals, identified by their operational accomplishment.

b. Overall and FBDs, and associated descriptions.

c. Logic principles shall be described beginning with an introduction to the basic digital logic symbology used in the manual. Each logic function shall be described and supported by Boolean equations, truth tables, simplified logic diagrams, and timing diagrams.

d. Functional description of power distribution, power supplies, and regulators shall be in accordance with 3.7.4.6.4.

3.7.4.6.4 Detailed circuit analysis IP <**DetlCircuitAnalysisIP**>. This IP shall briefly describe conventional electronic circuits found in NAVSEA SE000-01-IMB-010 and refer to the maintenance schematic diagrams provided in troubleshooting. Detail circuits not covered in NAVSEA SE000-01-IMB-010 shall be described and supported by simplified schematic diagrams. Alternating current (AC) and direct current (DC) power distribution shall be described in detail and supported by reference to the power distribution diagrams provided in the TM troubleshooting. Mechanical devices, cooling systems, and so forth shall be described and supported by reference to mechanical schematic, overall, and functional block diagrams.

3.7.4.6.5 Integrated circuits and micro-miniature capsules IP <**IntegratedCircuitIP**>. This IP shall include a brief description of overall functional operation for circuits within different types of non-repairable integrated circuits and micro-miniature capsules. Non-repairable circuits are not required for functional understandings of theory of operation. Simplified schematics in accordance with NAVSEA SE000-01-IMB-010 or logic diagrams showing input and output connections, truth tables, and waveforms as applicable shall support the text.

3.7.4.6.6 Equipment function directory IP <**SysFuncDirIP**>. This IP shall include an equipment function directory tabulating operation control functions and the signal data described in the detailed level of functional description. The tabulation shall include the following information, as applicable:

a. Official name of the function, common name, and symbol.

b. Type of control or signal (AC frequency and voltage, DC polarity and voltage, hydraulic pressure, mechanical motion, synchro, and so forth).

c. The origin and termination of the control or signal.

d. Identify components (relay transmitters, coordinate converters, distribution boxes, switches, and the like) between the origin and termination of the output control or signal.

e. A reference to where the function is illustrated, including the fault-isolation diagrams.

3.8 Procedural information. Task-oriented procedural data such as operating, maintenance, operational checkout and troubleshooting, and installation data shall be divided into individual, stand-alone units of procedural oriented information. Procedures that can be hazardous to personnel or equipment shall be emphasized by DANGERS, WARNINGS, or CAUTIONS, as applicable (see MIL-DTL-24784). The following IMs, each of which consists of one or more IPs, shall be developed as applicable:

a. Operation IM (see 3.8.1).

b. Maintenance IM (see 3.8.2).

c. System/equipment installation IM (see 3.8.3).

d. Operational checkout and troubleshooting IM (see 3.8.4).

3.8.1 Operation IM <**OperationIM**>. The operation IM shall be sub-divided into individual IPs. IPs shall be developed that contain operating instructions including all the procedures necessary to enable operating personnel to efficiently and effectively use the system or equipment in accomplishing its designated task. These operating instructions shall be in sufficient detail to allow operators, having previous experience in the operation of similar or related equipment, to independently and safely operate the equipment without additional training or explanation. When applicable, at the beginning of each operating procedures IP, instructions shall include safety precautions to be observed, tools, parts, materials, and test equipment required (see 3.7.2.3). Operating procedures IPs may have an introduction. In a **system** TM, equipment-operating instructions shall be general in nature, since the detailed operating instructions in the equipment manuals are required to be complete in every available mode or condition (both system interfacing and independent).

3.8.1.1 Introduction IP <**IntroductionIP**>. The introduction IP shall describe each operator's relationship to the equipment and each other, and shall identify those units having controls and indicators that the operator is expected to use in the performance of his duties. The intended function and application of the equipment shall be fully explained so that the operators will know exactly what he or they should expect to accomplish with the equipment.

3.8.1.2 Controls and indicators IP <**ControlsAndIndicatorsIP**>. This IP shall provide data for the system/equipment hardware controls and indicators and shall include a description of all operator controls, indicators, protective devices, and jacks. The following information shall be included in tabular format (<**ControlsIndicatorsTable**>), as applicable:

a. Names of panel designations as marked on the equipment.

b. Positions and operating functions for each control, and the normal operating condition of each indicator in each of the operating functions.

c. The text shall be supported by detailed illustrations (see figure 11).

d. When more than one operator is required to operate the equipment, his designated position and function, and the relationship to his controls and indicators shall be specified.

3.8.1.3 Displays and alerts IP <**DisplaysAndAlertsIP**>. This IP shall provide data for the system/equipment software displays and alerts and shall include a description of all operator monitor displays and audio alerts. The following information shall be included in tabular format (<**DisplaysAlertsTable**>), as applicable:

a. "Index No. <**IndexNumber**>" reference, if used.

b. "Display/Alert <**DisplayAlert**>" nomenclature.

c. "Function <**function**>".

The purpose of the table is to provide the required data for each display and alert. The table will indicate the index number (when used) referenced from the illustration, the associated display or alert and its nomenclature, including the reference designator, if applicable, and the function of the display or alert.

3.8.1.4 System operating procedures IP <**OperatingProceduresIP**>. The system operating procedures IP shall be prepared in accordance with 3.8.1.4.1 through 3.8.1.4.5.

3.8.1.4.1 Preoperational conditions and setup <**PreopCondition**>. Specific preoperational conditions presumed to be in effect prior to system operation shall be established. A system readiness check-off list of significant switch positions and indicator status shall be tabulated. For indicators such as dials, where a band of readings are possible, upper and lower limits shall be delineated. The initial conditions of associated system equipment that directly affect system operation shall be treated in a similar manner. In addition, for **weapon systems**, provide loading instructions as follows:

a. Initial loading instructions. Provide instructions for the initial loading of the computer program into the computer if the system includes a general-purpose digital computer. All required instructions covering operation of the peripheral input equipment and controls on the computer maintenance panel shall be included to ensure that the applicable program and routine are correctly loaded.

b. Unique parametric instructions. The instructions and data required to load or to set any specific parametric values, modes, or sequences into the equipment that are unique to the facility and that are not included in the computer program shall be included. This material may include the setup of items such as program constants and parallels, into specific memory locations, and the setting of controls that modify equipment interfaces in readiness for tactical system operation at the specific facility.

3.8.1.4.2 Operating modes <**OperatingMode**>. Beginning with the primary mode, each available mode of operation shall be described in the normal and characteristic sequence of major phases, events, tactical options, supervisory commands, and responsive actions. Operating modes that are common to all modes (for example, launcher loading and assignment) shall be detailed under the primary mode and referred to under the secondary modes with such modifications of procedure as may be necessary. The primary mode operating description shall be supported by either a block or logic illustration of operational sequence. The block diagram form shall be used when the operator has no choice of action. However, when an operational phase involves any operator's judgment, the description shall be supported by an operational sequence logic diagram that indicates the factors which must be favorable prior to operator's action; or, if unfavorable, indicates an alternate optional action.

3.8.1.4.3 Normal operation <**NormalOperation**>. 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. Descriptive words (such as switch, button, dial, or indicator) may be added to clarify the type of control involved, for example: "Press ACCESS button and observe channel spot." If system controls and indicators and/or displays and alerts must be observed or used during normal operation, a reference to the controls and indicators IP (see 3.8.1.2) and displays and alerts IP (see 3.8.1.3) may be used to support the procedures. Controls and indicators and/or displays and alerts provided only for maintenance and non-system application shall not be called out.

3.8.1.4.4 Emergency operation <**EmergencyOperation**>. 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. When applicable, emergency operational routines shall be included which emphasize the controls that permit immediate braking or de-energizing of the system. Emergency procedures shall be supported by illustrations.

3.8.1.4.5 Special operation <**SpecialOperation**>. Special operations such as test, checkout, training, or evaluation exercises shall be described. Illustration support shall include block diagrams and pictorial diagrams.

3.8.1.5 Equipment operating procedures IP <**EquipOperatingProceduresIP**>. The IP for equipment operating procedures shall include the following information:

a. Procedures:

(1) Operator turn-on. All steps necessary to bring the equipment from OFF through STANDBY condition to full operation.

(2) Modes of operation. Procedures for each mode of operation, for example, manual, automatic, local, remote, and so forth. The use and relative advantage of each mode shall also be described.

(3) Operation under interfering conditions. Describe the equipment anti-jamming and interference reduction features, the advantages of each feature, and the operating procedures to be followed in all possible situations. Supporting illustrations (such as indicator displays, wave forms, and so forth) shall be included which provide typical observations of jamming and interference for evaluation by the operator.

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

(5) Battle-short or emergency operation. This procedure shall cover operating the equipment during emergency conditions (control failure, air failure, lube oil failure, loss of cooling water, and so forth). Emergency operator instructions shall be included. Provide a warning or caution to return the equipment to proper operation when the emergency is over.

(6) Emergency turn-off. This procedure shall cover turning the equipment off during an emergency (fire, water, smoke, hazard to personnel, loss of coolant, normal power, and so forth).

(7) Electromagnetic interference (EMI). This procedure shall include information pertaining to the recognition of EMI (such as sights, sounds, lack of response, or other irregularities) and operating procedures to cope with them during operations.

b. Method of presentation. Operating procedures shall be presented in concise, simply-worded, step-by-step procedures and shall include the following:

(1) A short explanation of the operation to be performed.

(2) Initial safety requirements (actions, inspections, and reference to emergency turn-off procedures).

(3) Connection of any accessory equipment not permanently connected.

(4) Instructions for obtaining or confirming the presence of all critical inputs such as power, coolant, air, signal, air-conditioning, and so forth.

(5) Procedures for setting controls and making adjustments that shall be accomplished by the operator prior to equipment turn-on.

(6) Procedures for determining operational readiness and the acceptable indications expected from built-in indicators such as meters, lamps, gauges, and recorder readouts.

(7) Milestones in the operational status of the equipment shall be identified and included by brief statements such as “the generator is now in STANDBY”.

(8) Visual or audio observations that occur as a result of an operator action, such as boom lowering, sweep rotation, blower motor running, and so forth.

(9) Operator’s checks and adjustments in proper sequence.

(10) Operating controls and indicating devices as well as normal in-use positions or indications shall be included. A reference to the controls and indicators IP (see 3.8.1.2) and/or displays and indicators IP (see 3.8.1.3) may be used to support the procedures.

(11) Operator’s maintenance actions and schedules.

3.8.1.6 Non-tactical operation IP (weapon systems only) <**NonTacticalOperationIP**>. This IP shall include, but not be limited to, such non-tactical operations as training exercises using dummy missiles and simulated targets, training and evaluation exercises using telemetering missiles and recording equipment. The procedures shall not duplicate information contained in a subsystem or equipment manual.

3.8.1.7 Conditions of readiness IP (HM&E systems, electronic systems and weapon systems) <**ConditionsOfReadinessIP**>. This IP shall be provided for guidance purposes and shall represent engineering considerations. Conditions of readiness requirements shall be listed prior to the operation of the system. Activities or conditions within compartments or areas outside the system shall be described as necessary. When it is impractical or illogical to separate the conditions of readiness information from operational information, request shall be made with justification, to combine these requirements with the system operation requirements. Do not duplicate information that is contained in the Engineering Operational Sequencing System (EOSS) or Combat System Operational Sequencing System (CSOSS) manuals.

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

a. Watch condition.

b. General quarters condition.

c. 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 12).

b. Block diagrams and descriptions of IC links between compartments and areas, including sound-powered telephone circuits, announcing systems, and closed-circuit television.

c. Presumptions relative to system status at specified times. (For example, from watch condition to general quarters condition, or from general quarters condition to emergency condition.)

d. The operating console and panel positions shall be illustrated.

3.8.1.7.1.1 Watch condition. The condition of all systems equipment and the personnel situation (how many of what class or type of personnel to be stationed where) for watch condition shall be described.

3.8.1.7.1.2 General quarters condition. The condition of all systems equipment and the personnel situation shall be described for general quarters condition.

3.8.1.7.1.3 Emergency condition. The condition of all systems equipment and the personnel situation for emergency condition shall be described.

3.8.2 Maintenance IM <**MaintenanceIM**>. Scheduled and corrective maintenance procedures shall be developed and contained in a maintenance IM. These maintenance procedures shall be logically subdivided into task-oriented IPs to enable a technician to receive, process, test, and maintain the system or equipment to the lowest level replaceable component or part in accordance with the established maintenance concept or approved maintenance plan.

3.8.2.1 Introduction IP <**IntroductionIP**>. The introduction IP shall provide a brief explanation of the purpose, scope, and arrangement of the corrective maintenance data, sufficient for an understanding of its use and relationship to the rest of the maintenance documentation.

a. For **weapon equipment**, the introduction shall also include and explain the use of a table of established values or an adjustment effectivity list, if required by the acquiring activity.

   (1) Table of established values. Any functional parameters with center values dependent upon specific parts or assemblies in the equipment, and which have sufficient accuracy or long-term stability requirements with respect to established center values, shall be listed in a table of established values. Such parameters shall be listed in alphabetical order of symbols or descriptive nomenclature, or by appropriate functional groups, as applicable. Adequate space shall be provided for entries of the actual values pertaining to individual sets of the equipment. In addition, the table shall reference the establishing procedure for each datum value to be entered. Usually, this will be an adjustment procedure, but may be the replacement procedure itself if the installed item is to be monitored for long-term stability although no compensating adjustments are required. This table is to be included in the manual and the values are to be entered by the technician using the material. Figure 13 is an example of a table of established values.

   (2) Adjustment effectivity list. A cross-reference list shall be provided to relate equipment adjustment and alignment procedures to output functions. All adjustment and alignment procedures for the subject equipment shall be listed in numerical order. For each procedure, the outputs that are subject to change when that procedure is accomplished shall be referenced. When more than one output is affected by a given procedure, the output that is most critical or most sensitive to the procedure shall be flagged, underlined, or marked by asterisks, to identify the priority setting. If two or more outputs are equally critical to one procedure, then only one shall be flagged arbitrarily unless the several outputs are related to different specific portions of the procedure. In the latter situation, the applicable step numbers shall be identified as a reference guide to verification of restored operability following any equipment adjustments resulting from indications other than specific test faults. Figure 14 is a sample of an adjustment effectivity list.

b. For **weapon systems** the introduction shall describe the principles of test-based system alignment in terms of its vital contribution to system effectiveness, the subsystem interdependencies involved, and the test and troubleshooting documentation required to maintain system alignment. To promote a better understanding of system alignment, the description shall point out the distinction between alignments and adjustments. The alignment interdependencies among the various equipment shall be illustrated by a classification chart arranged in a diagrammatic sequence to fully depict the dependency relationships of all alignments affected or related.

3.8.2.2 Scheduled maintenance IP <**ScheduledMaintenanceIP**>. Scheduled maintenance shall not be included in the TMs. Scheduled maintenance instructions are furnished in the Planned Maintenance System (PMS). However, an IP shall be provided that contains the following information:

"INTRODUCTION.

Scheduled maintenance instructions are furnished in the Planned Maintenance System (PMS). When conflicts exist between this manual and the PMS, the PMS documentation shall take precedence. Such conflicts should be reported immediately, using the Technical Manual Deficiency/Evaluation Report (TMDER) form.

PLANNED MAINTENANCE SYSTEM.

Recommended preventive maintenance procedures to be performed on a scheduled basis are provided in PMS documentation. OPNAVINST 4790.4 describes the PMS, and also covers departmental and work center record keeping, as well as the Maintenance Index Page (MIP) and Maintenance Requirements Cards (MRCs). The MRCs cover scheduled inspection and lubrication procedures for the (insert name of system or equipment being covered here). The extensive and comprehensive scheduled maintenance information provided by the MRCs precludes the need for the detailed coverage within this manual. Specific corrective maintenance requirements (adjustments, alignment, repair, etc.) are covered as part of this TM."

3.8.2.3 System corrective maintenance procedure synopsis IP (weapon systems only) <**ProcedureSynopsisIP**>. This IP shall provide coverage for a synoptic description of each system alignment. Each synopsis shall state the objectives of the alignment and list the initial requirements and the significant parameters or functions to be considered. The synopsis shall highlight major alignment procedures to provide maintenance personnel with the background information necessary for understanding the alignment and what is to be achieved by a satisfactory conclusion of alignment procedures. The text shall identify any additional system alignment procedures to be accomplished prior to, in conjunction with, or subsequent to the subject system alignment.

3.8.2.4 Maintenance IPs <**MaintenanceIP**>. Maintenance information shall be functionally divided into as many individual maintenance IPs as necessary to convey the maintenance tasks described below in a logical and useable manner. Maintenance IPs may contain an introduction. A series of IPs shall provide all the corrective maintenance information required to adjust and align the equipment, remove, clean, inspect, repair, reinstall, and align repairable parts, modules, subassemblies, and assemblies. As applicable, at the beginning of each IP, instructions shall include safety precautions to be observed, tools, parts, materials, and test equipment required (see 3.7.2.3). Instructions shall identify the action to be accomplished; preliminary control settings; test equipment setup instructions; and step-by-step instructions, with supporting illustrations, to accomplish the maintenance task. Corrective maintenance instructions shall be provided for all items designated repairable irrespective of the maintenance concept unless this information is included in another TM and can be referenced.

3.8.2.4.1 Maintenance tasks. IPs may contain preliminary setup information and shall be developed in a logical order for the maintenance tasks listed below, as applicable. For usability and clarity, the maintenance tasks listed below may be combined in a single IP or provided in individual IPs as necessary.

a. Preliminary setup <**PreliminarySetup**>.
b. Maintenance turn-on (test) <**MaintenanceTurnOn**>.
c. Adjust/align <**AdjustAlign**>.
d. Repair <**Repair**>.
e. Remove <**Remove**>.
f. Disassembly <**Disassembly**>.
g. Inspect <**Inspect**>.
h. Reassembly <**Reassembly**>.
i. Adjust <**Adjust**>.
j. Install <**Install**>.
k. Calibrate <**Calibrate**>.
l. Checkout <**Checkout**>.
m. Cleaning <**Cleaning**>.

n. Lubrication <**Lubrication**>.

o. Storage <**Storage**>.

p. Grooming <**Grooming**>.

q. Unit break-in <**UnitBreakIn**>.

r. Packaging <**Packaging**>.

s. Transportation <**Transportation**>.

t. Handling <**Handling**>.

u. Special preservation, storage, and transportation <**SpecialPreservation**> <**SpecialStorage**> <**SpecialTransportation**>.

v. Special handling and packaging <**SpecialHandling**> <**SpecialPackaging**>.

w. Refurbishment <**Refurbishment**>.

x. Examination and acceptance criteria <**ExaminationAcceptanceCriteria**>.

y. Test and inspection <**TestAndInspection**>.

3.8.2.4.2 Adjustment and alignment procedures. Step-by-step procedures required to perform alignment and adjustment of systems/equipment or to restore electrical and mechanical alignment and adjustment between various system equipment shall be provided. Alignments and adjustments for all repairable assemblies and parts shall also be provided. All values and tolerances shall be included. The alignment shall be cross-referenced to respective fault-isolation procedures and diagrams provided in the operational checkout and troubleshooting IPs. Alignment procedures shall include references to equipment publications where further procedures are required at the equipment. Adjustments and alignments shall include but not be limited to:

a. Non-operator type adjustments.

b. Alignments requiring external jigs, test equipment, or bench setups.

c. Alignments that are accomplished after a repair or replacement of a part or module.

d. Test equipment setup and other illustrations necessary to support the procedures.

3.8.2.4.3 Special preservation, storage, and transportation requirements. The requirements for special preservation, storage, and transportation of the repairable items shall be identified. For example, preservation for storage when the repair item is not to be installed (fleet use) for an extended period of time and the methods used for preservation and storage of the repairable items are critical.

3.8.2.4.4 Special handling procedures. Describe the procedures required for using the special crates, boxes, containers, transportation vehicles, and other facilities for repairable items handling.

3.8.2.4.5 Special packaging procedures. Describe the procedures required for special packaging of the repairable items.

3.8.2.5 Yard or tender corrective maintenance IP (weapon equipment only) <**YardOrTenderMaintenanceIP**>. When specified by the acquiring activity (see 6.2), this IP shall provide procedures and instructions for performing maintenance that is beyond the capabilities of the ships force. The procedures shall be presented in step-by-step narrative form and shall be supported by selected illustrations, and by reference to appropriate engineering drawings, specifications, ordnance directives, and similar data. An introduction may be included as necessary. The presentation format for yard or tender procedures shall be based upon recommendations submitted to and approved by the Government. General overhaul and repair practices shall be presented first. A series of IPs shall cover the major physical subdivisions of the equipment. For each item requiring replacement, procedures shall be given for removal, installation, and test. If repair is practicable below the level of replacement parts, procedures shall be given. If repair or replacement requires readjustment or alignment, references shall be made to MRCs when appropriate, otherwise the required procedure shall be included. Procedures that are obvious upon inspection of equipment shall be omitted. Block diagrams illustrating possible sequences of disassembly and reassembly shall be provided.

3.8.3 System/equipment installation IM <**SystemEquipInstallationIM**>. When specified by the acquiring activity (see 6.2), drawings and information concerning system/equipment installation shall be provided. The following type of information shall be included: site selection, or installation location guide lines (such as moisture precautions and maximum temperature allowed as appropriate), 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, and recommendations for reduction of electrical and EMI, and other interface requirements, as applicable. In addition, coverage shall contain tests and test procedures required to demonstrate that the equipment after installation is capable of satisfying operational requirements. Also, it shall include information relating to the electromagnetic compatibility (EMC) measures taken in the original design or subsequently incorporated to maintain EMC integrity of the equipment at all times in its life cycle. The measures include, as a minimum, shielding, filtering, grounding, bonding, and routing. In addition, for **system** TMs, include installation drawings and information not contained in the equipment TM necessary to install and checkout the system. The system/equipment installation information shall be provided in the IPs described in 3.8.3.1 through 3.8.3.9. When the installation data is fairly simple or relatively short in content the data may be combined into a single installation IP.

3.8.3.1 System cable interconnection check IP (all systems) <**SystemCableInterconnectIP**>. This IP shall provide a checklist with procedures to verify the proper installation of all system cables. The checks shall be conducted with all power off and all equipment completely shut down.

3.8.3.2 Site or installation location IP <**SiteLocationIP**>. This IP shall provide data supplemental to the installation drawings. If all site information is contained on the installation drawings, reference shall be made to the applicable drawings.

3.8.3.3 Unpacking and repacking IP <**UnpackingRepackingIP**>. This IP shall provide unpacking and repacking data supplemental to the installation drawings. Include step-by-step procedures to prevent damage to the equipment or injury to personnel. Supporting illustrations shall be provided to clarify procedures. When packing for reshipment is required, step-by-step procedures for packing shall be included and illustrated. Any special environmental conditions required for storage shall be provided. Instructions shall be included for items in the following categories:

a. De-preservation procedures required at time of installation.
b. Re-preservation packaging required prior to repacking for storage or shipment.
c. Intricate mounting, blocking, or bracing.
d. Special cushion inserts.
e. Repairable items.
f. Sensitive or fragile components.
g. Items held in special cradles.
h. Items furnished in reusable containers.
i. Special environmental conditions required for storage.
j. Special handling procedures required.
k. Container storage or disposition instructions, as applicable.

3.8.3.4 Preparation of foundations IP <**PreparationFoundationIP**>. This IP shall provide preparation of foundation data supplemental to the installation drawings. If all information is contained on the installation drawings, reference shall be made to the applicable drawings.

3.8.3.5 Input requirements IP <**InputRequirementsIP**>. A summary of the input data contained on the installation drawings shall be included in this IP. Parameters with tolerances, if applicable, 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. Ship gyro information.

e. Fluid cooling.

f. Steam.

g. Refrigerant.

3.8.3.6 Utilities list IP (HM&E and electronic systems only) <**UtilitiesListIP**>. This IP shall provide a utilities list that presents in tabular form all utilities required, and the quantities of each, in each system, compartment, and area, such as air, water, power, steam, refrigerant.

3.8.3.7 Active system tests IP (HM&E and electronic systems only) <**ActiveSystemTestIP**>. This IP shall provide all active system test procedures required to verify the proper installation and operation of the system. Reference may be made to applicable tests and procedures in corrective maintenance. Procedures for complete setup, testing, shut down, and data analysis shall also be provided.

3.8.3.8 Installation procedures IPs <**InstallationProceduresIP**>. As applicable, IPs shall be provided for installation procedures. For **HM&E and electronic systems,** complete step-by-step instructions shall be provided for installation of system components not covered in any of the equipment manuals for the equipment comprising the system. Illustrations shall be included, as applicable. Step-by-step procedures shall be developed for the following when not provided on the installation drawings:

a. Instructions required to assemble units/components.

b. Instructions required to mount units/components. Include bolting and bracing diagrams and data on shock mounts.

c. Instructions for making electrical, waveguide, 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 and adjustments.

f. Instructions for bonding and grounding.

3.8.3.8.1 Installation drawings. Reproduction of appropriate installation control drawings shall consist of the following, as applicable:

a. Drawing list.

b. Block diagrams.

c. Outline and installation drawing.

d. Auxiliary cooling diagram.

e. Auxiliary dry gas diagram.

f. Cable running sheets.

g. Summary list of installation material.

h. RF transmission line diagram.

i. Hydraulic fluid piping diagram.

3.8.3.9 Installation checkout IP <**InstallationCheckoutIP**>. This IP shall provide step-by-step procedures to demonstrate that the system/equipment operates correctly and within tolerances. These procedures shall provide for equipment checkout in three test phases as follows:

a. Phase 1 - installation inspection and pre-energizing procedures. Inspection procedures shall be provided in the form of checklists to verify the following:

(1) That all units of the equipment and required auxiliary equipment have been installed and that their location and orientation is proper; that all cables, filters, antennas, waveguides, transmission lines, dehydrators, coolant lines, piping, and so forth, have been installed in accordance with plans and specifications; that continuity exists in all interconnections.

(2) That the test equipment listed in the special tools and test equipment list (see 3.7.2.3) is onboard, operating satisfactorily, has been calibrated and has adequate storage in accordance with NAVSEA ST000-AB-GYD-010/PEETE.

(3) That all alterations such as field changes and SHIPALTS, have been accomplished. For **HM&E systems, electronic and weapon equipment**, that all installation and reference standards are entered on the installation standards summary sheet.

(4) That all rotating devices are free from obstruction.

(5) That there is access to the equipment for maintenance.

(6) That all pre-energizing servicing procedures, including lubrication have been accomplished.

(7) That it is safe to turn on the equipment.

b. Phase 2 - initial turn-on and preliminary test. Procedures shall be included for energizing the equipment for the first time. This may be accomplished by reference to the applicable portions of operation. Step-by-step procedures shall be included for testing electrical, steam and fluid supply, supply circuits, distribution panels, switches, breakers, relief valves, and interlocks as applicable. Procedures shall be included for testing piping, electrical cables, wire rope, stays, proper installation of transmission lines and waveguides, hangar spacing, torquing of connectors, pressure testing, flow rates, standing wave ratio and attenuation checks, and so forth.

c. Phase 3 - Installation verification test. Complete instructions shall be included for testing the equipment in all modes of operation. Where applicable, refer to the scheduled performance tests in scheduled maintenance. Procedures shall cover checking gauges, meters, alarms, and other sensing devices for proper operation and calibration. The tests shall verify that all inputs are in tolerance. Where applicable, include voltage standing wave ratio 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. In addition, for **HM&E systems**, also include dynamic and static load tests for hoists, winches, etc. 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 referenced in the procedure.

(1) Test procedures for **systems**. Testing procedures shall be presented in a logical order as follows:

(a) Energize the equipment.

(b) When test results are within the required tolerance, include reference to the next logical test.

(c) When test results are out of tolerance, include a reference to the corrective maintenance or troubleshooting data. Reference shall be made to troubleshooting diagrams except where probable causes of failure can be predicted, in which case reference may be made directly to an alignment or repair procedure.

(2) Test procedures for **equipment**. Testing procedures shall be presented in a logical order as follows:

(a) Energize the equipment.

(b) Test the first units (normally power supplied) that must be operating properly.

(c) When test results are within the required tolerance, include reference to the next logical test.

(d) When test results are out of tolerance, include a reference to the corrective maintenance or troubleshooting data.

(3) Installation standards summary sheet (HM&E systems, and electronic and weapon equipment only). The installation standards summary sheet shall provide spaces for recording the results of all installation verification tests and significant reference standard tests that should be made a matter of record for reference by the technician during troubleshooting and for a standard to be re-established after overhaul (see figure 15). Each space shall be identified by the step or paragraph number or title that provides the instructions for accomplishment. Each space shall contain the respective unit of measurement (for example, amp, dB, or V). 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 the length of the transmission line.

3.8.4 Operational checkout and troubleshooting IM <**OperationalCheckoutTroubleshootingIM**>. Operational checkout and troubleshooting information shall be developed and contained in operational checkout and troubleshooting IPs as described in 3.8.4.1 through 3.8.4.6. The information shall be developed to the extent required to maintain the system or equipment at the authorized maintenance level. The number of interrelated systems, assemblies, subassemblies, and components, types of equipment, and maintenance concept/plan shall be taken into consideration to determine the type and depth of checkout and troubleshooting procedures to be developed. Additional testing and troubleshooting information may be developed and contained in IPs as described in 3.8.4.7 through 3.8.4.11.

3.8.4.1 Procedure development assumptions. Procedures shall be developed in accordance with the established maintenance concept and shall be based on the following assumptions:

a. When more than one level of maintenance must be provided for, separate checkout and troubleshooting procedures shall be developed for each maintenance level.

b. Operational checkout, maintenance turn-on, and troubleshooting procedures shall include all elements of pretest setup and post-test shutdown.

c. Maintenance turn-on procedures to energize the equipment from the fully de-energized condition to full operation may be used in lieu of an operational checkout procedure to determine which major function or supporting function is malfunctioning.

d. Successful completion of an operational checkout or testing procedure verifies system/equipment operation.

e. Procedures normally trace one malfunction at a time. However, possible multiple failures shall be anticipated and considered in the testing process.

f. If several components are suspected, the one most likely to have failed shall be considered first.

g. Whenever a component is replaced, checkout shall be restarted to ensure that the replacement did not introduce a new fault into the system or equipment. This assumption shall not be interpreted as a requirement to repeat an entire system/equipment checkout in all cases.

3.8.4.2 Introduction IP <**IntroductionIP**>. This IP shall describe the general approach that is used in operational checkout and troubleshooting. The introduction shall provide a brief explanation of the purpose, scope, and arrangement of the data, sufficient for an understanding of its use.

3.8.4.3 System fault descriptor IP (system troubleshooting only) <**SystemFaultDescriptorIP**>. This IP shall contain a description of reported malfunctions and related maintenance codes for each system. An introduction explaining the fault descriptor data and how this data is used as an aid in relating reported malfunctions to maintenance codes shall be included. For each system, a table listing all fault descriptions along with the corresponding maintenance action to be taken shall be developed (<**FaultDescriptorTable**>). Fault descriptor data and associated malfunction identification is normally derived from built-in-test using preprogrammed tests or diagnostic software or from electronically controlled sensors within the systems to be tested.

3.8.4.4 Operational checkout IP <**OperationalCheckoutIP**>. Operational checkout procedures or maintenance turn-on procedures that subject the systems, subsystems, components, accessories, and items of equipment to prescribed conditions to determine that they shall function in accordance with predetermined test parameters shall be developed. The following information shall be included in the IP, as applicable;

a. Introduction <**intro**>. An introduction shall be included explaining how the operational checkout procedures are to be used to perform testing and how they relate to the associated troubleshooting IPs.

b. General procedures and precautions <**GeneralProcedure**>. Any general procedures that must be performed prior to checkout and precautions that must be taken during the performance of the checkout procedure shall be included. Alignment/adjustment procedures that must be performed prior to or during the checkout procedures shall also be included.

c. Pretest setup procedures <**Pretest**>. Procedures for connecting any test and accessory equipment, including cable connections, shall be included. Procedures for the initial setting of controls shall also be provided.

d. Operational checkout procedures <**OperationalCheckout**>. Operational checkout procedures shall consist of a series of numbered steps and sub-steps which lead to an indication or condition. Based on these indications or conditions, a corrective action is provided. This corrective action can either be stated as a specific remedy or can be a reference to a detailed troubleshooting procedure IP. This process is continued until the entire operational checkout procedure is completed.

e. Post-operational checkout shutdown procedures <**Shutdown**> <**EmergencyShutdown**>. Procedures to return the system or equipment to its normal configuration, prior to pretest setup, if required, shall be included. When applicable, procedures shall be included for both normal shutdown and emergency shutdown.

3.8.4.5 Troubleshooting procedures IP <**TroubleshootingProceduresIP**>. Troubleshooting procedures for detecting, isolating, and correcting systems, subsystems, and equipment failures and malfunctions shall be developed. The following information shall be included in the IP, as applicable.

a. Introduction <**intro**>. An introduction shall be included explaining how the troubleshooting procedures are to be used to perform troubleshooting and how they relate to the associated operational checkout IPs. When applicable, a consolidated list of malfunctions or symptoms that reference to the applicable troubleshooting procedures shall be included.

b. General procedures and precautions <**GeneralProcedure**>. Any general procedures that must be performed prior to troubleshooting or precautions that must be taken during the performance of the procedure shall be included. Alignment/adjustment procedures that must be performed prior to or during the troubleshooting procedures shall also be included.

c. Troubleshooting procedures <**Troubleshooting**>. Based on the complexity of the troubleshooting to be performed, troubleshooting procedures can be structured differently and, therefore, shall contain different content. The following two methods shall be used to prepare troubleshooting procedures.

(1) Method A - text-logic <**TroubleshootingProcedure-A**>. Troubleshooting procedures for specific fault symptoms shall combine text and logic and consist of a series of steps and sub-steps that lead to an indication or condition (usually stated in the form of a question). Based on these indications or conditions, a “YES” or “NO” response is provided to guide the technician to either the next step or a series of steps, or to a corrective action which may consist of a malfunction or action followed by a reference to the IP or paragraph that contains the data to perform the corrective action. This process is continued until the entire troubleshooting procedure is completed.

(2) Method B - text <**TroubleshootingProcedure-B**>. Troubleshooting procedures shall consist of an all-inclusive series of specific fault symptoms for the system/equipment being troubleshot. For each fault symptom, the probable malfunction or series of malfunctions that may have caused the fault shall be listed. For each probable malfunction identified, a corrective action shall be stated with a reference to the IP or paragraph that contains the data to perform the corrective action.

d. Post-troubleshooting shutdown procedures <**Shutdown**> <**EmergencyShutdown**>. Procedures to return the system or equipment to its normal configuration, prior to setup, if required, shall be included. When applicable, procedures shall be included for both normal shutdown and emergency shutdown.

3.8.4.6 Operational checkout and troubleshooting procedures IPs <**OperationalCheckoutTroubleshootingIP**>. A series of IPs shall be developed containing operational checkout and troubleshooting procedures for integrated systems and for each independent system and subsystem or equipment, as applicable. Content and development requirements are provided in 3.8.4.6.1 through 3.8.4.6.2.1.

3.8.4.6.1 Operational checkout and troubleshooting procedures content. Operational checkout and troubleshooting procedures shall guide a technician in as practical a manner as possible in detecting, isolating, and correcting system and equipment failures/malfunctions. Procedures shall ultimately lead to isolating faults to an appropriate adjustment, replaceable parts, interface wires, or mechanical linkage and direct repair or replacement of parts authorized for repair or replacement at the maintenance level covered. As applicable, safety precautions to be observed, tools, parts, materials, and test equipment required (see 3.6.1) shall be included at the beginning of each IP. Procedures shall be accompanied by reference data such as schematics, signal flow diagrams, functional circuit diagrams, sequenced switching diagrams, waveforms, tables, and other illustrations for comprehensive understanding of the procedures. When reference data are required for backup, they may be contained in the same IP. If a large number of schematics or other type diagrams are required, they may be included in a separate IP (see 3.8.4.7). The schematics shall integrate fluid, mechanical, electrical, and electronic components. Illustrations may also be included that locate and identify the controls and displays used to perform the testing and troubleshooting procedures. For **systems**, special attention shall be given to system interface wiring fault isolation procedures. Wiring fault isolation procedures shall include the following types of data, as applicable:

a. Specific wire reading access points and resistances for wiring components (where practical).

b. Wire-to-wire and wire-to-ground criteria for circuit integrity.

c. Where required, special wire definition (including interconnecting criteria for proper sealing or terminal application), and special notations where wire harnesses should be completely replaced and not repaired.

3.8.4.6.2 Operational checkout and troubleshooting procedure IP development. Based on the following factors and as agreed to by the Government, operational checkout and troubleshooting procedures may be combined into a single IP or may be developed in a separate operational checkout IP and a separate troubleshooting IP.

a. Complexity of the system/equipment.

b. The type of test equipment used.

c. System/equipment self-test or built-in-test/built-in-test-equipment (BIT/BITE) capability.

d. Complexity of the test and troubleshooting procedures as determined by the task analysis.

e. Clarity and usability.

3.8.4.6.2.1 Combined operational checkout and troubleshooting IP. Depending on the complexity and the intended use, operational checkout and troubleshooting procedures may be combined and included in a single IP. The operational checkout and troubleshooting information may be combined into a single procedure (see d(1), below), or when necessary, developed as individual checkout and troubleshooting procedures within the same IP (see d(2) and (3) below). The following information shall be included, as applicable:

a. Introduction <**intro**>. An introduction shall be included explaining how the operational checkout and troubleshooting procedures are to be used to perform checkout and troubleshooting and how they relate to the associated IPs that included the corrective actions which returns the equipment to proper operation.

b. General procedures and precautions <**GeneralProcedure**>. Any general procedures that must be performed prior to checkout and precautions to be followed during the performance of the checkout procedure shall be included. Alignment/adjustment procedures that must be performed prior to or during the checkout and troubleshooting procedures shall also be included.

c. Pretest setup procedures <**Pretest**>. Procedures for connecting any test and accessory equipment, including cable connections, shall be included. Procedures for the initial setting of controls shall also be provided.

d. Operational checkout and troubleshooting procedures <**OperationalCheckout**> <**Troubleshooting**> <**OperationalCheckoutTroubleshooting**>. Depending on their complexity, the operational checkout and troubleshooting procedures may be combined in a single procedure or may be prepared as separate procedures within a single IP.

(1) Combined operational checkout and troubleshooting procedures. Combined operational checkout and troubleshooting procedures shall consist of a series of test procedures (steps and sub-steps) which lead to an indication or condition. When a normal indication is obtained, the operational checkout continues until the entire checkout is completed or until an abnormal condition or indication is observed. When the test procedure results in an abnormal indication or condition, a malfunction or a series of malfunctions is provided. For each malfunction, the possible corrective actions shall be provided. When required, the corrective action may include a reference to the IP or paragraph that contains the data to perform the corrective action.

(2) Separate operational checkout procedures. When it is determined that the operational checkout procedures shall be separated from the troubleshooting procedures, the operational checkout procedures shall be included under the heading "OPERATIONAL CHECKOUT." Operational checkout procedures shall be developed in accordance with 3.8.4.4d.

(3) Separate troubleshooting procedures. When it is determined that the troubleshooting procedures shall be separated from the operational checkout procedures, the troubleshooting procedures shall be included under the heading "TROUBLESHOOTING." Troubleshooting procedures shall be developed in accordance with 3.8.4.5c.

e. Post-operational shutdown procedures <**Shutdown**> <**EmergencyShutdown**>. If required, procedures to return the system or equipment to its normal configuration, prior to operational checkout or troubleshooting setup shall be included. When applicable, procedures shall be included for both normal shutdown and emergency shutdown.

3.8.4.7 System/equipment testing and troubleshooting reference IPs <**TroubleshootingReferenceIP**>. As determined in paragraph 3.8.4.6.1, IPs shall be developed that contain reference data that is required to support operational checkout and troubleshooting IPs. A reference IP may include an introduction. Reference data may include:

a. Electronic, electrical, mechanical, and maintenance schematic diagrams.
b. Piping diagrams.
c. Cabling, wiring, or signal tracing diagrams.
d. System control function diagrams.
e. System data function diagrams.
f. System functional diagrams (SFDs).
g. Digital SFDs.
h. Power distribution diagrams.

See 3.7.8 of MIL-DTL-24784 for specific development requirements.

3.8.4.8 Relay coil, switch, and lamp indices IP <**TroubleshootingIndicesIP**>. These indices shall be prepared for all relay coils, switches, and indicator lamps. The relay and lamp indices (<**TroubleshootingIndex**>) shall include the item reference designation, the functional name, energizing voltage, and a reference to the troubleshooting diagram(s). Any components that are part of a circuit card assembly that is a lowest replaceable unit, shall not be listed on the component indices.

3.8.4.9 Protective device index IP <**ProtectiveDeviceIndexIP**>. This index shall list all protective devices, such as fuses, circuit breakers, and so forth. The index (<**ProtectiveDeviceIndex**>) shall include the item reference designation, front panel marking of the device, trip-out value of the circuit breaker and rating of fuses, name of the circuit protected and a reference to troubleshooting diagram(s).

3.8.4.10 Redundant pluggable electronic components IP <**RedundantPluggableElectronicComponentsIP**>. When applicable, a list of redundant (identical) pluggable electronic components shall be provided to facilitate the interchange of parts in use within the system/equipment. The list of components shall appear in tabular form with items grouped by part number and arranged in alphanumeric part number order. The list shall include reference designators for each part number listed. Reference designators shall be arranged in ascending order with the least critical component appearing first. Non-pluggable items and items having minor degrading impact on the system/equipment shall not be listed (example: indicator lamps and light bulbs). This table shall be titled "Component Interchangeability".

3.8.4.11 Maintenance assistance modules (MAMs) IP <**MAMsIP**>. When applicable, this IP shall provide a list of MAMs and other redundant and swappable components for the system/equipment. This table shall be titled "Special Purpose Test Equipment - MAMs." These MAMs enable maintainers to swap or replace suspected faulty parts identified by troubleshooting routines.

3.9 Illustrated parts breakdown (IPB) IM <**IllustratedPartsBreakdownIM**>. When specified by the acquiring activity (see 6.2), IPB information may be developed and delivered as indicated below:

a. Provided in a separate TM.

b. Developed as IPB IMs and included in the applicable maintenance TM.

c. Developed as a parts information database and included in the applicable maintenance TM.

See MIL-DTL-24784/23 for detailed requirements.

3.10 CSTOM IMs. Combat system description information shall be developed and divided into the following types of IMs, as applicable:

a. Combat system introduction and description IM (see 3.10.1).

b. Combat system description IM (see 3.10.2).

c. Combat system operational description IM (see 3.10.3).

d. Combat system readiness assessment IM (see 3.10.4).

e. Fault detection and impact evaluation IM (see 3.10.5).

f. Fault isolation IM (see 3.10.6).

3.10.1 Combat system introduction and description IM <**CSTOMIntroductionIM**>. Coverage shall consist of information for combat system personnel that summarizes ship physical and functional characteristics, missions, capabilities, and the interrelationships between combat system elements. The IM shall contain a series of IPs that introduce the CSTOM and provide a physical and functional description of the ship. An overview of the ship mission and capabilities shall be included, and shall identify the elements comprising the combat system, and the physical location of selected elements.

3.10.1.1 Types of data level descriptions. Descriptive portions of CSTOM shall identify principal combat system elements with a textual synopsis for each. A reference to the element documentation shall be made for detailed information. The data in CSTOM shall consist of levels of narrative and illustration coverage as follows:

a. Level 1 detailed introduction. Narrative text, explaining combat system and interfaces, and operational or testing dependencies or capabilities. The text shall be supported with block or pictorial drawings.

b. Level 2 functional and operational descriptions. Narrative text explaining principal combat system and element functions, operations, actions, capabilities, or fault isolation methods and tools. The text shall be supported with block or pictorial drawings.

c. Level 3 detailed description. Narrative text explaining signal characteristics and flow or test procedures. The text shall be supported with signal level drawings.

3.10.1.2 Introduction IP <**IntroductionIP**>. This IP shall briefly describe the purpose, scope, and content of CSTOM. Coverage shall also include submittal and routing instructions for reporting of errors and technical manual improvement. The following shall be included:

"Ships, training activities, supply points, depots, Naval Shipyards and Supervisors of Shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA technical manuals (TMs). All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA TMs shall be submitted as a Technical Manual Deficiency/Evaluation Report (TMDER). All feedback comments shall be thoroughly investigated and originators will be advised of action resulting there from.

(Use this statement for printed hard copy TMs)
Three copies of the NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report form, NAVSEA 4160/1 are included at the end of each separately bound hardcopy TM.

(Use this statement for a TM on CD-ROM)
The NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report form, NAVSEA 4160/1 is included as the last page of the TM.

(Include this statement for all TMs)
Copies of form NAVSEA 4160/1 may also be downloaded from:

https://nsdsa2.phdnswc.navy.mil/tmmp/forms/TMDER_BLANK_REV_7-2003.doc.

The following methods are available for generation and submission of TMDERs:

- The most expedient and preferred method of TMDER generation and submission is via the Technical Data Management Information System (TDMIS) website at: https://mercury.tdmis.navy.mil. TDMIS accounts can be requested at https://nsdsa2.phdnswc.navy.mil/.
- Generate and submit TMDER via the Naval Systems Data Support Activity (NSDSA) website at: https://nsdsa2.phdnswc.navy.mil/tmder/tmder-generate.asp?lvl=1.
- When internet access is not available, submit TMDER via hardcopy to:

  COMMANDER
  CODE 310 TMDERs
  NAVSURFWARCENDIV NSDSA
  4363 MISSILE WAY, BLDG 1388
  PORT HUENEME, CA 93043-4307

- TMDERs against classified TMs must be submitted using the hardcopy method cited above.
- Urgent priority TM deficiencies shall be reported by Naval message with transmission to Port Hueneme Division, Naval Surface Warfare Center (Code 310), Port Hueneme, CA. Local message handling procedures shall be used. The message shall identify each TM deficiency by TM identification number and title. This method shall be used in those instances where a TM deficiency constitutes an urgent problem, (i.e., involves a condition, which if not corrected, could result in injury to personnel, damage to the equipment or, jeopardy to the safety or success of the mission).

Complete instructions for TMDER generation and submission are detailed on the NSDSA website at: https://nsdsa2.phdnswc.navy.mil/tmder/tmder.asp?lvl=1."

3.10.1.3 Ship and combat system description IP <**ShipAndCombatSystemDescriptionIP**>. This IP shall provide a description of ship missions, capabilities, and physical characteristics. Coverage shall include a level 1 detailed introduction of all ship combat system elements and related armament; such as search radar subsystem, combat direction system, electronic warfare system, gun weapon system, underwater weapon system, missile weapon system, light airborne multi-purpose system (LAMPS), external navigation system, external communication system and support system. The primary ship combat missions of anti-air warfare (AAW), anti-submarine warfare (ASW), and surface and shore bombardment shall be described. An introduction to combat system operation in the manual, semiautomatic, automatic, and casualty modes shall be provided. Major combat system functions of detection and entry, tracking and identification, threat evaluation and threat-to-weapon pairing, and engagement and engagement assessment shall be described. A level 1 detailed introduction block diagram, similar to figure 16, shall be provided. The effective engagement envelop for each weapon system shall be illustrated.

3.10.1.4 Location of combat system components IP <**CSTOMCompLocationIP**>. This IP shall provide a description of the ship combat system compartments and areas. A ship profile drawing, similar to figure 17, shall pictorially identify external combat system elements and area locations. A three-dimensional plan view and room arrangement diagram, similar to figure 18 and 19, shall depict strategically located important combat system compartments and areas. Except for CSTOMs developed for a single ship configuration, these drawings shall be typical and shall represent the lead ship of a class. Figure references shall be provided and areas shall be shaded to identify compartments and areas for which equipment room arrangement diagrams are provided.

3.10.2 Combat system description IM <**CombatSystemDescriptionIM**>. The combat system description IM shall contain a series of IPs for each element. An abridged description of the physical and functional characteristics and, as applicable, a brief description and flow diagrams of operational programs shall be provided for each element. A pictorial of the combat system, similar to figure 20**,** shall be provided. Related text shall describe element functions; functions shall be described to the depth necessary to enable the reader to understand each element's role in the combat system. The physical and functional characteristics of the combat system elements shall be described to level 1 detailed introduction and level 2 functional and operational descriptions. Pictorial art, similar to figures 21 and 22**,** shall be used to depict the physical characteristics and define the functional interface between elements, and between equipment of the element. A separate table for each element shall list major equipment (<**MajorEquipmentTable**>). The tables shall include common name or abbreviation, nomenclature, quantity, and location. A bibliography for each element IP shall list all source documentation. In addition to an introduction IP, the elements described in 3.10.2.2 through 3.10.2.15 shall be included in individual IPs, as applicable.

3.10.2.1 Introduction IP <**IntroductionIP**>. This IP shall introduce the elements that comprise the combat system and provide the user with an overview of the content of the element information.

3.10.2.2 AEGIS combat system IP <**AEGISCombatSysIP**>. This IP shall describe and illustrate the elements of the AEGIS combat system, including, but not limited to, the following:

a. Radar system.
b. Command and decision system.
c. AEGIS display system.
d. Weapon control system.
e. Fire control system.
f. Vertical launch system.
g. Surface-to-air guided missile.
h. Operational readiness test system.
i. AEGIS combat training system.

3.10.2.3 Search radar system IP <**SearchRadarSysIP**>. This IP shall describe and illustrate major components of the sea and air search radar system that is not included in the AEGIS combat system, including the radar recognition, and radar distribution systems. When required for clarity, separate IPs may be developed to cover the radar recognition and/or radar distribution systems.

3.10.2.4 Combat direction system IP <**CombatDirSysIP**>. Where the AEGIS combat system is not installed, this IP shall describe and illustrate all components of the combat direction system. Areas of interface, other than with the ship support system, shall be addressed to the extent necessary for user understanding of the combat direction system role in the ship combat system. Block diagrams, similar to figure 23 shall illustrate the combat direction system and weapon system computer operational module interfaces. When applicable, combat direction system equipment for monitoring system performance and for testing combat system interfaces shall be described. Identification of operating stations for each mode configuration shall be provided.

3.10.2.5 Electronic warfare system IP <**ElectronicWarfareSysIP**>. This IP shall describe and illustrate all components of the electronic warfare subsystem, including electronic support measures, electronic countermeasures, and ancillary equipment.

3.10.2.6 Gun weapon system IP <**GunWeaponSysIP**>. This IP shall be developed for each installed gun weapon system including the Close-in Weapon System (CIWS). This IP shall describe and illustrate all components of the gun weapon system, including gun ordnance and ancillary equipment.

3.10.2.7 Antisubmarine warfare system IP <**AntiSubWarfareSysIP**>. This IP shall describe and illustrate all components of the antisubmarine warfare system, including the underwater surveillance and communication system and the underwater weapon system.

3.10.2.8 Missile weapon system IP <**MissileWeaponSysIP**>. An IP shall be developed for each installed missile weapon system other than AEGIS such as, Harpoon, Tomahawk, and Seasparrow. This IP shall describe and illustrate all components of the missile weapon system, including operational and training ordnance and ancillary equipment.

3.10.2.9 LAMPS system IP <**LAMPSSysIP**>. This IP shall describe and illustrate all components of the LAMPS system, including all airborne LAMPS equipment, ordnance, and shipboard LAMPS equipment.

3.10.2.10 Underwater countermeasures system IP <**UnderwaterCounterMeasSysIP**>. This IP shall describe and illustrate all components of the underwater countermeasures system, including ancillary equipment.

3.10.2.11 External communication system IP <**ExternalCommSysIP**>. This IP shall describe and illustrate all external communications systems and related components. Coverage shall support radio frequency (RF) links from extremely low frequency (ELF) to extremely high frequency (EHF), including, but not limited to, voice, video, data networking, and control and management information.

3.10.2.12 Internal communication system IP <**InternalCommSysIP**>. This IP shall describe and illustrate all interior communications systems, including audio and data communication systems, alarm systems, indicating and control systems, and ancillary equipment.

3.10.2.13 Navigation system IP <**NavigationSysIP**>. This IP shall describe and illustrate all components of the navigation system. Coverage shall be provided for, but not limited to, satellite navigation, Radio Direction Finder (RDF), Tactical Air Navigation (TACAN), and ancillary equipment.

3.10.2.14 Combat system support system IP <**CombatSupportSysIP**>. This IP shall describe and illustrate the support equipment associated with the combat system. Simplified block diagrams, similar to figures 24 and 25**,** shall depict interfaces between the ship support systems and the combat system. As a minimum, coverage for the following support systems shall be provided. For usability and clarity, individual IPs may be developed for each system.

a. Air and nitrogen pressurization systems.

b. Liquid cooling and heating systems.

c. Air conditioning.

d. Bridge ship-control system.

e. Ship parameters.

f. Power distribution.

g. Test equipment repair and calibration facility, when applicable.

3.10.2.15 Additional systems IPs <**AdditionalSysIP**>. IPs shall be developed for any additional combat system not covered in the paragraphs above.

3.10.3 Combat system operational description IM <**CSTOMOperationIM**>. This IM shall contain a series of IPs for the description of major combat system functions used in all modes of combat system operations. Include combat system functions of detection and entry, tracking and identification, threat evaluation and threat-to-weapon pairing, and engagement and engagement assessment. These major functions of the combat system shall be defined and summarized in an IP and each function shall be described in detail in subsequent IPs. Level 1 combat system configurations, including normal, alternate, and backup features available through combat system switching, that relate to the major combat system functions shall be described. A level 2 functional flow pictorial, similar to figure 26, shall illustrate each described combat system function or principal sub-function. A bibliography for each function IP shall list all source documentation. In addition to an introduction IP, the functions described in 3.10.3.2 through 3.10.3.6 shall be included in individual IPs, as applicable.

3.10.3.1 Introduction IP <**IntroductionIP**>. This IP shall introduce and define combat system functions, and element functions pertinent to the modes of combat system operation, and explain data transmission between elements. The general description shall prepare the reader for more detailed functional descriptions in subsequent IPs.

3.10.3.2 Detection and entry IP <**DetectionEntryFuncDescIP**>. This IP shall describe the initial track, detection and entry functions, and functional flow between elements performed for all radar, sonar, visual, or remote contacts to include air, surface, or subsurface threats entered manually or automatically into the combat system.

3.10.3.3 Tracking and identification IP <**TrackingAndIdentFuncDescIP**>. This IP shall describe combat direction system tracking and identification functions and functional flow between elements occurring for any track entered into the combat system, either locally by own-ship sensors or remotely by any participating unit within the operational areas of the fleet.

3.10.3.4 Threat evaluation and threat-to-weapon pairing IP <**ThreatEvalFuncDescIP**>. This IP shall describe threat evaluation and threat-to-weapon pairing function, including weapon assignment. Data flow between elements to accomplish threat evaluation and weapon pairing for tracks considered hostile to own-ship and to fleet security shall be described.

3.10.3.5 Engagement and engagement assessment IP <**EngagementFuncDescIP**>. This IP shall describe target engagement and engagement assessment functions for functional flow between elements occurring for targets assigned to the electronics warfare system, gun weapon system, underwater weapon system, missile weapon system, interceptor aircraft, or LAMPS.

3.10.3.6 Additional functions IP <**AdditionalFuncDescIP**>. IPs shall be developed for any additional functions not covered in the paragraphs above.

3.10.4 Combat system readiness assessment IM <**CSTOMSystemReadinessIM**>. This IM shall provide guidance to the Ship Electronic Readiness Team (SERT) for evaluating and improving combat system material and operational readiness in a series of IPs. Combat system readiness assessment information shall include data for readiness assessment, fault detection and impact evaluation, and fault isolation. The guidance shall primarily address organizational level maintenance within the capability of ship senior maintenance personnel. In addition to an introduction IP, the readiness assessment, fault detection and impact evaluation, and fault isolation data described in 3.10.4.2 through 3.10.4.7 shall be included in individual IPs, as applicable. A bibliography shall be included in each IP listing all source documentation.

3.10.4.1 Introduction IP <**IntroductionIP**>. This IP shall contain an overview of the combat system readiness assessment, fault detection, fault isolation, and impact evaluation tools. A drawing similar to figure 27 shall be used to introduce and explain the relationship between readiness assessment, fault detection and impact evaluation, and fault isolation. The following introductory information shall be included.

a. Fault detection and impact evaluation overview. The use of impact evaluation tables and operational fault directories provided for fault detection to readiness assessment shall be explained. The relationship of fault detection to readiness assessment shall be stressed. Primary topics shall cover the fault detection role in readiness assessment.

b. Fault isolation overview. A description of a typical fault isolation pictorial and its associated table of interface references shall be provided. The table of interface references, similar to figure 28, shall be described. The use of a typical fault isolation pictorial, similar to figure 29, for diagnosing combat system faults shall be explained in detail.

3.10.4.2 Readiness assessment information IP <**ReadinessAssessIP**>. This IP shall provide the principles and objectives of combat system readiness assessment using the SERT concept. The data shall define the means for determining system readiness within ship organizational constraints. Details of the Planned Maintenance System (PMS), with reference to the PMS record, shall be discussed. The description shall cover the scope and organization of readiness assessment, and identify major factors and processes contributing to combat system readiness. A drawing similar to figure 30 shall illustrate the dependency of readiness assessment on fault detection, fault isolation, and impact evaluation.

3.10.4.3 SERT information IP <**SERTIP**>. This IP shall explain SERT organization and responsibilities. Emphasis shall be given to SERT activities such as test, training, material, and personnel management; preventive and corrective maintenance management; and status reporting. Techniques to generate optimum test schedules based on personnel and material assets and the ship's operating schedule shall be presented. Recommended forms, similar to figures 31 and 32**,** for preparing mission summary reports and combat system daily fault reports shall be provided and described.

3.10.4.4 PMS IP <**PMSIP**>. This IP shall describe the principles and elements of integrated testing, and explain the concepts and documentation available for testing. The major objectives of fault isolation shall be defined, and the various types of fault isolation tools that personnel may select for fault isolation shall be described. Each type of fault isolation tool, that is, directories, computer programs, fault logic diagrams, and so forth, shall be sufficiently described to facilitate its understanding and use. A figure, similar to figure 33**,** shall depict the Planned Maintenance System. The integration of combat system, element, and equipment documentation for establishing maintenance requirements, test scheduling, fault isolation, and corrective action verification shall be depicted by a drawing similar to figure 34.

3.10.4.5 Training and maintenance support elements IP <**TrainingMaintenanceSupportIP**>. This IP shall identify and describe the training and maintenance support elements available to, or resident in, the applicable ship class, and shall evaluate their functions as tools to increase combat system personnel and equipment readiness. Tables similar to figures 35 and 36 shall be developed to:

a. Identify the elements of the combat system challenged by each of the exercises in Fleet Exercise Publications, FXP2 and FXP3.

b. Identify on a system or equipment level all exercises that challenge the element and identify the major combat system functions, such as detection, entry, identification, and tracking that are challenged by each exercise.

c. Identify the training operational programs and procedures resident on the ship; determine the element challenged by each one, and provide a brief description.

3.10.4.6 Ship test equipment repair facility (STERF) IP <**STERFIP**>. When the ship configuration includes a STERF (phase A-1, A-2, and C-1, C-2), an IP shall include a list of test equipment calibration requirements that show parameters to be calibrated, calibration periodicity, and references to calibration procedures. When the ship configuration does not include a STERF, documentation shall be specified that prescribes calibration requirements and outlines procedures for obtaining off-ship calibration services.

3.10.4.7 Readiness assessment diagrams (RAD) and synoptic test description IP <**ReadinessAssessSynopticTestDescIP**>. This IP shall identify the top-level combat system, element, and equipment level tests required to determine combat system readiness for AAW, ASW, surface warfare (SUW), and shore missions. A table of tests, with fault isolation pictorial and fault impact evaluation references, similar to figure 37 (<**TestFaultImpactTable**>), and a RAD, similar to figure 38**,** shall be provided for each combat mission (AAW, ASW, SUW, and shore bombardment). The table and its associated RAD shall be provided for each major combat system function, including detection and entry, tracking and identification, threat evaluation and threat-to-weapon pairing, and engagement and engagement assessment. The RAD shall identify required functional interfaces applicable to the specific mission and major combat system function, and shall provide a reference to the table that lists the highest-level test (combat system level, element level, or equipment level) that verifies each function identified. Detailed, comprehensive, user instructions that explain the use of the RAD and its associated table shall be provided. A synoptic description of each combat system, element, and equipment test included on all the tables shall be provided. The test descriptions shall state test objectives, restrictions, and specify significant parameters that evaluate readiness.

3.10.5 Fault detection and impact evaluation IM <**FaultDetectionIM**>. This IM shall contain a series of IPs that describe methods of detecting material and personnel faults encountered during testing and operation and shall provide guidance to the SERT in evaluating the impact of detected faults on combat system readiness. The purpose of the IPs is to support the SERT in carrying out their corrective maintenance management responsibilities of coordinating fault isolation efforts and discerning impact evaluation.

3.10.5.1 Operational fault directories IP <**OperationFaultDirectoriesIP**>. This IP shall include operational fault directories for faults observed during combat system operation. Operational fault directories shall identify hardware and software fault isolation tools employed with each element to isolate operationally related fault symptoms. Operational fault directories for each mission and major combat system functions shall be provided (see figure 39 for a typical presentation format). Faults occurring as a result of loss or degradation of inter-system functions and parameters shall be provided. A narrative shall explain the role of operational fault directories in the combat system maintenance concept.

3.10.5.2 Impact evaluation IP <**ImpactEvaluationIP**>. This IP shall provide SERT with the criteria required to determine the impact of specific faults on combat system capabilities. A table, similar to figure 40, shall list equipment functions and the impact the loss of these functions shall have on specific combat system missions. Primary topics of combat system degradation, trade-off considerations, restoration time, fault isolation constraints, and alternative combat system configurations shall be related.

3.10.6 Fault isolation IM <**FaultIsolationIM**>. This IM shall contain a series of IPs that identify and discuss available combat system and element level fault isolation tools and the techniques employed to verify and correct inter-subsystem faults. Additional IPs shall provide fault isolation procedures and diagrams for specific interfaces. Depending on the number of interfaces involved, an IP may address the interfaces between a pair of elements, or the interfaces of one element with all other elements. Where intra-element interface fault isolation is inadequate, an IP shall be developed to cover that element.

3.10.6.1 Introduction IP <**IntroductionIP**>. This IP shall introduce and summarize the following two IPs and provide a listing of the fault isolation diagrams.

3.10.6.2 Fault isolation techniques IP <**FaultIsolationTechniqueIP**>. This IP shall provide the identification and description of fault isolation tools and procedures, and their effective use. This shall include, but not be limited to, installed operational monitoring equipment, built-in test equipment, performance monitoring software, and PMS testing. The techniques used with each combat system element shall be described in detail. Descriptions shall encompass such factors as when and under what circumstances a particular fault isolation tool should be used, and the degree of reduced capabilities incurred as a result of using a particular fault isolation tool.

3.10.6.3 Introduction to combat system functional interface diagrams IP (CSFIDs) <**CombatSysFuncInterfaceIP**>. This IP shall introduce and describe the content and intended use of the Combat System Functional Interface Diagrams (CSFIDs) presented in the remaining IPs. This IP shall include and describe the use of the interface function directory and the CSFID symbology table.

3.10.6.3.1 Functional data flow. In CFIDs, functional data flow will normally be depicted from left to right and top to bottom. However, where this logic is not practical, the direction of functional flow will be represented by arrows.

3.10.6.3.2 Intersystem tabulation. Intersystem tabulation will be provided to identify cable, connector, terminal, and wire information for analog interfaces. Data fields will be tabulated for intersystem digital interfaces and accessible termination or test points for terminal pin connectors within equipments will be provided.

3.10.6.4 Support system fault isolation IP <**SystemFaultIsolationIP**>. When Combat System Operational Sequencing System (CSOSS) documentation is deemed to be inadequate for any support system, an IP shall be developed to address fault isolation techniques for the various systems that comprise the support system. The IP shall include only those support systems for which CSOSS is deficient. Descriptions shall be to level 2 or to level 3 (refer to 3.10.1.1), as applicable, and involve only basic methods of fault isolation. Fault isolation material to support this IP shall include system schematics similar to figures 41 and 42; tables of fault symptoms and probable causes, similar to figure 43; and a table of audiovisual alarms similar to figure 44**.** References to the applicability of support systems to individual elements of the combat system shall be provided. The table of audiovisual alarms, in addition to specifying alarm and alarm sensor locations, shall prescribe action to be taken when the alarms are activated. The action, in most cases, will involve preliminary checks to verify and assess the abnormal condition, and a reference to a system publication (provided in the bibliography) for detailed fault isolation procedures. The primary topics shall support, as applicable, fault isolation of the following support system elements:

a. Central dry air.
b. High-pressure air.
c. High-pressure nitrogen.
d. Electronic salt-water liquid coolant.
e. Chilled water liquid coolant.
f. Air-conditioning.
g. Steam heating.
h. Salt-water fire main.
i. Anti-icing.
j. Power distribution.
k. Ship parameters.

3.10.6.5 Fault isolation IP <**FaultIsolationIP**>. Ideally, an IP shall be developed for each pair of interfacing combat system elements. Alternately, an IP may be developed to cover the interfaces involving a central element. In addition, an IP may be developed to cover the intra-system interfaces for a combat system element where adequate system-level documentation does not exist. When descriptions are required to support the fault isolation combat system elements, the descriptions shall be developed to level 2 or to level 3, as applicable, and involve only basic methods of fault isolation. The introduction to the IP shall list the fault isolation diagrams contained in the IP.

4. VERIFICATION

4.1 Verification. The verification requirements shall be in accordance with MIL-DTL-24784.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. The TMs prepared to this specification are intended to be used for installation, operation, maintenance, repair, and parts support of CSTOMs, HM&E systems and equipment, electronic, service test electronic, experimental electronic and interior communications systems and equipment, and weapon systems and equipment. The TMs should be used as a training document in the classroom and as a source of on-the-job training.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification (or any TMCR referencing this specification).

b. Issues of documents to be cited in the solicitation (see 2.2.1, 2.2.2, 2.3).

c. Type and quantity of the manual required (see 3.1 and 3.2).

d. Specify the maintenance coverage in accordance with the technical content requirements provided herein (see 3.5).

e. Specify warranty and guarantee information (see 3.7.1.1f).

f. Specify if an IP shall provide procedures and instructions for performing maintenance that is beyond the capabilities of the ships force (see 3.8.2.5).

g. Specify if drawings and information concerning system/equipment installation shall be provided (see 3.8.3).

h. Specify if an Illustrated Parts Breakdown (IPB) shall be developed (see 3.9).

i. Specify packaging (see 5.1).

6.3 Supersession data. This specification sheet supersedes MIL-DTL-24784/3B, /12B, /14B, /17B, /18B, /19B, /20B, and /21B dated 15 February 2002.

6.4 Definitions. The words or phrases used throughout this specification are defined in MIL-DTL-24784.

6.5 Acronyms. The acronyms used in this specification sheet are defined in MIL-DTL-24784.

6.6 Subject term (key word) listing.

Descriptive Information

Equipment

Illustrated Parts Breakdown

Installation

Maintenance

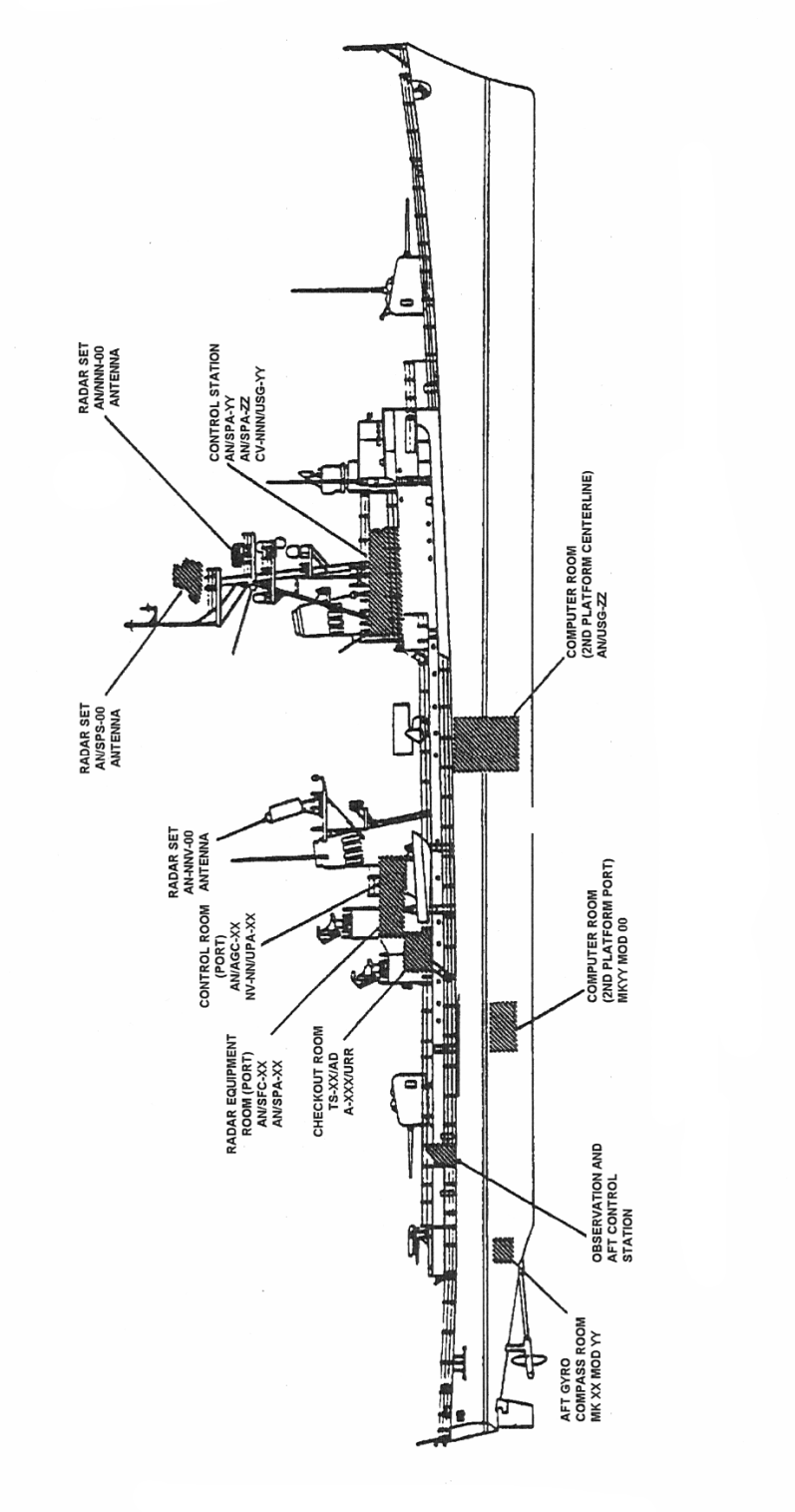
Operation

Operational Checkout

Procedural Information

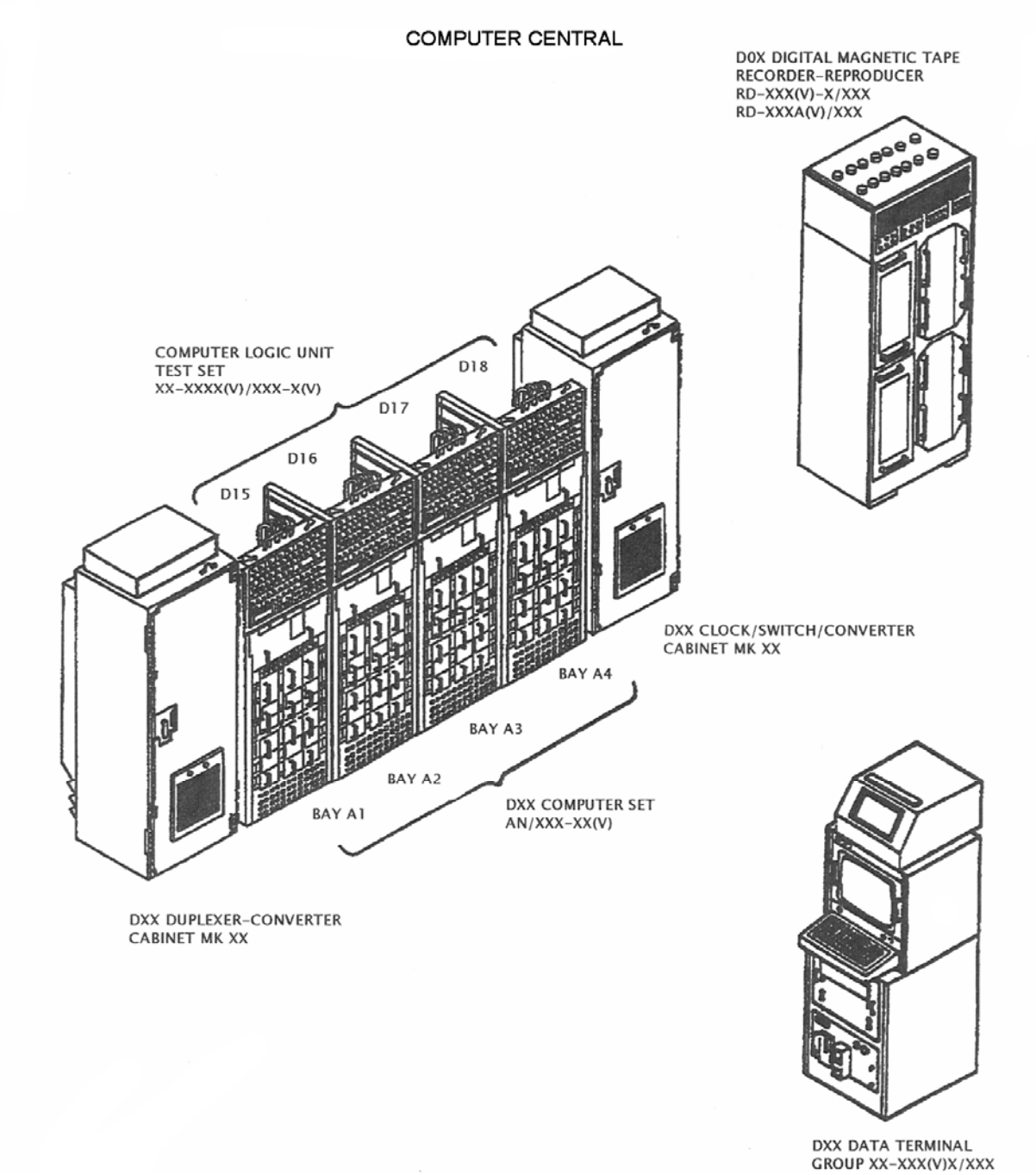
System

Troubleshooting



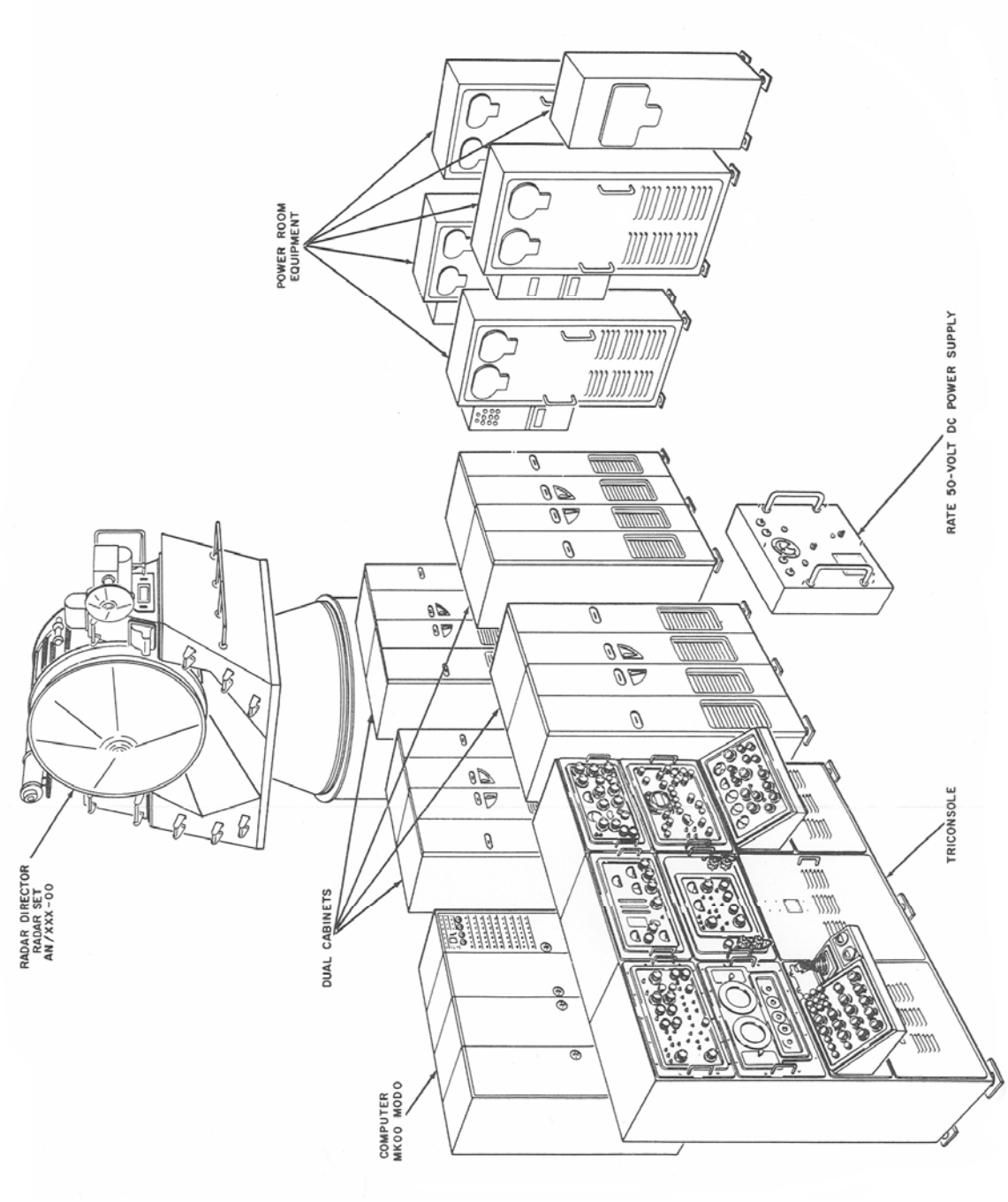
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 1. System compartments.



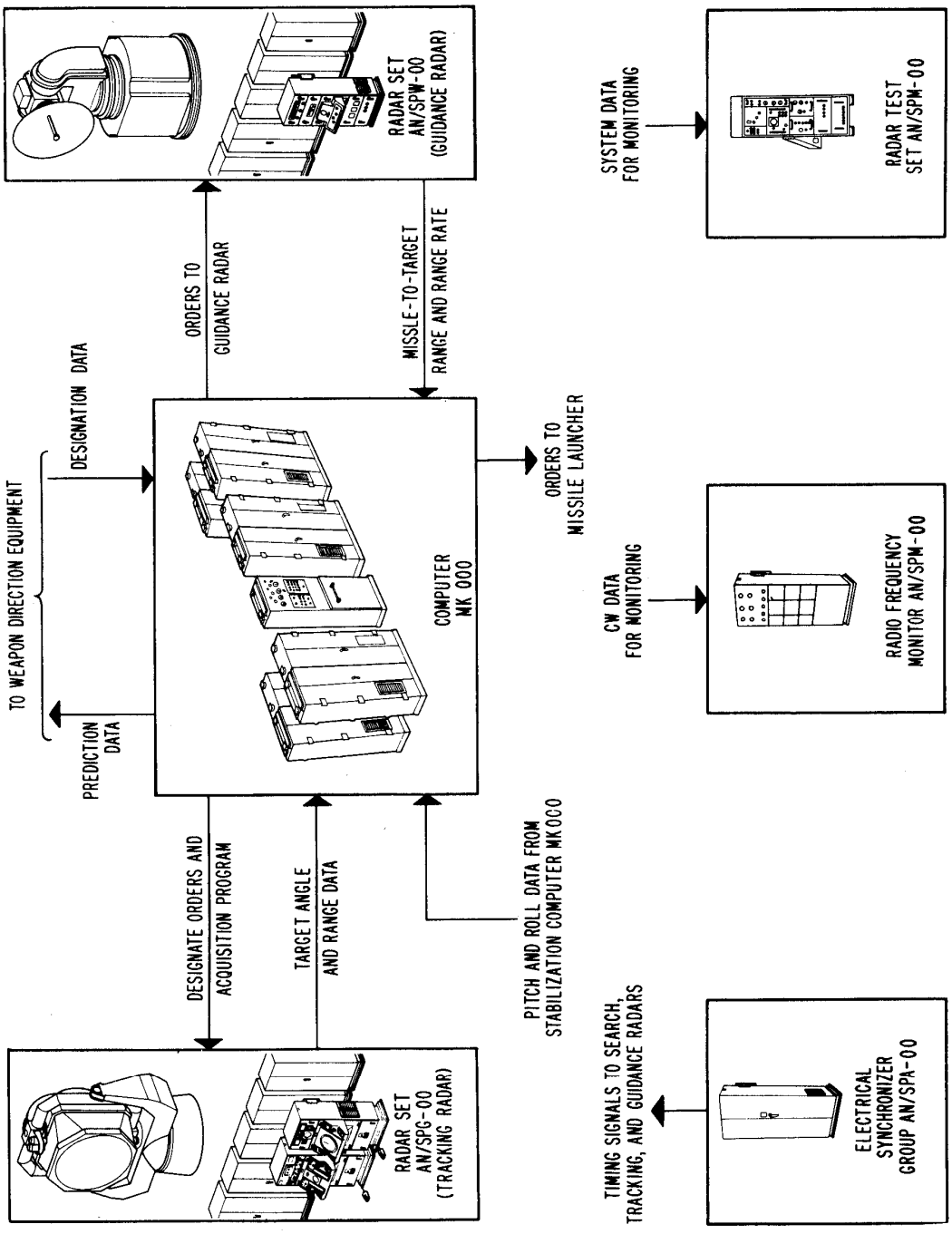
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 2. Compartment areas.



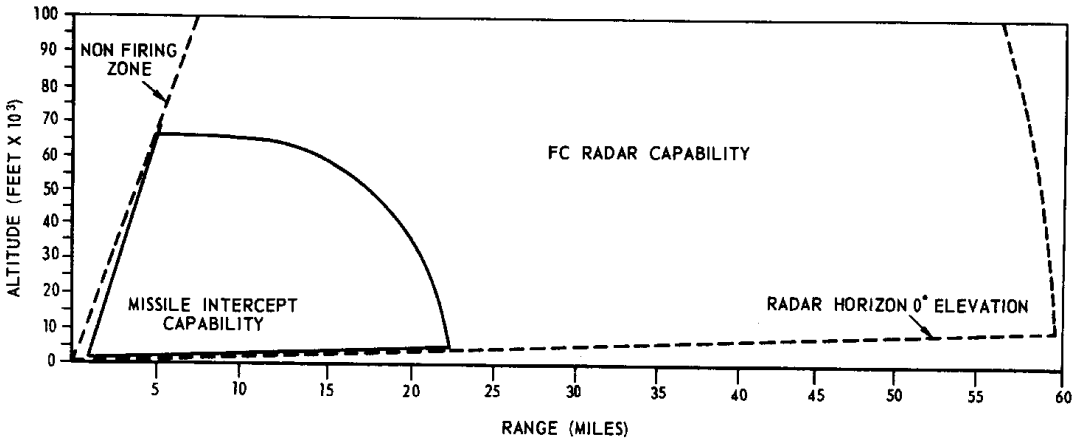
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 3. Weapon system/subsystem/equipment group (typical).

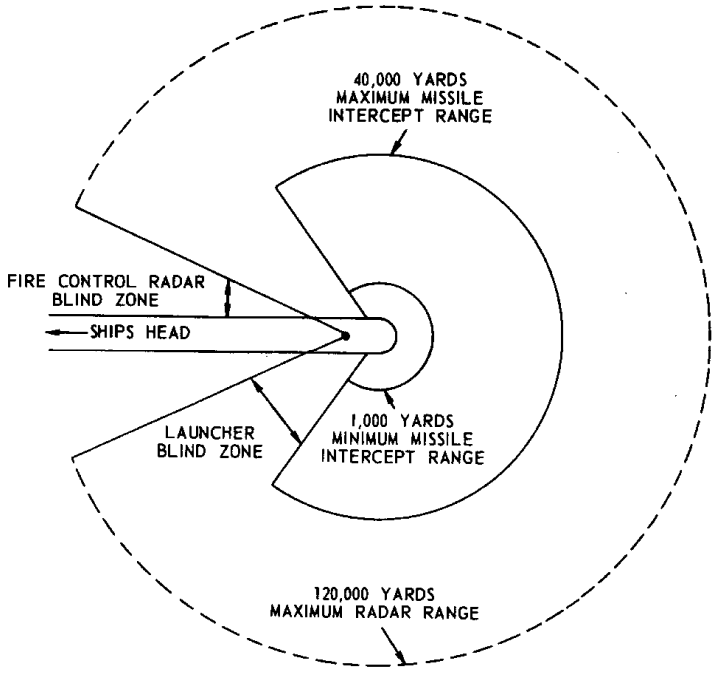


Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 4. Equipment/system integration illustration.



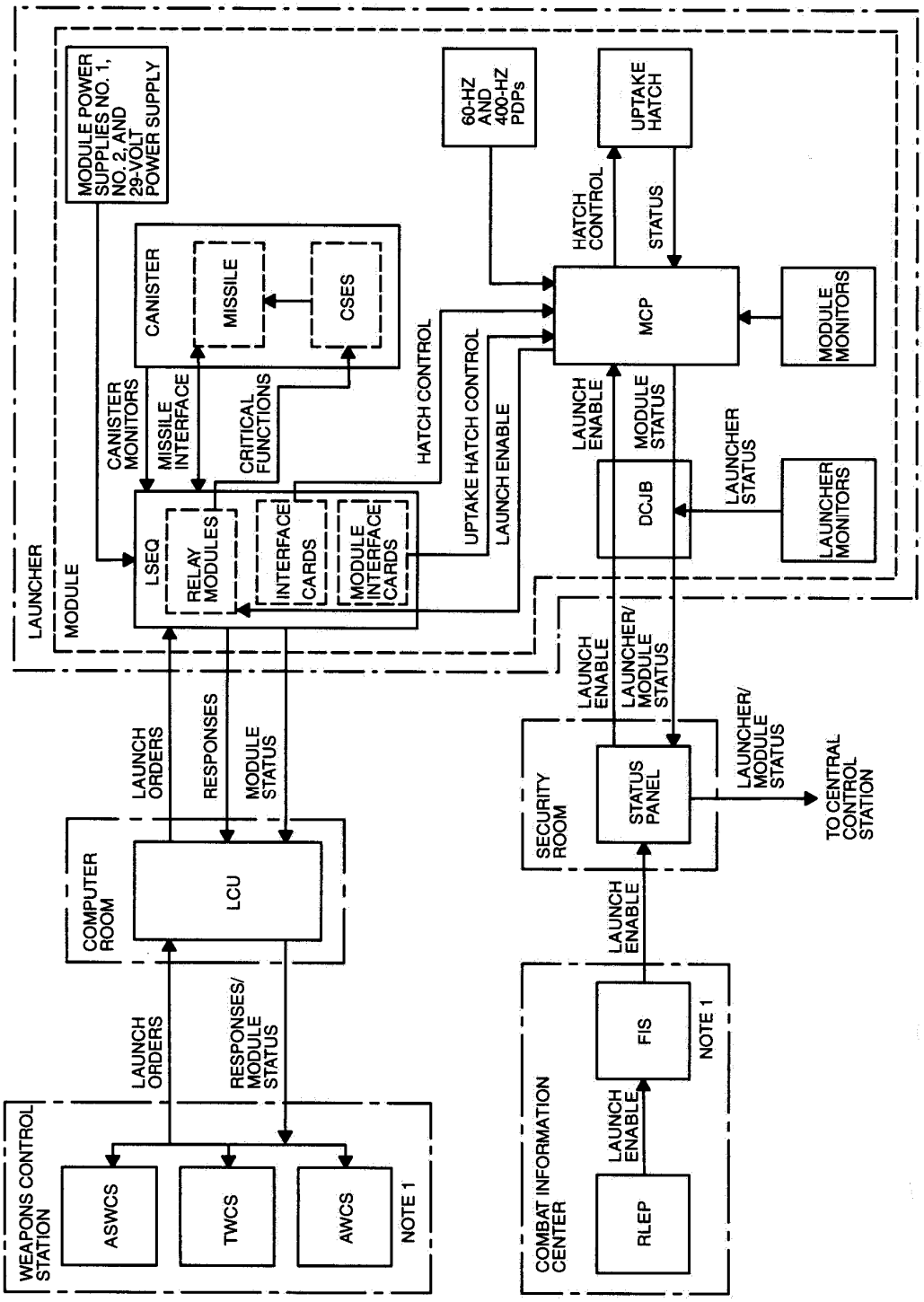
A. MISSILE AND FC RADAR CAPABILITIES



B. MINIMUM AND MAXIMUM MISSILE INTERCEPT RANGES AND MAXIMUM FC RADAR RANGE

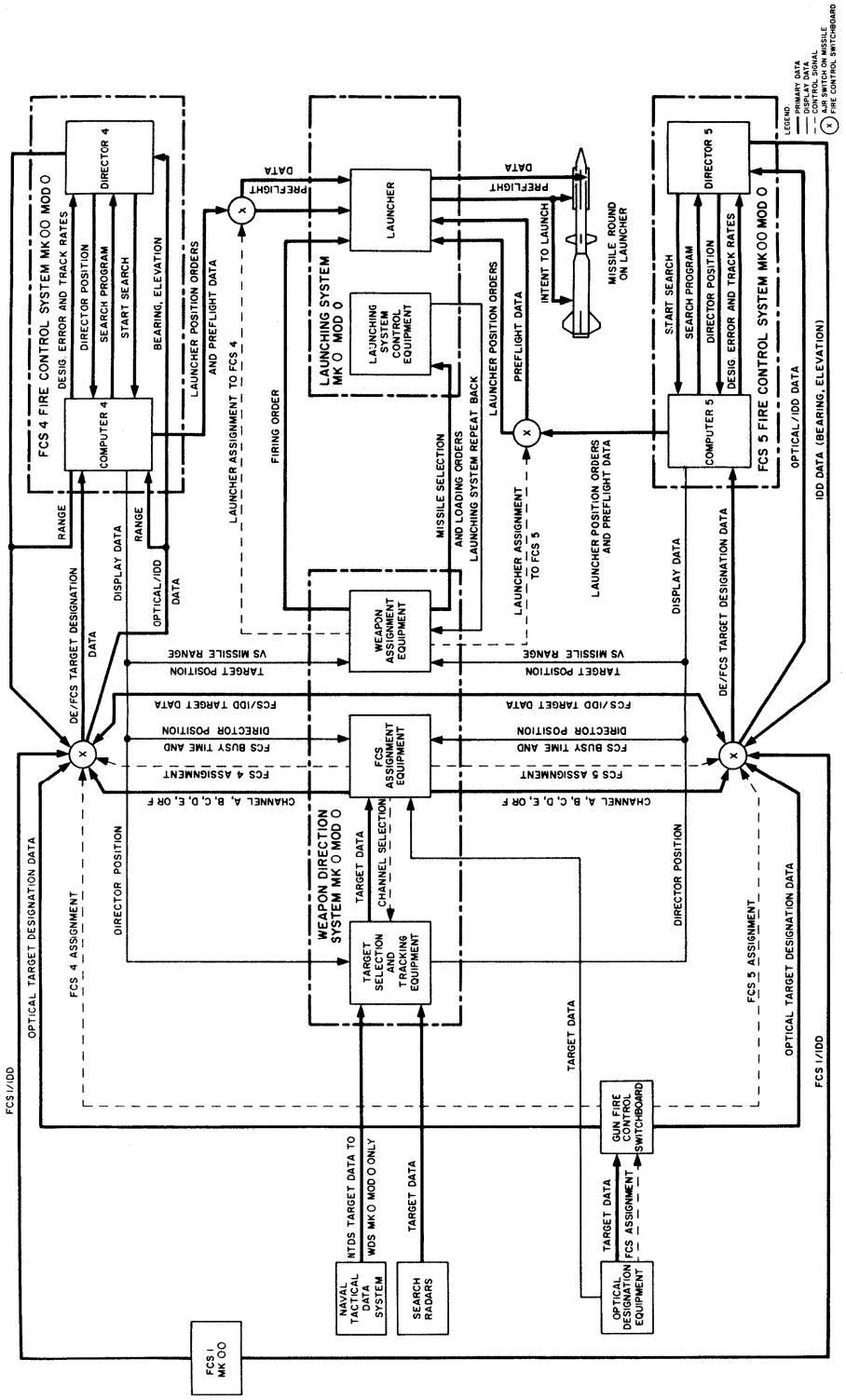
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 5. System capability envelope drawing.



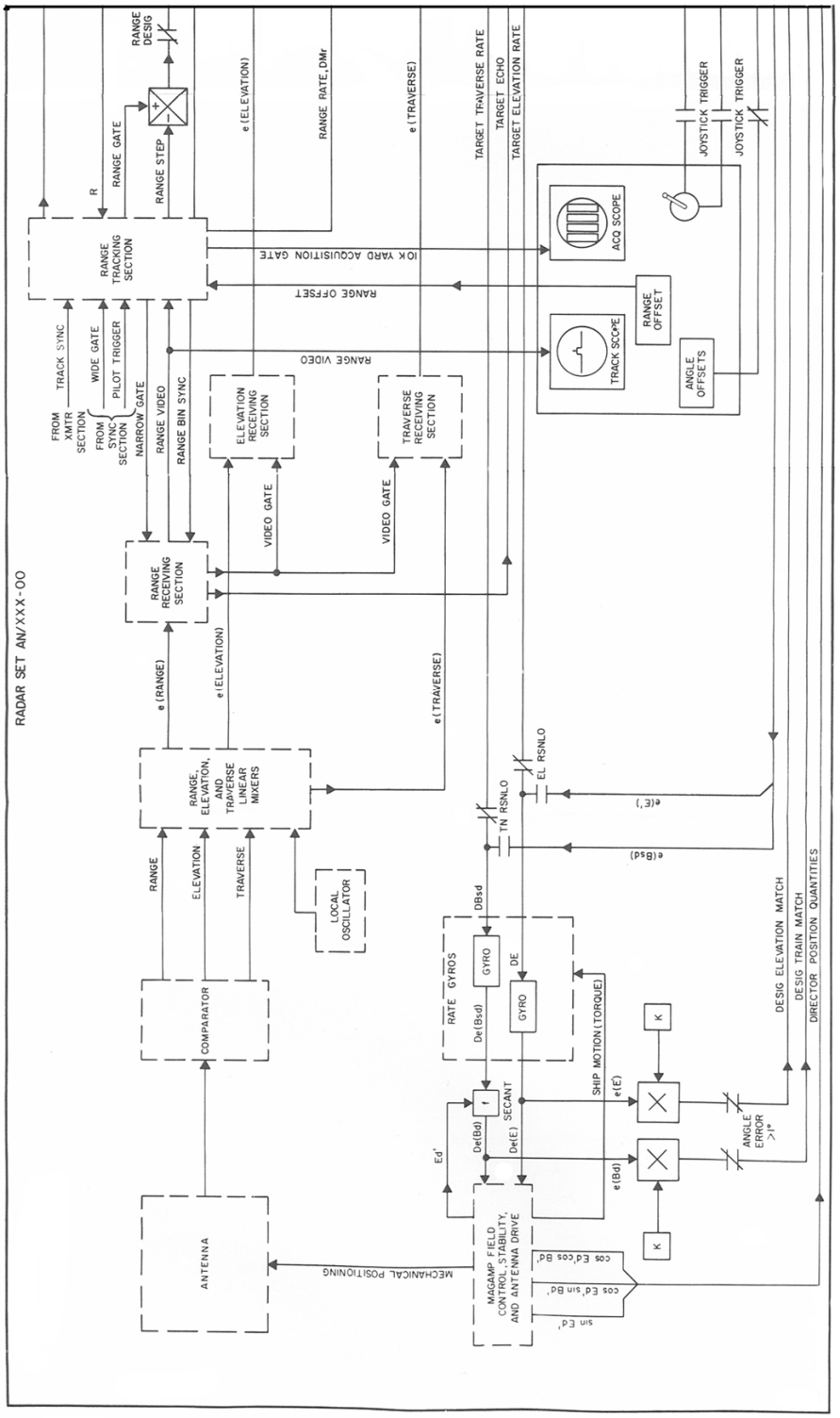
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 6. System block diagram.



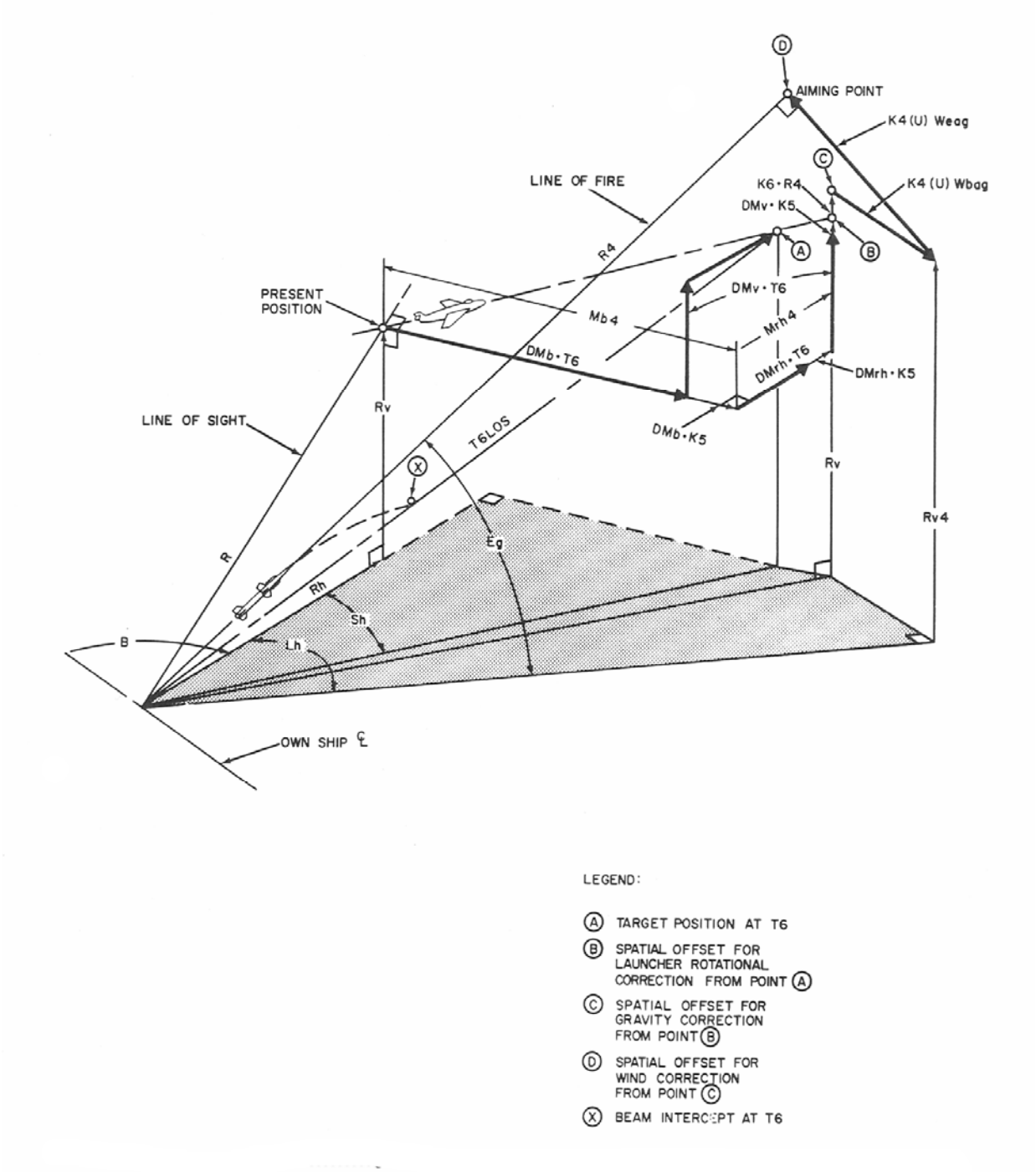
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 7. Functional block diagram, interface.



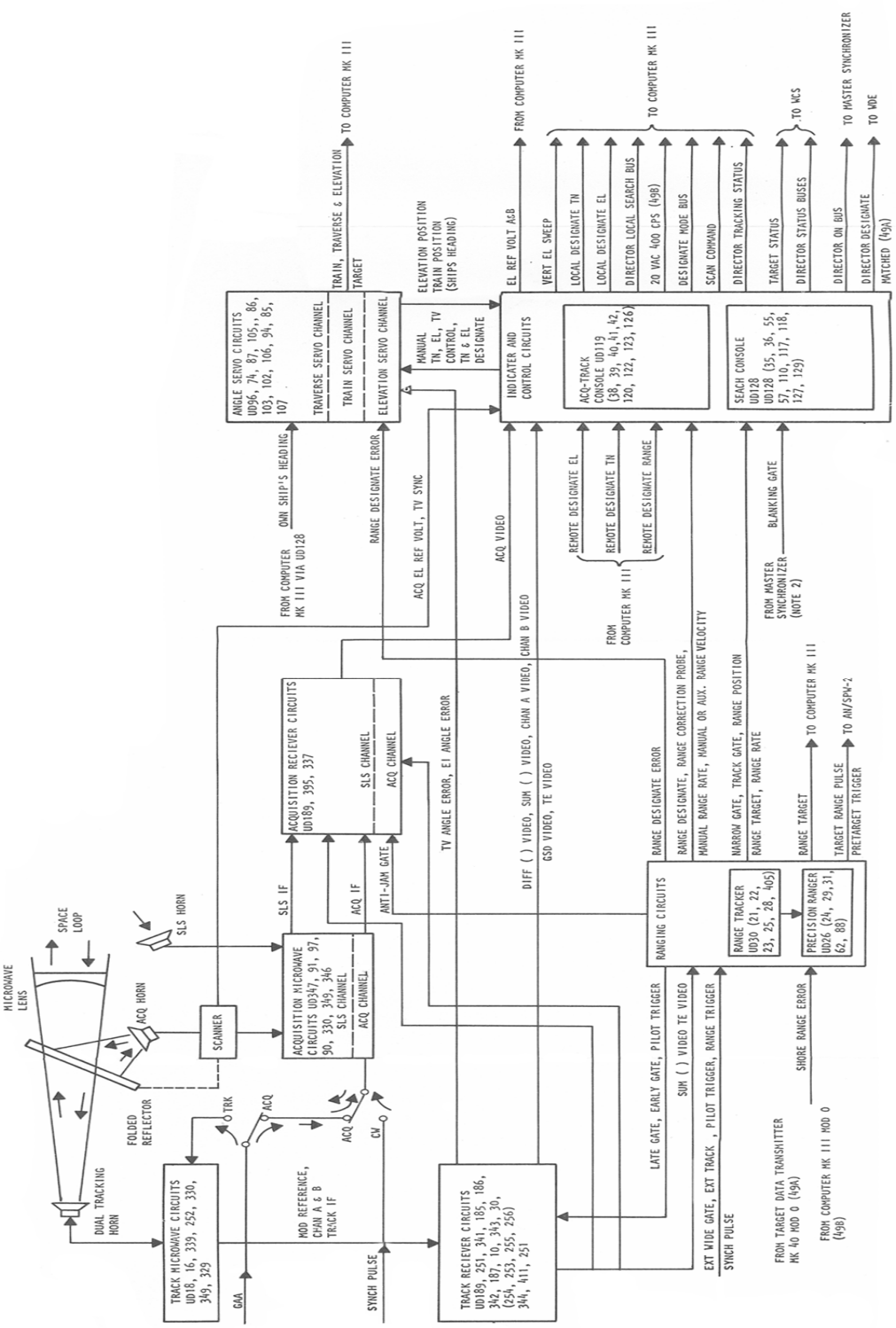
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 8. Functional diagram, simplified.



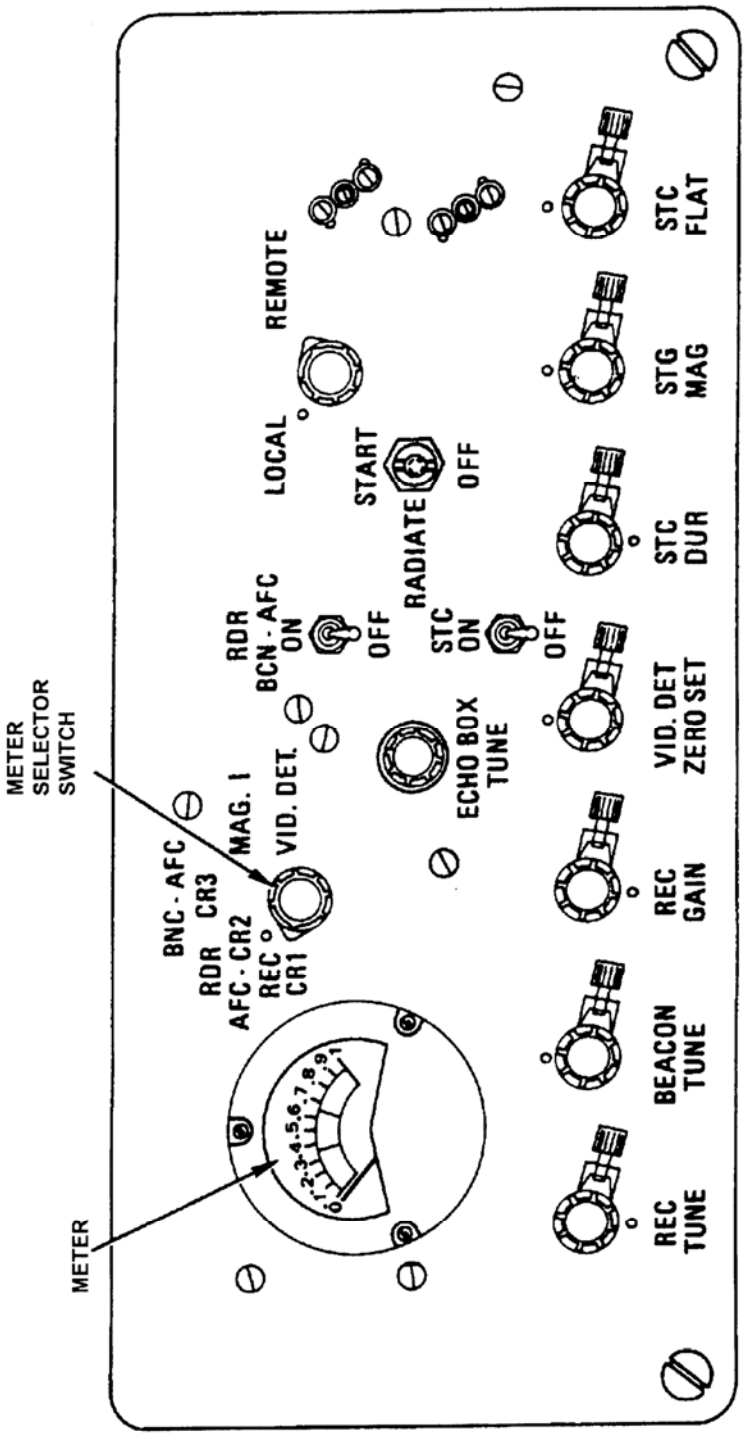
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 9. Simplified geometric diagram.



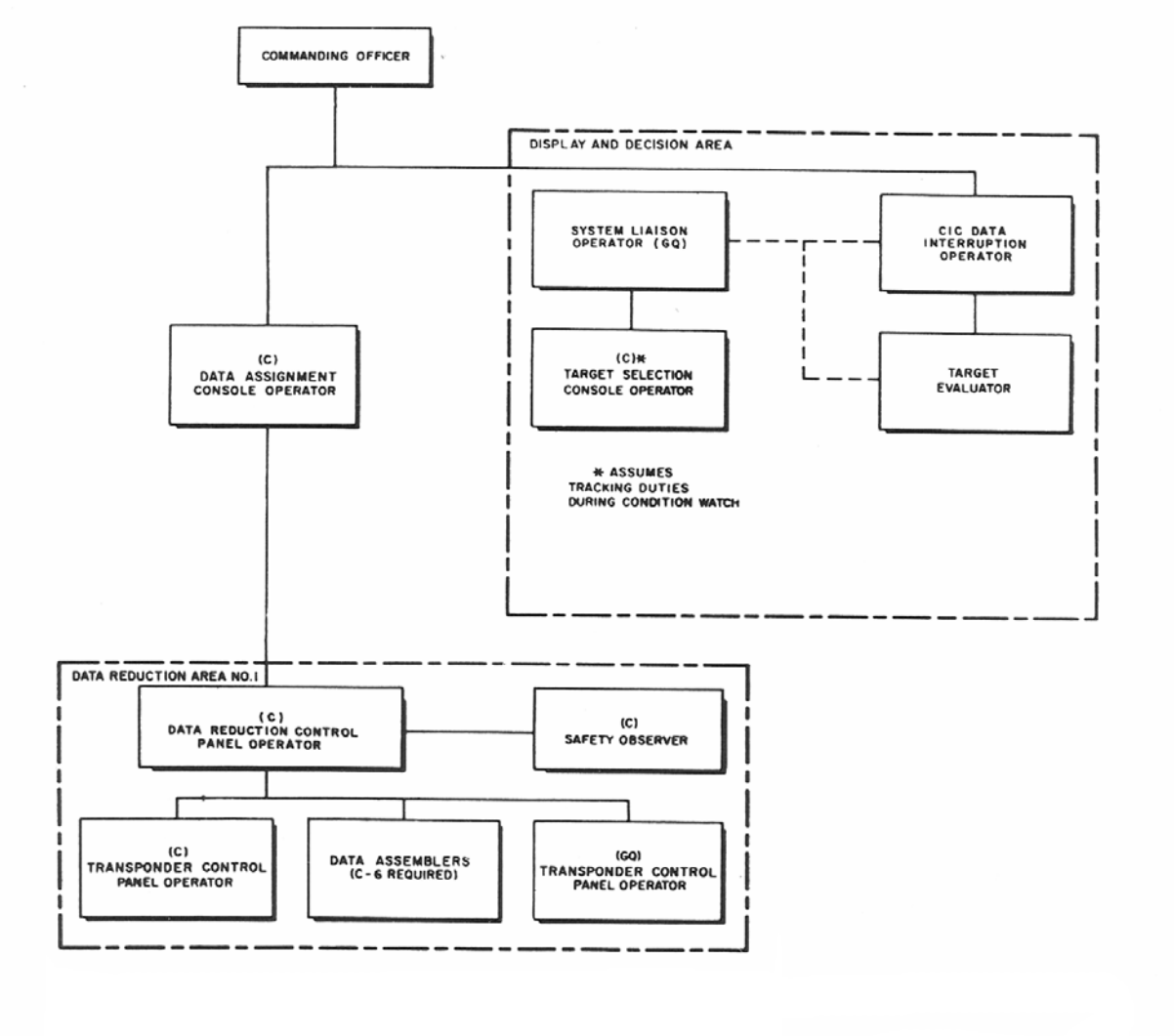
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 10. Equipment/system relationship block diagram.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 11. Equipment controls and indicators.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 12. Simplified geometric diagram.

CLASSIFICATION
NAVORD OP 0000 (PMS/SMS) VOLUME 0 PART 0

TABLE 0-0. RADAR SET AN/XXX-00, TABLE OF ESTABLISHED VALUES

Parameter	Value		Establishing Procedure
	PC IN	PC OUT	
Absolute Range Calibration			MRC R-12
Precision Range Gear Train Range Dial Slippage	_____	_____	
Range of 2nd Range Calibrator Return	_____	_____	
Range of 6th Range Calibrator Return	_____	_____	
Range of 11th Range Calibrator Return	_____	_____	
Range of 16th Range Calibrator Return	_____	_____	
Range of Maximum Range	_____	_____	
Range Calibrator Return	_____	_____	
ACQ-SLS Test Fixture Attenuator Setting AT(20)11:			
SLS switch at BLANK	_____	_____	
SLS switch at CANCEL	_____	_____	
Acquisition Receiver Sensitivity (Pulse Compression Out)	_____	_____	MRC R-19
Angle Servo Input (Elevation):			1. Perform MRC R-5 through R-11.
Second Range Calibrator Return:			2. Perform test of figure 5-62, sheet 5, box 19 and record values.
3 Mils Up	_____	_____	
1 Mil Up	_____	_____	
1 Mil Down	_____	_____	
3 Mils Down	_____	_____	
4:1 Signal-to-Noise Range Calibrator Return:			
3 Mils Up	_____	_____	
1 Mil Up	_____	_____	
1 Mil Down	_____	_____	
3 Mils Down	_____	_____	
2:1 Signal-to-Noise Range Calibrator Return:			
3 Mils Up	_____	_____	
1 Mil Up	_____	_____	
1 Mil Down	_____	_____	
3 Mils Down	_____	_____	

UNCLASSIFIED WHEN VALUE COLUMN BLANK
CLASSIFICATION

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 13. Table of established values.

Table 4-1. Adjustment Effectivity List

MR Number	Adjustment/Alignment Procedures	Output
R-1	1. Adjust VERT. POS. RANGE	Preamplifier output dc reference range.
	2. Adjust 2ND STAGE PLATE BAL. and VAR. ATTEN. BAL.	Preamplifier output dc reference stability.
R-2	1. Adjust GAIN ADJ.	Preamplifier gain calibration.
	2. Adjust attenuator section balance.	Attenuator dc differential balance.
	3. Adjust HF differential balance capacitor.	Preamplifier high frequency differential balance.
R-3	1. Adjust output compensation.	Preamplifier high frequency response.
	2. Adjust input capacitors.	Square-cornered, flat-topped square wave display.
	3. Adjust attenuator capacitors.	Square-cornered, flat-topped square wave display.

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 14. Adjustment effectivity list.

RADIO RECEIVER R-XXX/URR

NAVSEA

INSTALLATION STANDARDS SUMMARY

Input Voltage _____Vac
Input Frequency _____Hz
(When reference standard tests are made)

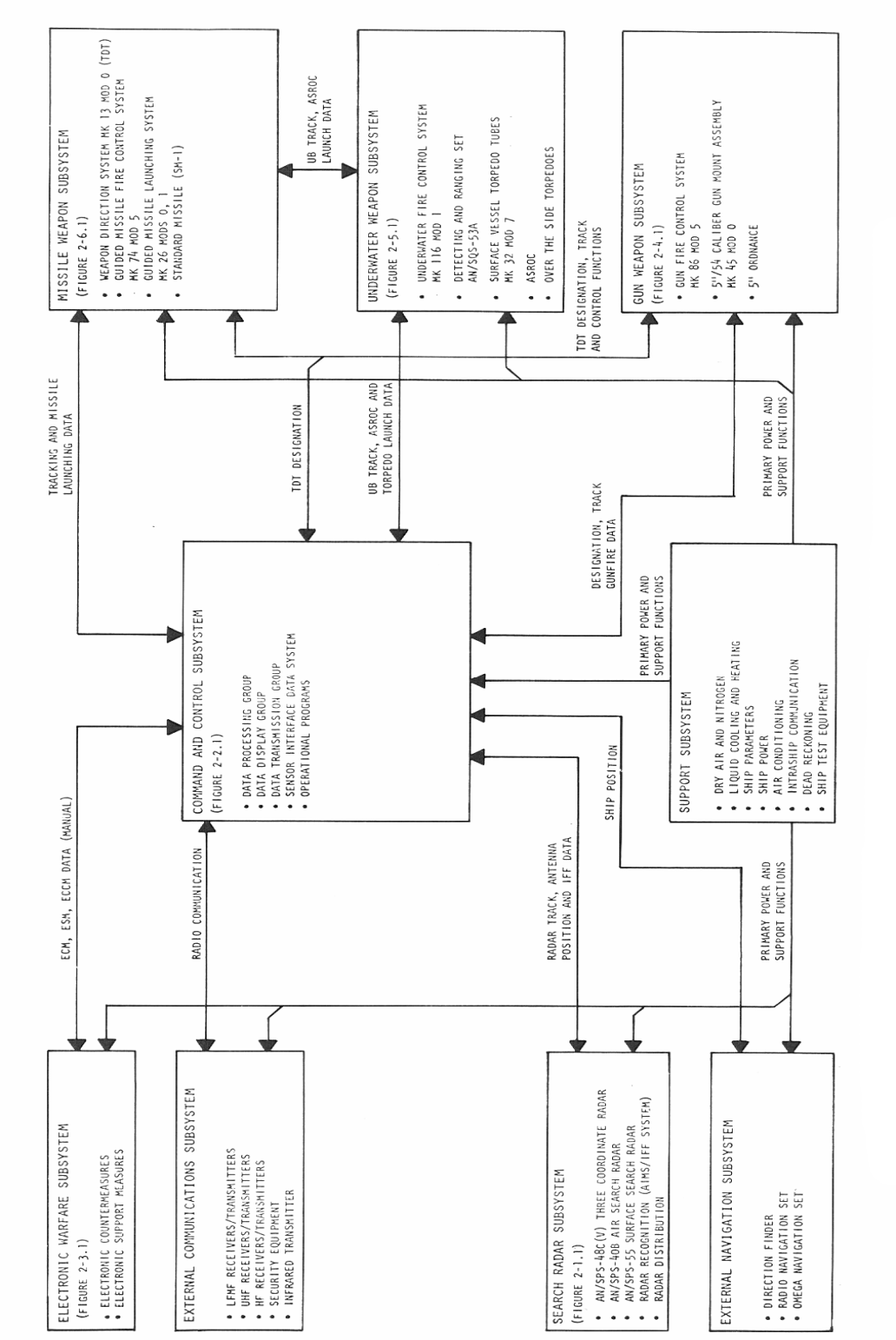
Date _____
Serial Number _____
of Model _____
Installed in (ship or station)
_____
Length of transmission line
_____

Record on this summary sheet the test indications which have been obtained during the installation verification test.

Paragraph No.	Observed Value	Reference Standard
8-10	a._____ Check	
8-21	a._____ VDC	a. 1.0 to 1.2 VDC
	b._____ VDC	b. 2.35 to 2.36 VDC
	c._____ VDC	c. 24.0 to 24.5 VDC
	d._____ VDC	d. 12.6 to 12.8 VDC
8-33	a._____ VDC	a. 2.5 to 2.7 VDC
	b._____ VDC	b. 11.3 to 11.7 VDC
	c._____ VDC	c. 3.0 to 3.6 VDC
	d._____ VDC	d. 6.6 to 7.0 VDC

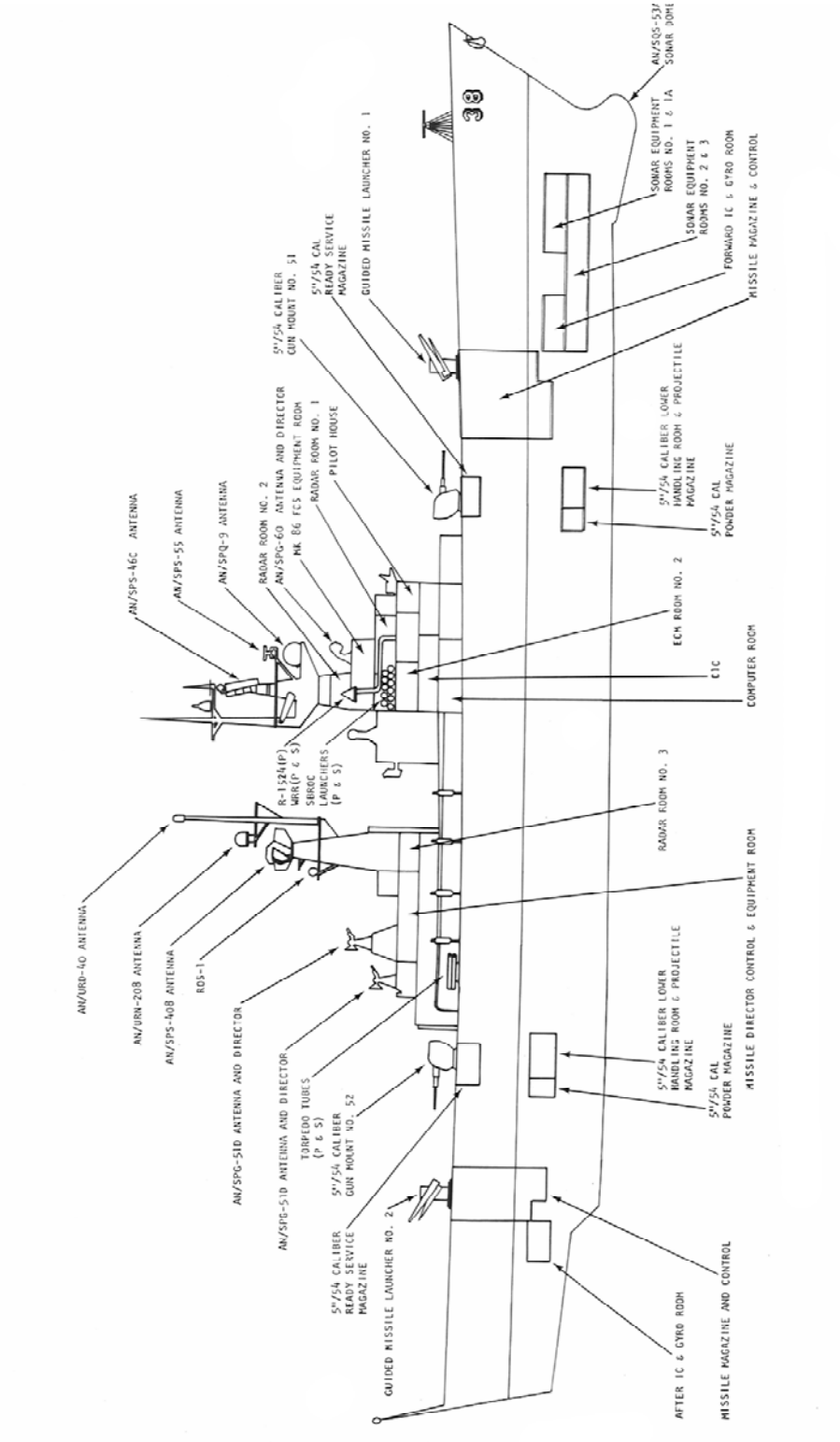
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 15. Installation standards summary sheet.



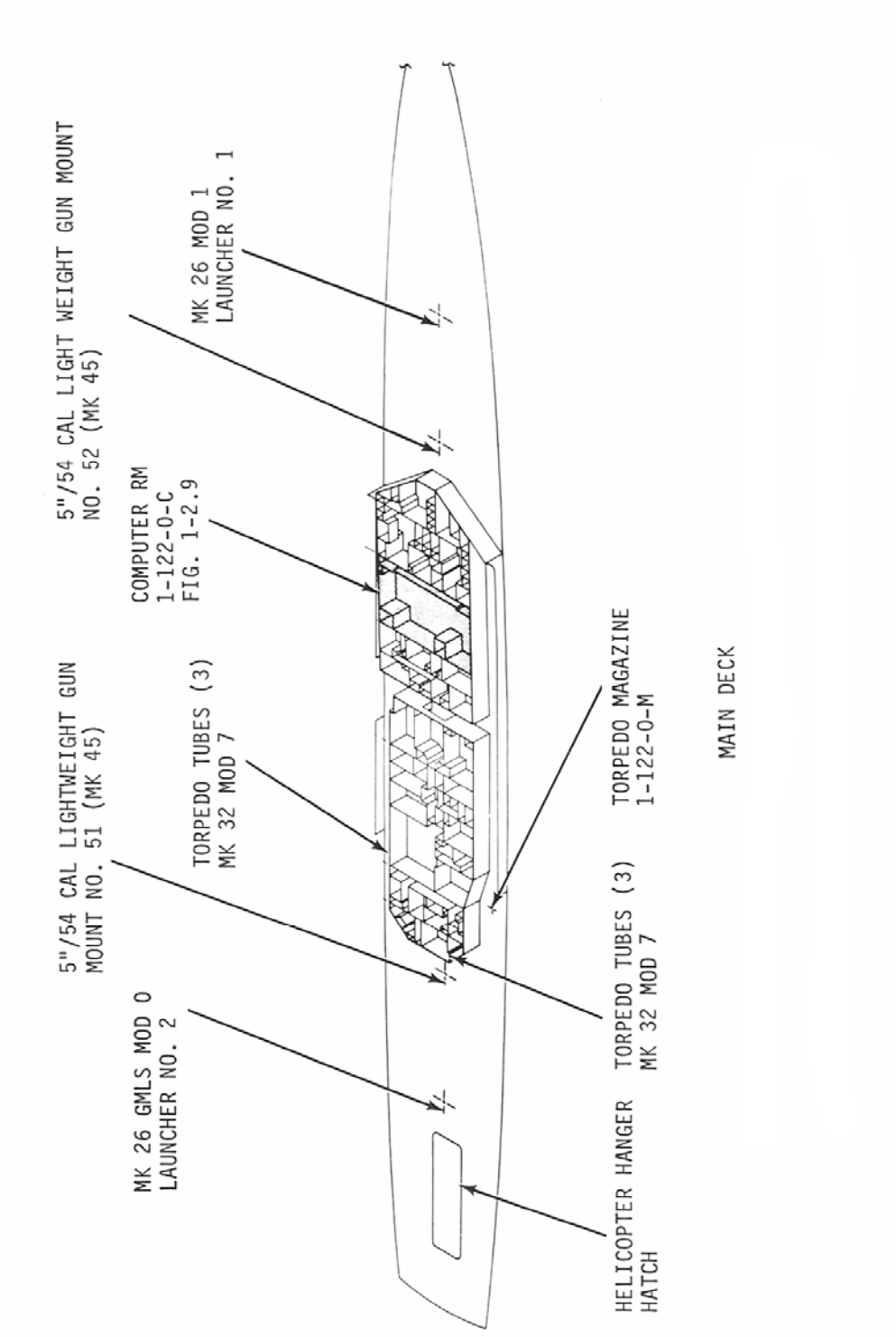
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 16. Combat system level 1 block diagram.



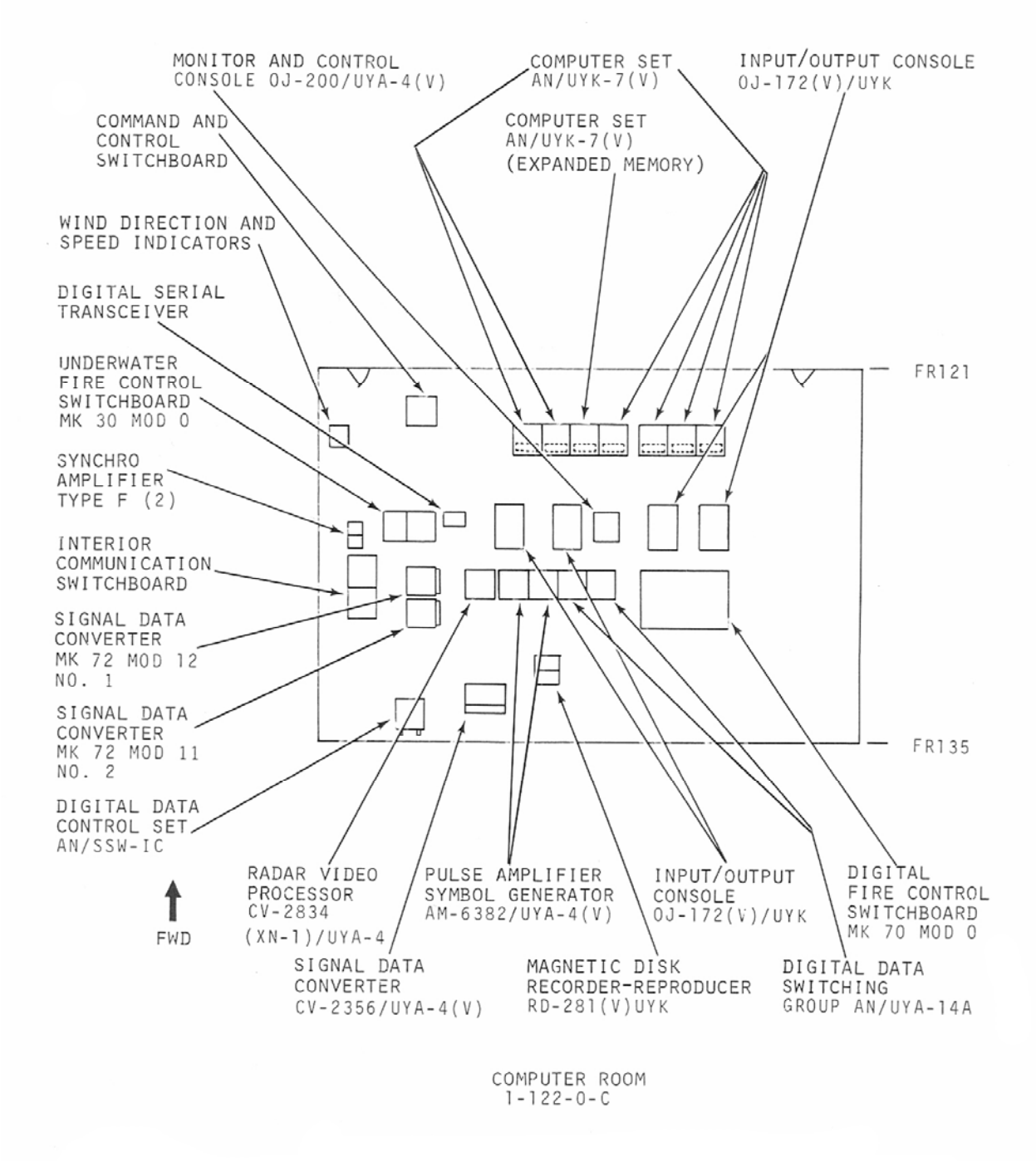
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 17. Ship profile and external components pictorial.



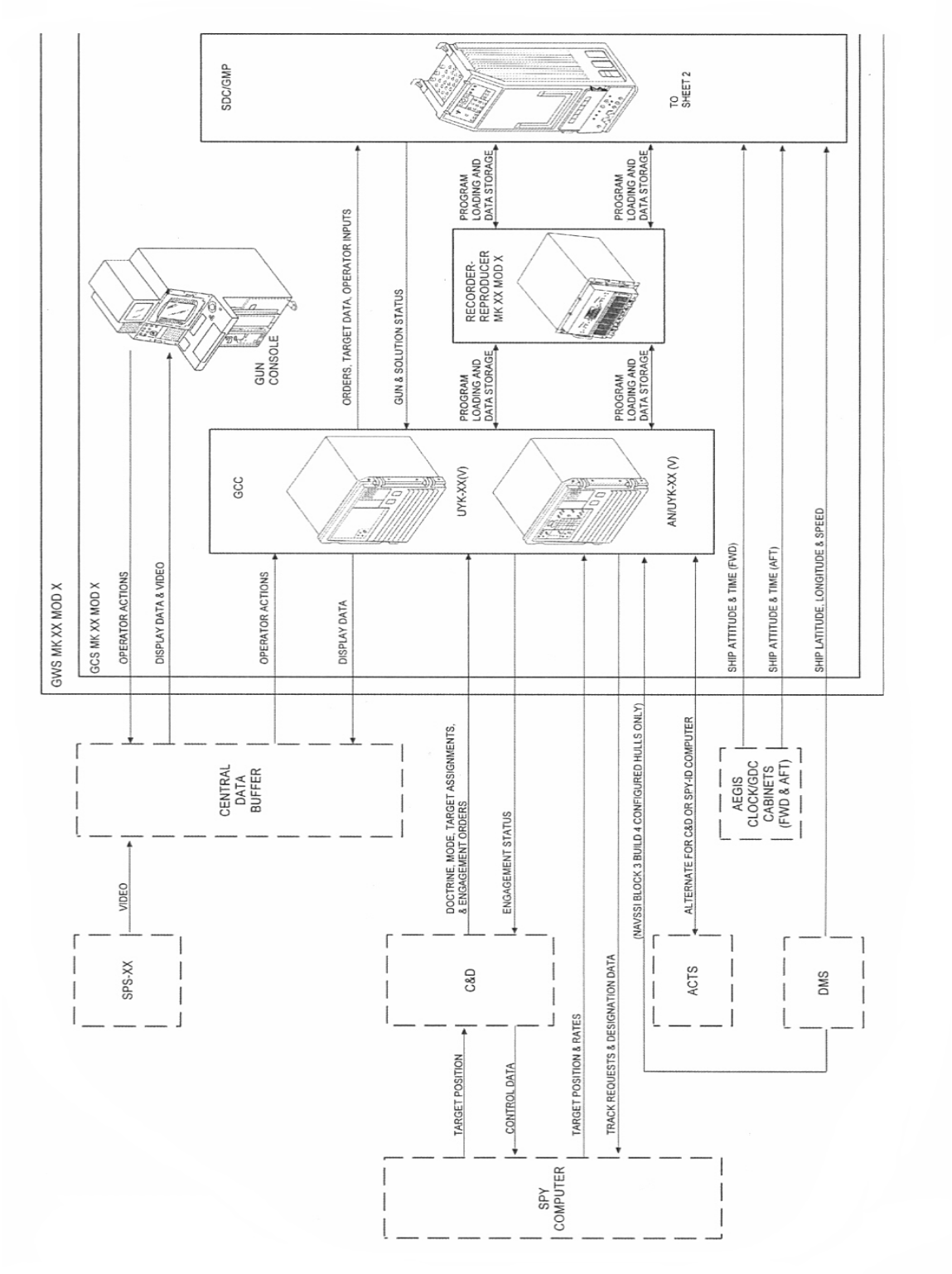
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 18. Three dimensional deck and compartments arrangement pictorial.



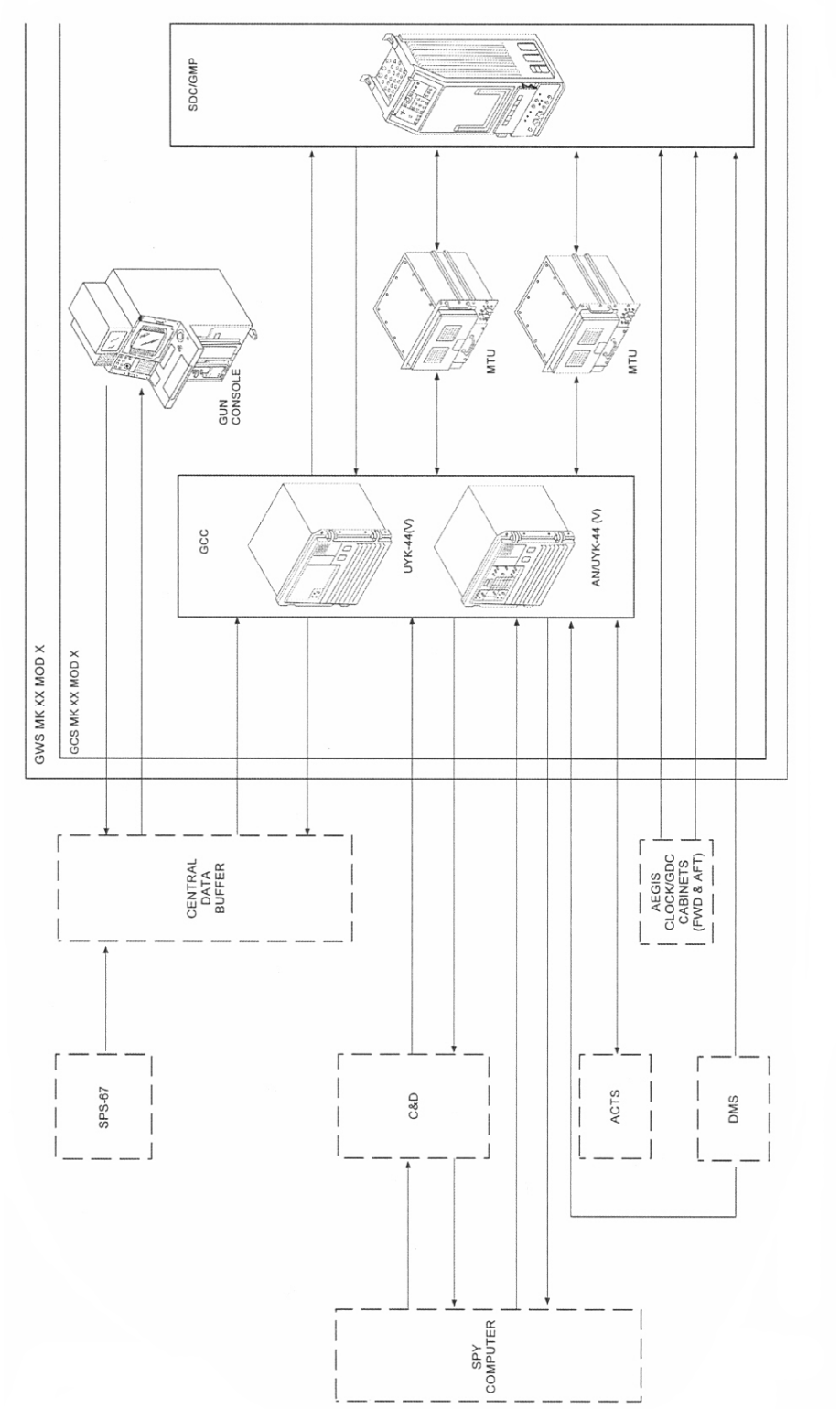
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 19. Room arrangement diagram.



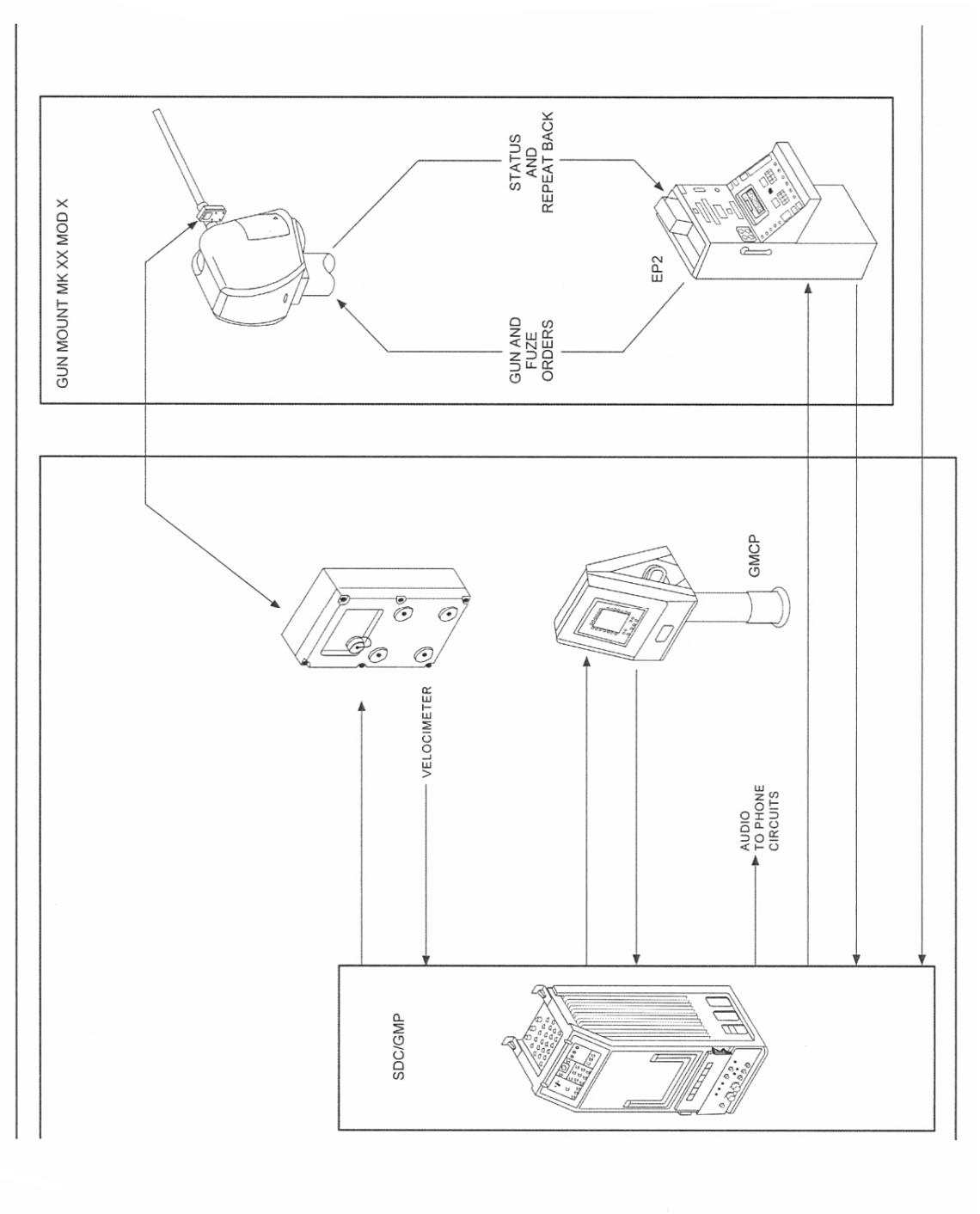
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 20. Combat system level 1 pictorial.



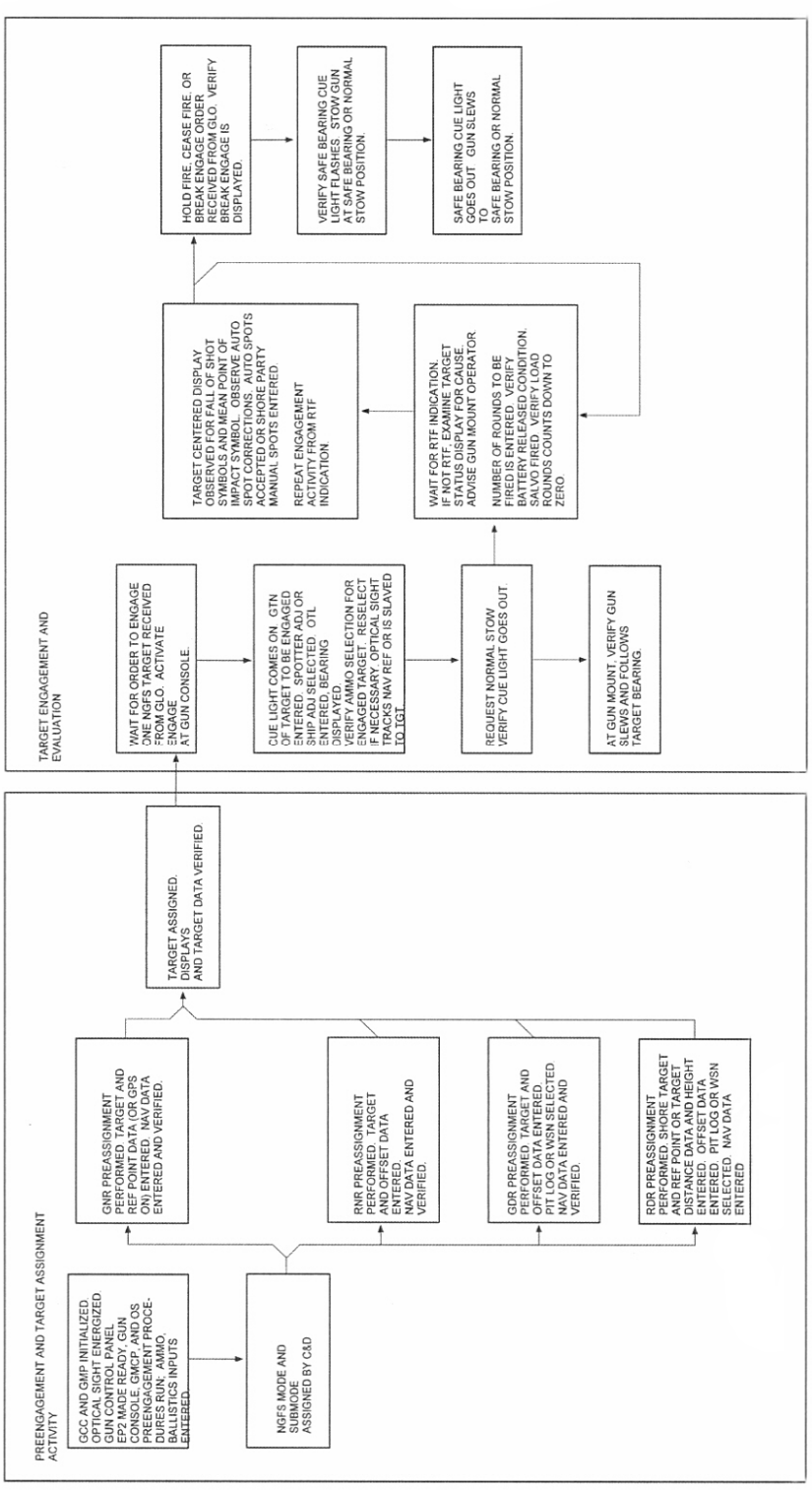
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 21. System level 2 pictorial.



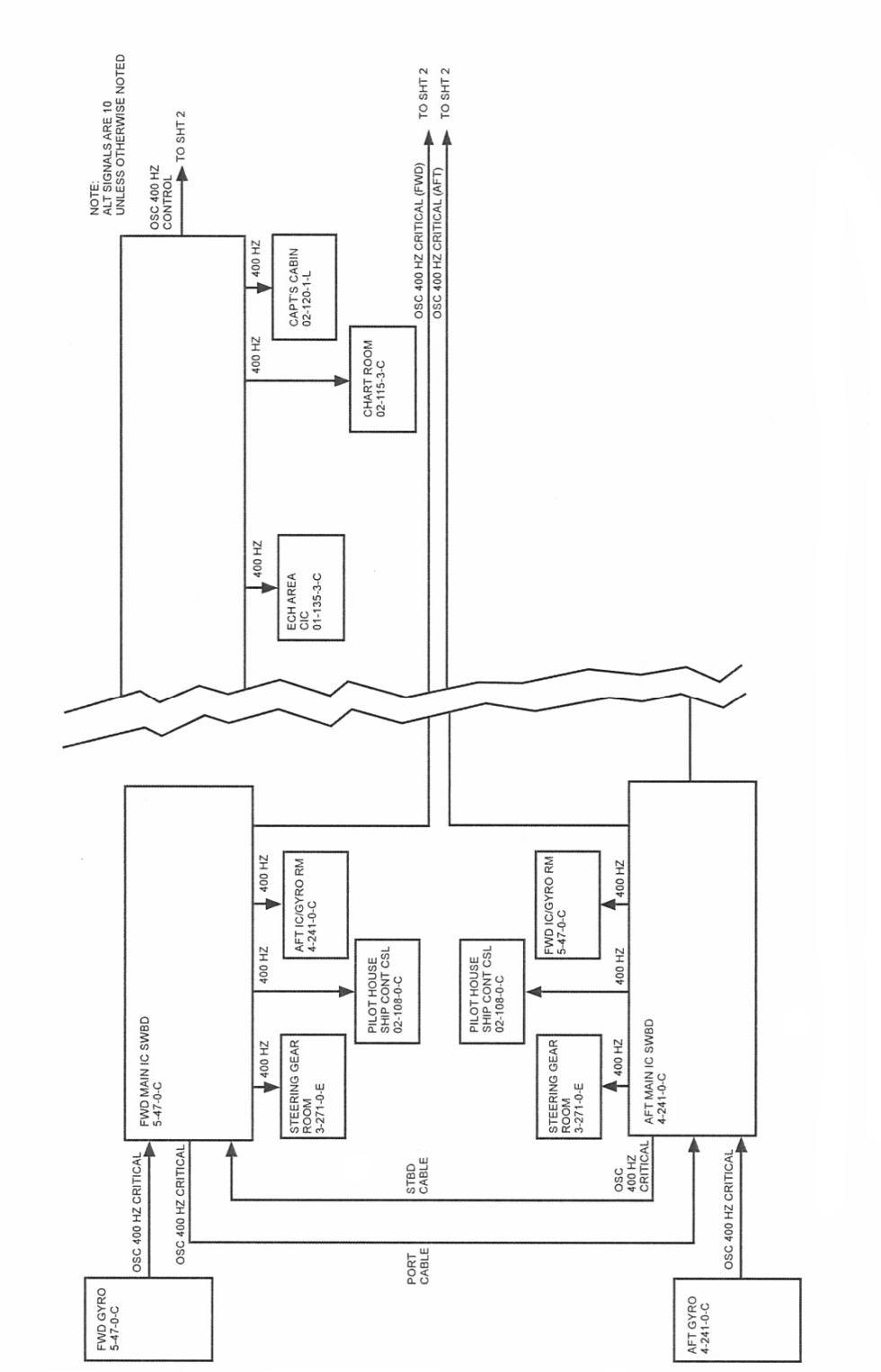
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 22. Equipment level 2 pictorial.



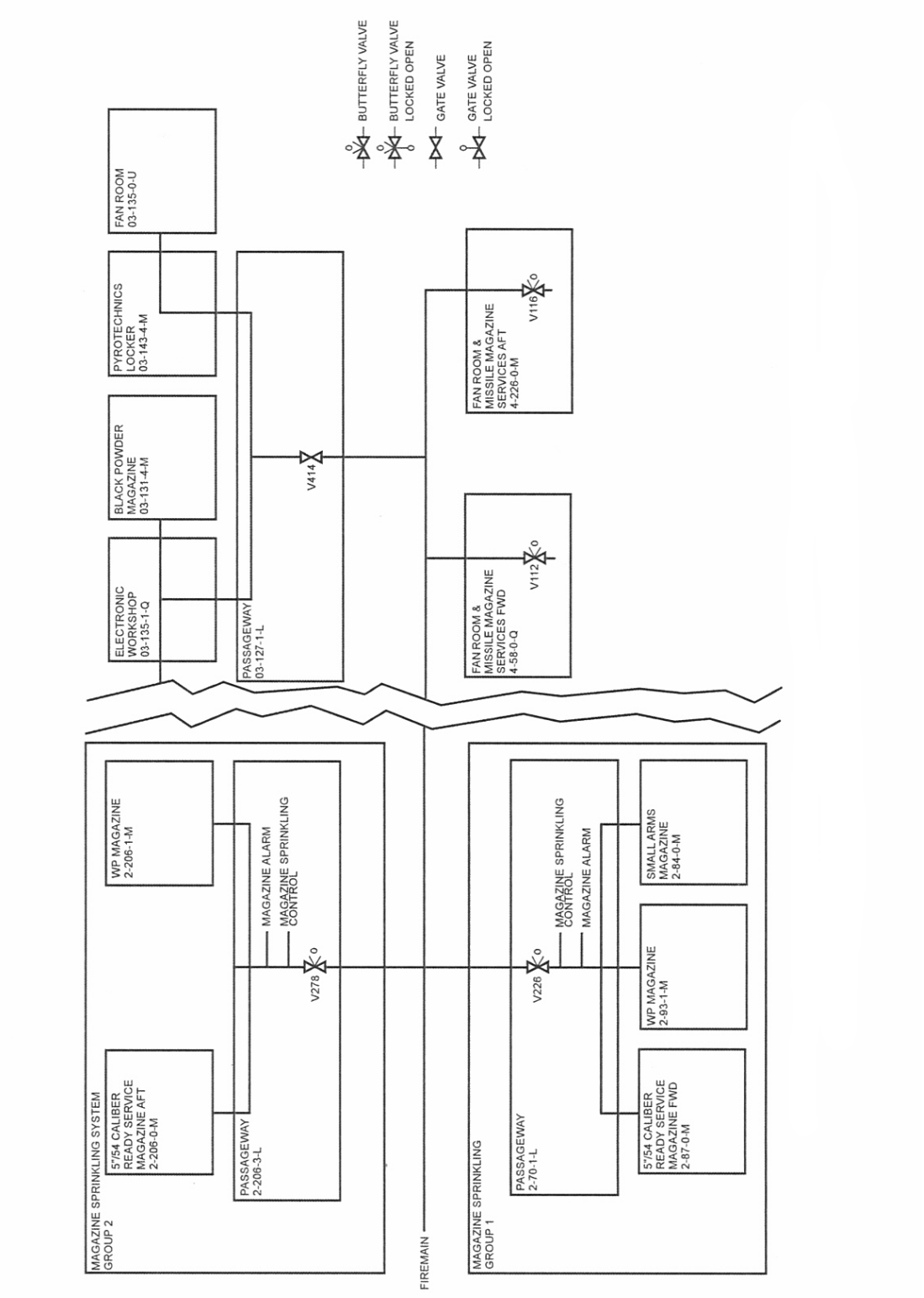
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 23. System operational program block diagram.



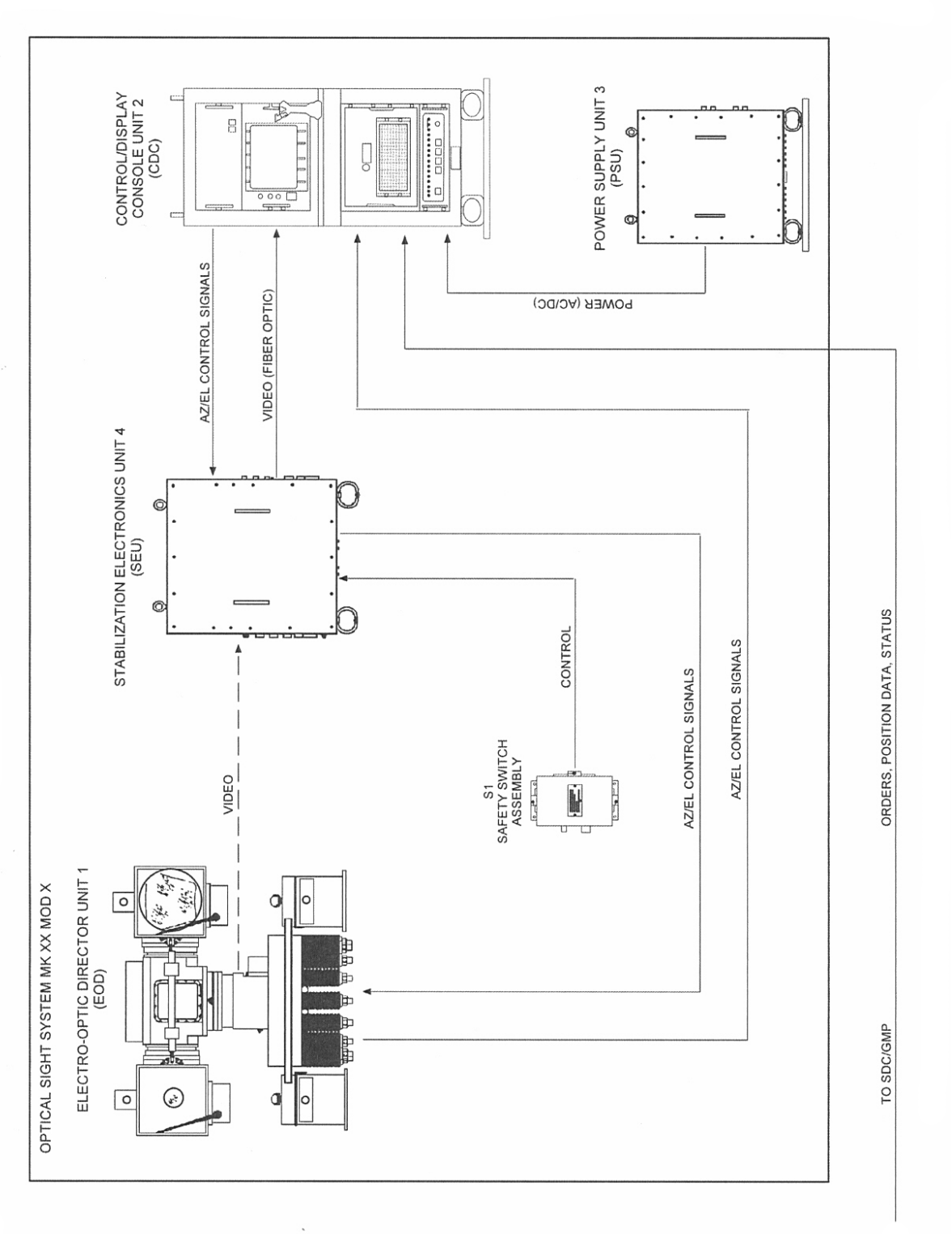
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 24. Support system (own ship heading distribution) block diagram.



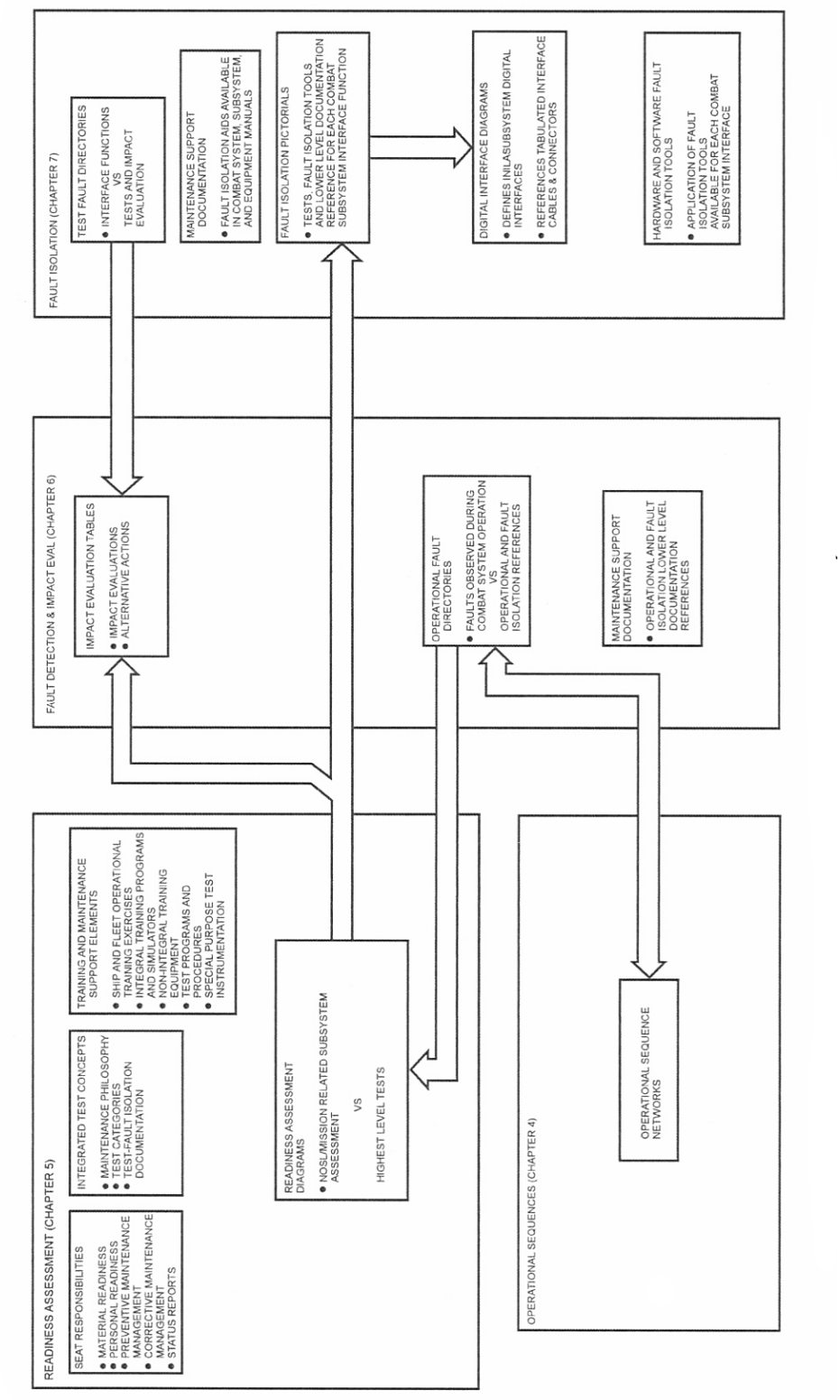
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 25. Support system (coolant, steam, and main fire) block diagram.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 26. Functional flow pictorial, level 2.



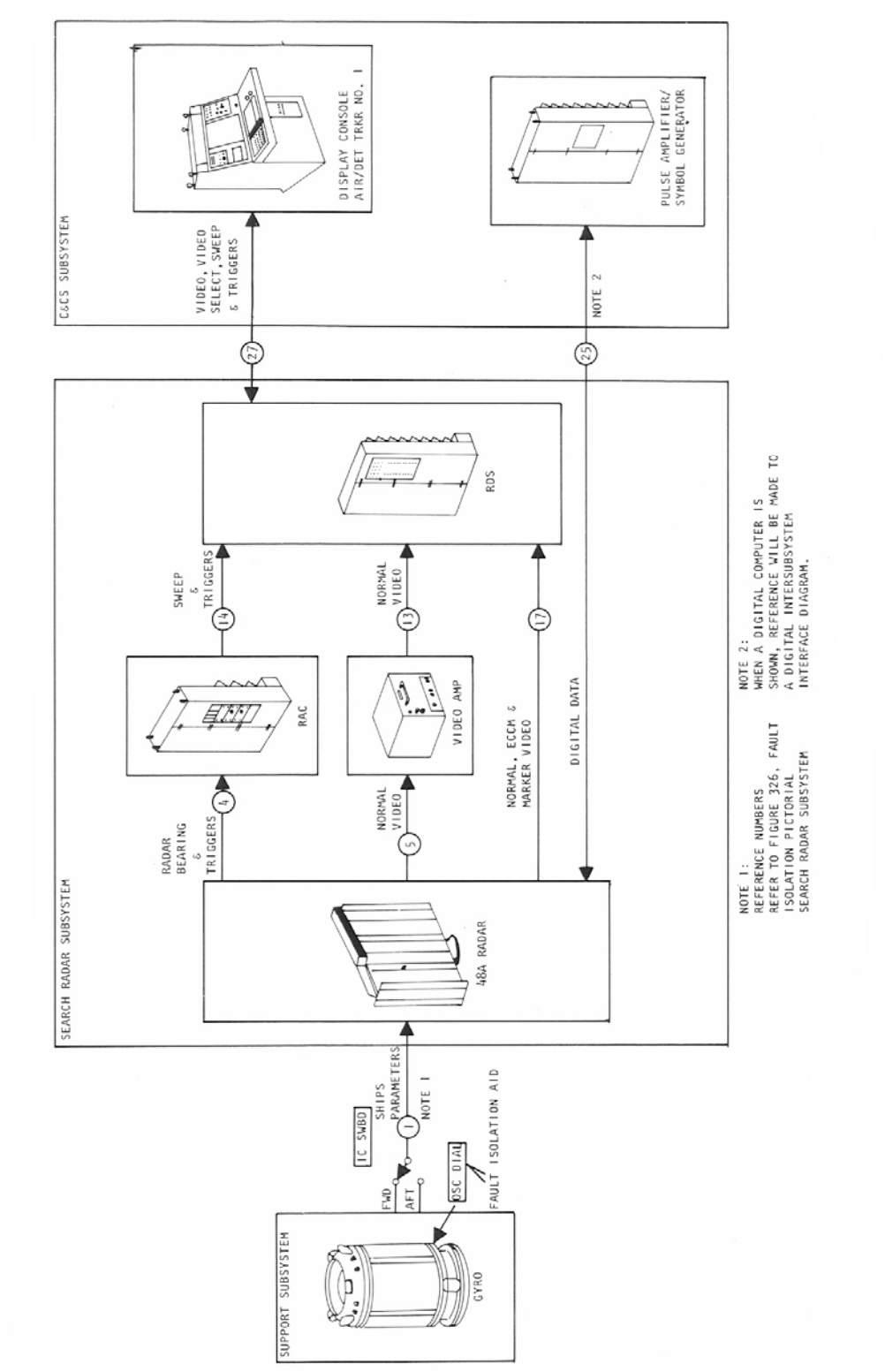
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 27. Readiness assessment and fault isolation tools overview.

Int	Function	From		To		Interface Reference
		Equipment	Test	Equipment	Test	
4	Ro	SPS-48A	R81/W-3	RAC	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	Rmjx	SPS-48A	R81/W-3	RAC	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	Rss	SPS-48A	R81/W-3	RAC	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	SIn By 5	SPS-48A	R81/W-3	RAC	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	Cos By 5	SPS-48A	R81/W-3	RAC	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
5	Yo	SPS-48A	SPS-48 Self Test	Video Amp No. 1	R25/Q-2	MS 0967-1P-014-1140 Vol 3/Pt 2
13	Yo	Video Amp No. 1	R25/Q-2	RDS	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
14	AX, AY	RAC	TD141/R1Q	RDS	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	Sign AX, AY	RAC	TD141/R1Q	RDS	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	uiu	RAC	TD141/R1Q	RDS	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2
	End Sweep	RAC	TD141/R1Q	RDS	TD141/R-1Q	MS 0967-1P-014-1140 Vol 3/Pt 2

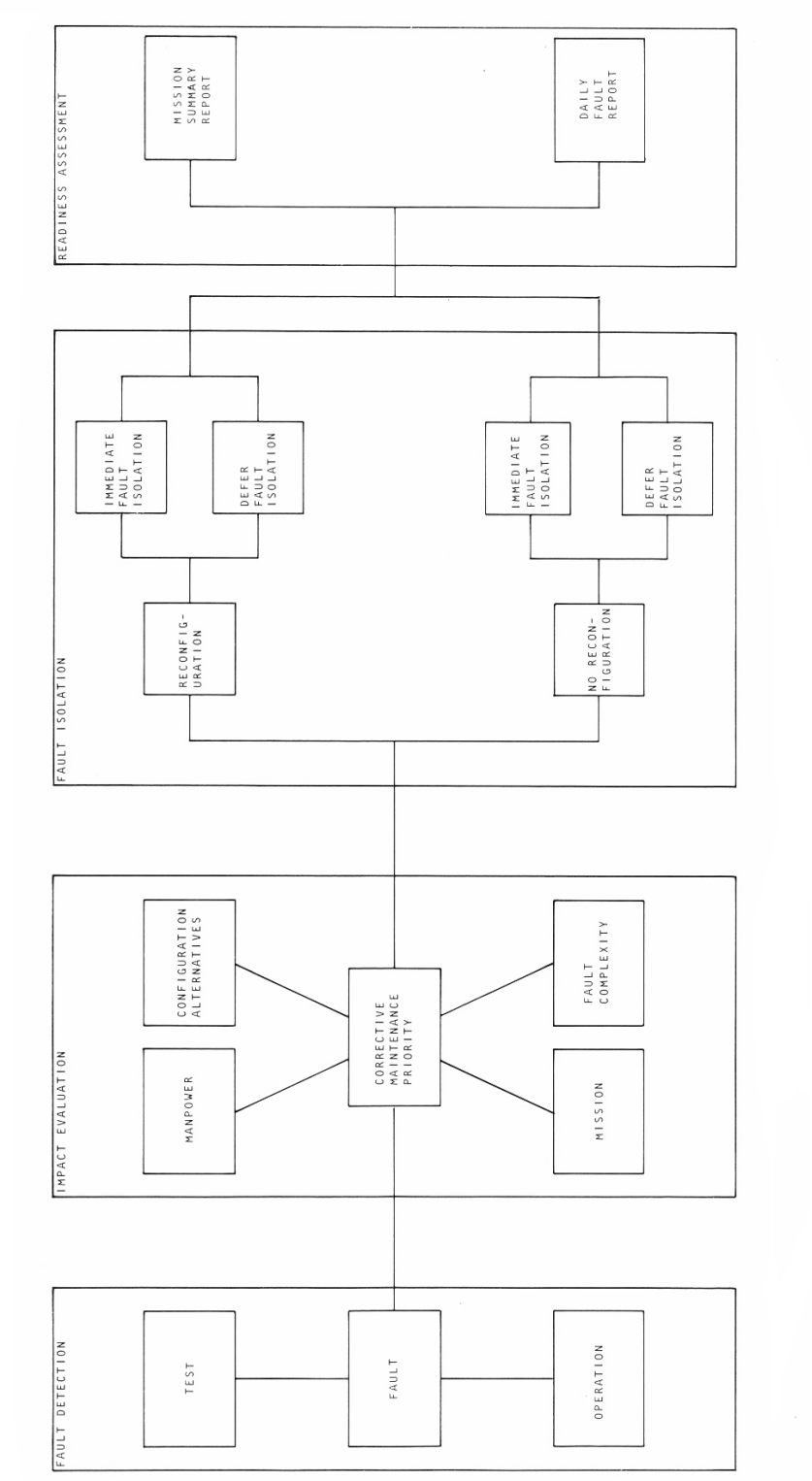
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 28. Table of interface reference for fault isolation pictorial.



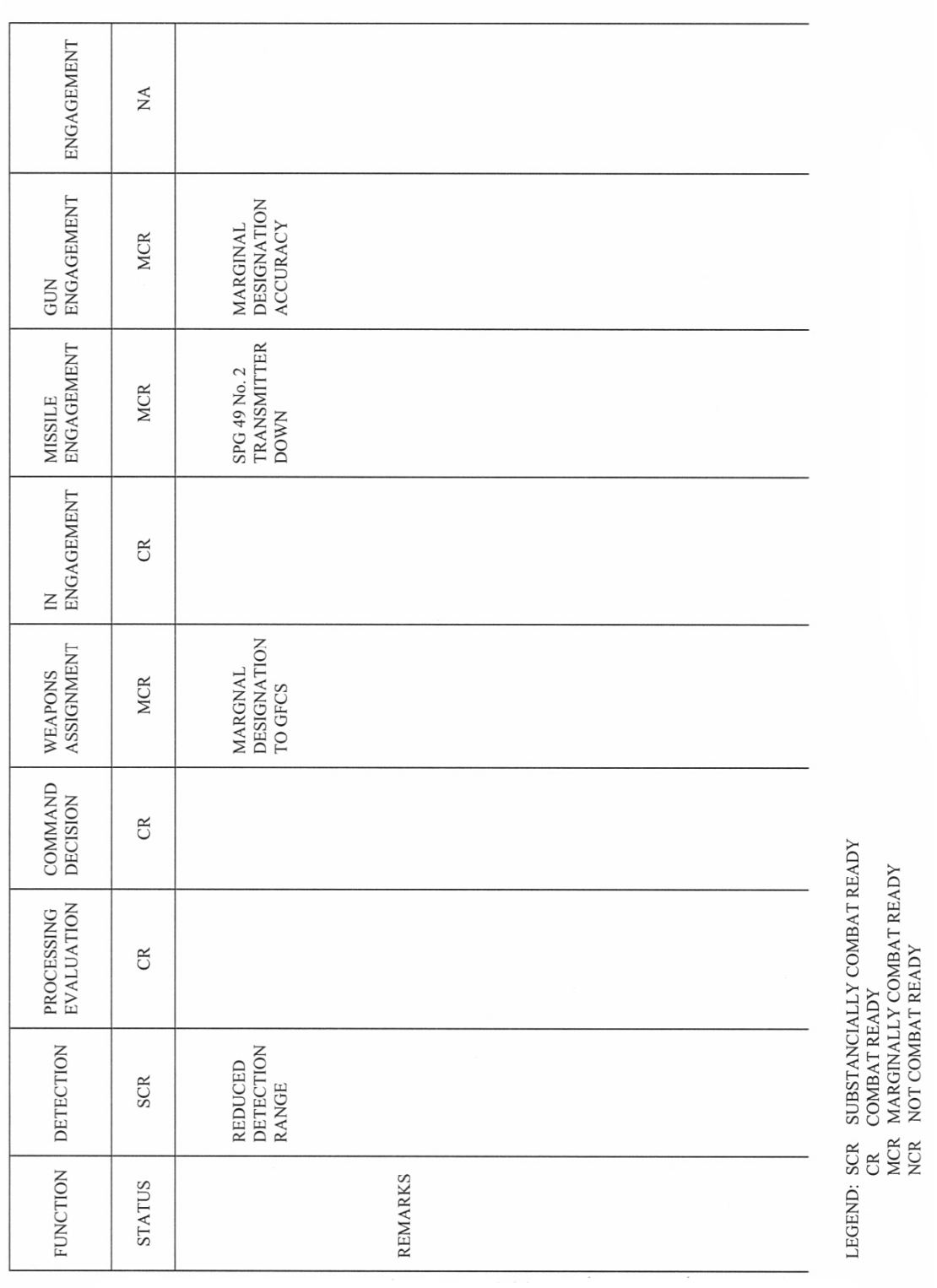
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 29. Fault isolation pictorial.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 30. Readiness assessment process diagram.



FUNCTION	DETECTION	PROCESSING EVALUATION	COMMAND DECISION	WEAPONS ASSIGNMENT	IN ENGAGEMENT	MISSILE ENGAGEMENT	GUN ENGAGEMENT	ENGAGEMENT
STATUS	SCR	CR	CR	MCR	CR	MCR	MCR	NA
REMARKS	REDUCED DETECTION RANGE			MARGNAL DESIGNATION TO GFCS		SPG 49 No. 2 TRANSMITTER DOWN	MARGINAL DESIGNATION ACCURACY	

LEGEND: SCR SUBSTANCIALLY COMBAT READY
CR COMBAT READY
MCR MARGINALLY COMBAT READY
NCR NOT COMBAT READY

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

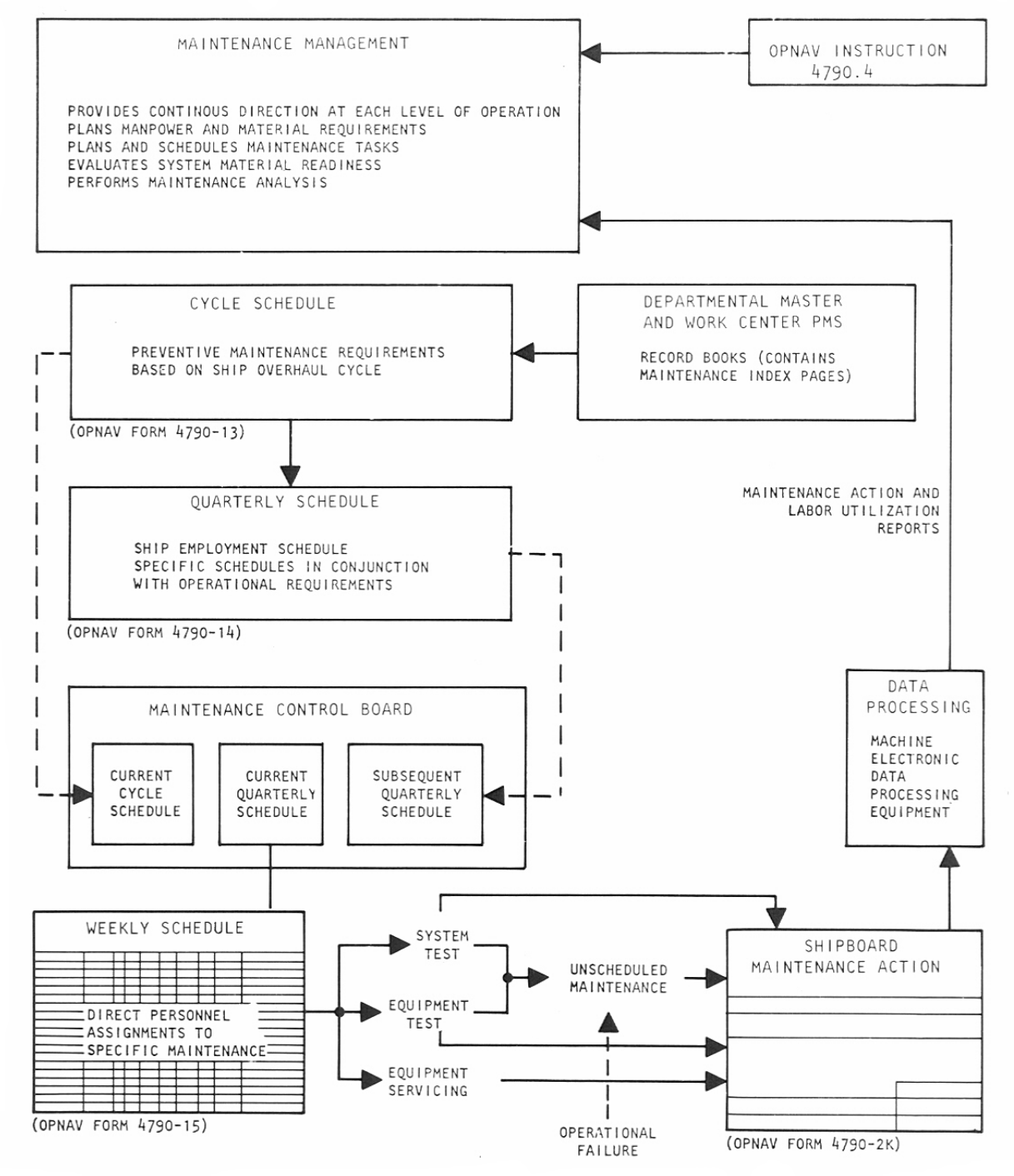
FIGURE 31. Mission summary report.

MAINTENANCE STATUS	FMNT	IMPACT				ALTERNATIVE	CTR	NOTE
		AAW	ASM	SURFACE	SHORE			
D	SPS-48 Low Power Output	Reduced range	NA	NA	NA	3D SPS-30 2D SPS-43	16.00	-
D	Marginal designation to GFCS	Increased acquisition time	ASMOC Tracking questionable	Increased acquisition time	NA	TDT or SPA-4	Sunday	Alignment
M	SPS-49 No. 2 pulse transformer	Reduced Forward Fire Power	NA	NA	NA	None		No part CASREPT

LEGEND: D - DEFERRED
M - MANDATORY

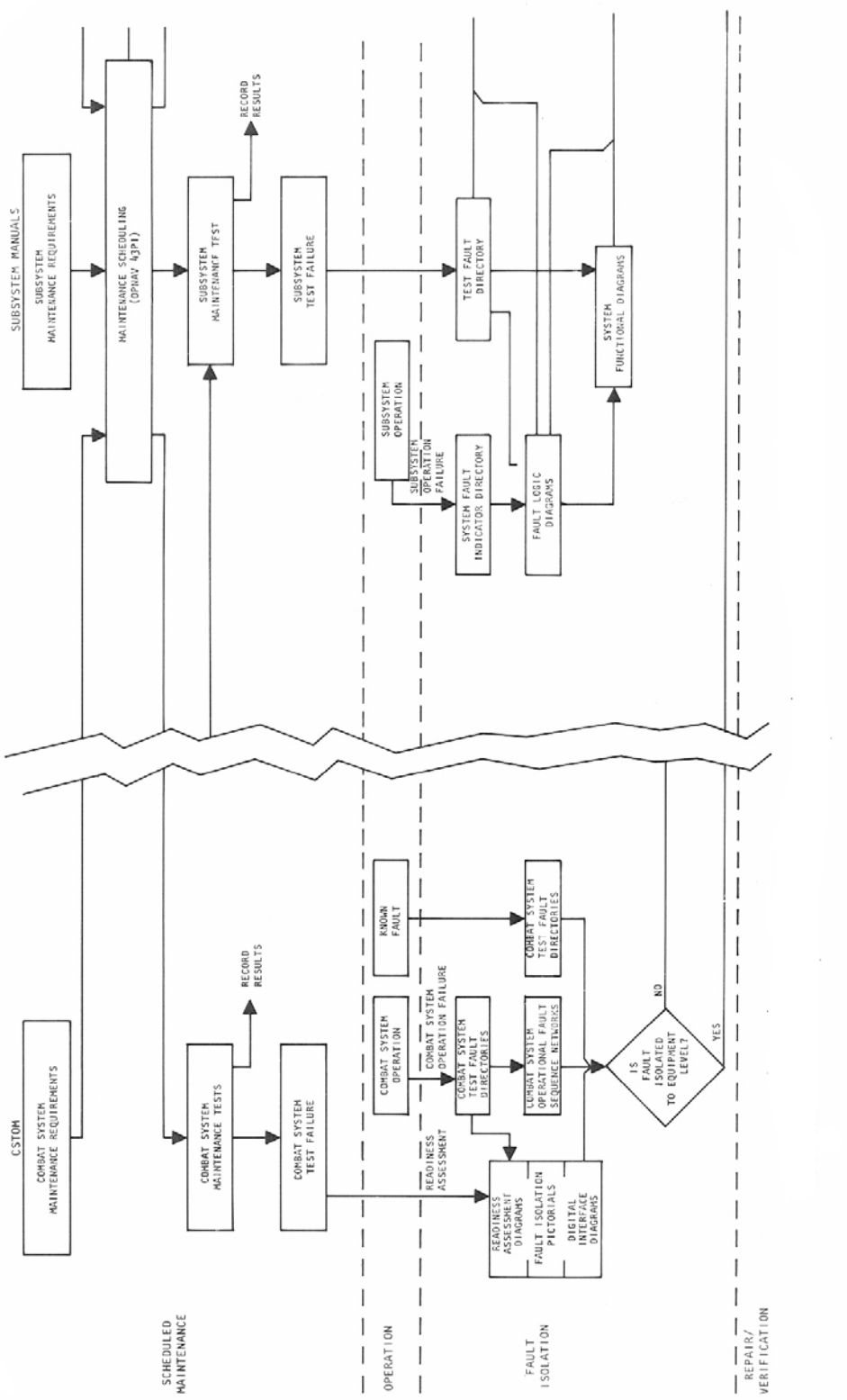
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 32. Combat system daily faults report.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 33. Planned maintenance system block diagram.



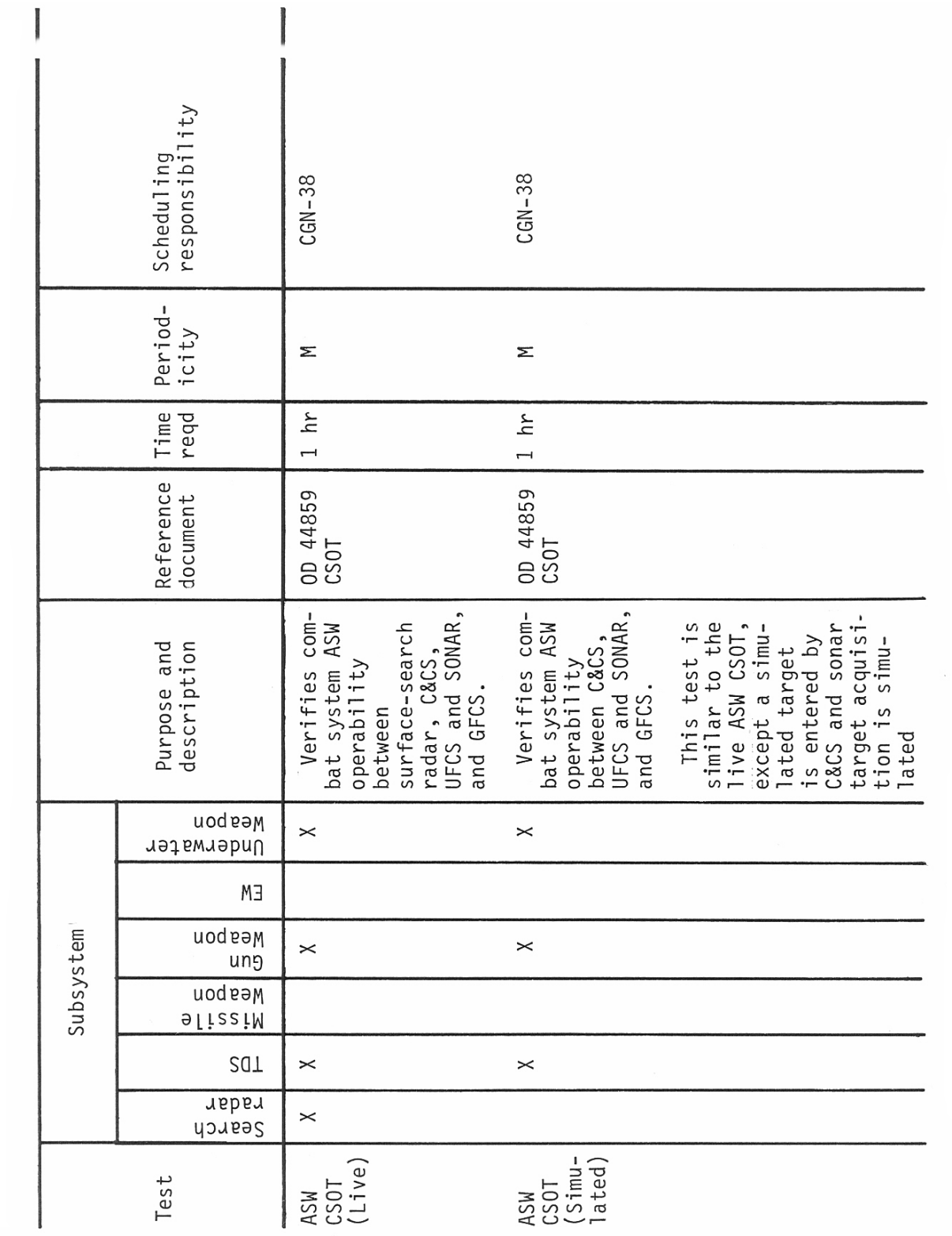
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 34. Integrated maintenance concept block diagram.

FXP Series Exercise	Title	Subsystem					Operational Phase			
		Search Radar	C&CS	Missile Weapon	Gun Weapon	EW	Detection, Evaluation, FCS Assign, and Track	Engageability Evaluation	Launcher Assign and Missile Firing	Engagement Assessment
Z-1-GM	Single Target Processing	X	X	X			X	X	X	
Z-2-GM	Multiple Target Processing	X	X	X			X			
Z-3-GM	Multiple Target Processing	X	X	X			X	X		
Z-4-GM	ECCM - Mechanical Jamming	X	X	X			X			
Z-5-GM	ECCM - Cap Coordination Mechanical Jamming	X	X	X			X	X	X	
Z-6-GM	ECCM - Electromagnetic Jamming	X	X	X			X			
Z-7-GM	ECCM - Mechanical and Electro-magnetic Jamming	X	X	X			X			
Z-10-GM	Tactical AAW	X	X	X			X	X	X	
Z-11-GM	Tactical AAW - Simulated Countermeasures	X	X	X			X	X	X	
Z-12-GM	Tactical AAW - Live Countermeasures	X	X	X		X	X	X	X	
Z-13-GM	Tactical AAW - CAP and Missile Coordination	X	X	X			X	X	X	
Z-14-GM	Tactical AAW - CAP and Missile Coordination with Simulated Countermeasures	X	X	X			X	X	X	
Z-15-GM	Comprehensive Non-Firing SAM in AAW	X	X	X	X	X	X	X	X	
Z-20-GM	Coordinated Missile Employment in Fleet AAW	X	X	X			X	X	X	
Z-21-GM	Coordinated Missile Employment in Fleet AAW - Countermeasures Envir.	X	X	X			X	X	X	

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 35. Table of fleet training exercises subsystem applicability.



Test	Subsystem: Search radar	TDS	Missile weapon	Gun weapon	EW	Underwater weapon	Purpose and description	Reference document	Time reqd	Periodicity	Scheduling responsibility
ASW CSOT (Live)	X	X		X		X	Verifies combat system ASW operability between surface-search radar, C&CS, UFCS and SONAR, and GFCS.	OD 44859 CSOT	1 hr	M	CGN-38
ASW CSOT (Simulated)		X		X		X	Verifies combat system ASW operability between C&CS, UFCS and SONAR, and GFCS. This test is similar to the live ASW CSOT, except a simulated target is entered by C&CS and sonar target acquisition is simulated	OD 44859 CSOT	1 hr	M	CGN-38

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 36. Table of operational test program.

Ref	Test	Test brief	Fault isolation pictorial*	Impact evaluation reference **
1		CSAT	Fig. 7	Table 6
2	R-81/R-2D	AN/SPS-48 Radar		
3	R-81/R-3D	AN/SPS-48 Radar		
4	R-81/R-6D	AN/SPS-48 Radar		
5		OCSOT		
6	TD-68/Q-1	AN/UYA-4 Data Display Group		
7	TD-141/R-1Q	Display Pofa		
8	R-13/R-2D	AN/SPS-40 Radar		
9		OCSOT		

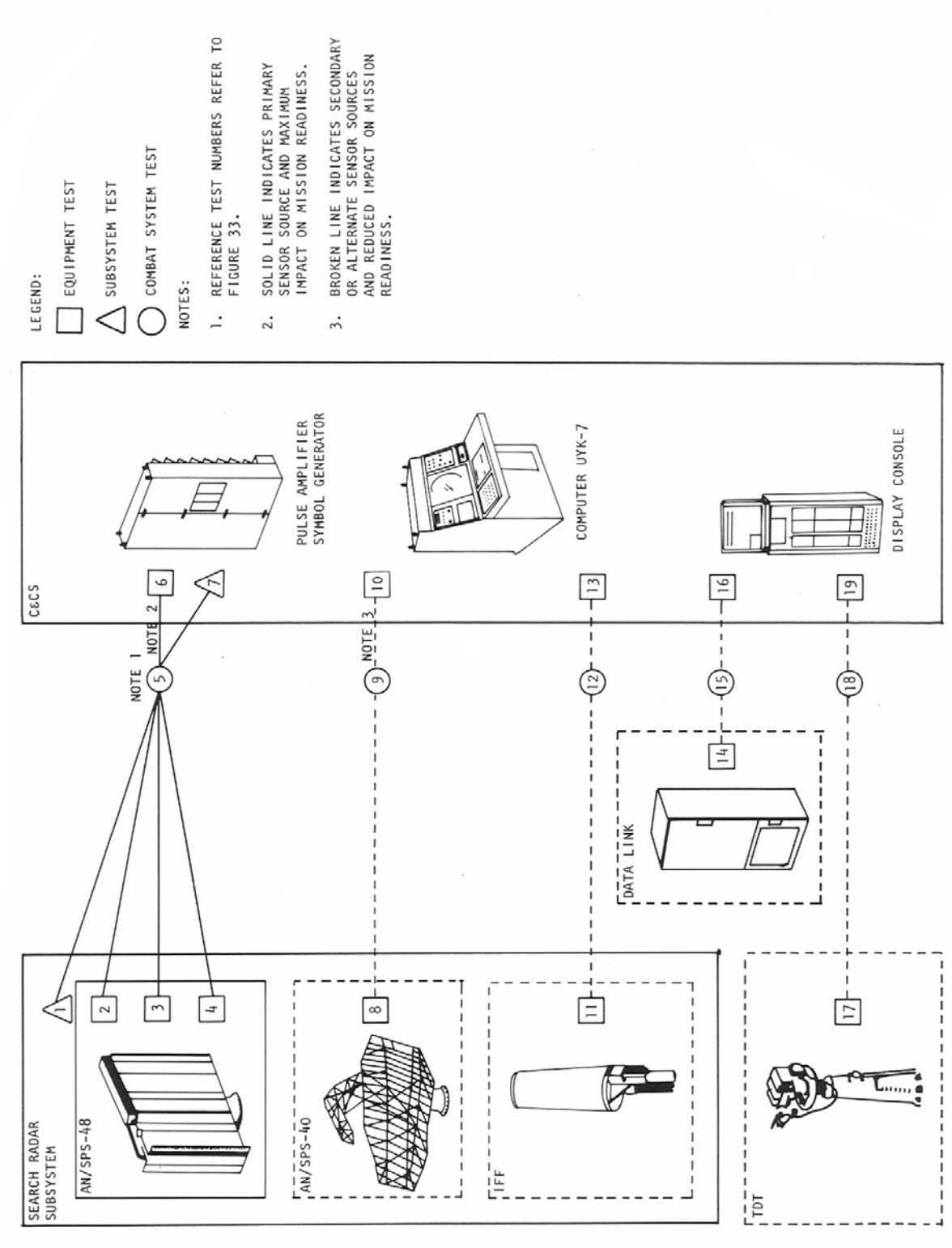
Note: This table and the associated diagram comprise the Readiness Assessment Diagram (RAD). Each RAD shall identify the highest level test or combination of tests that will verify readiness of the combat system to perform in a particular phase of a given mission. Specific tests are tabulated and reference given to a pertinent fault isolation pictorial as well as an impact evaluation reference.

* Refers to fault isolation pictorial in and interface data tabulation reference on that figure.

** Refers to impact evaluation table.

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 37. Table of test and fault impact evaluation references.



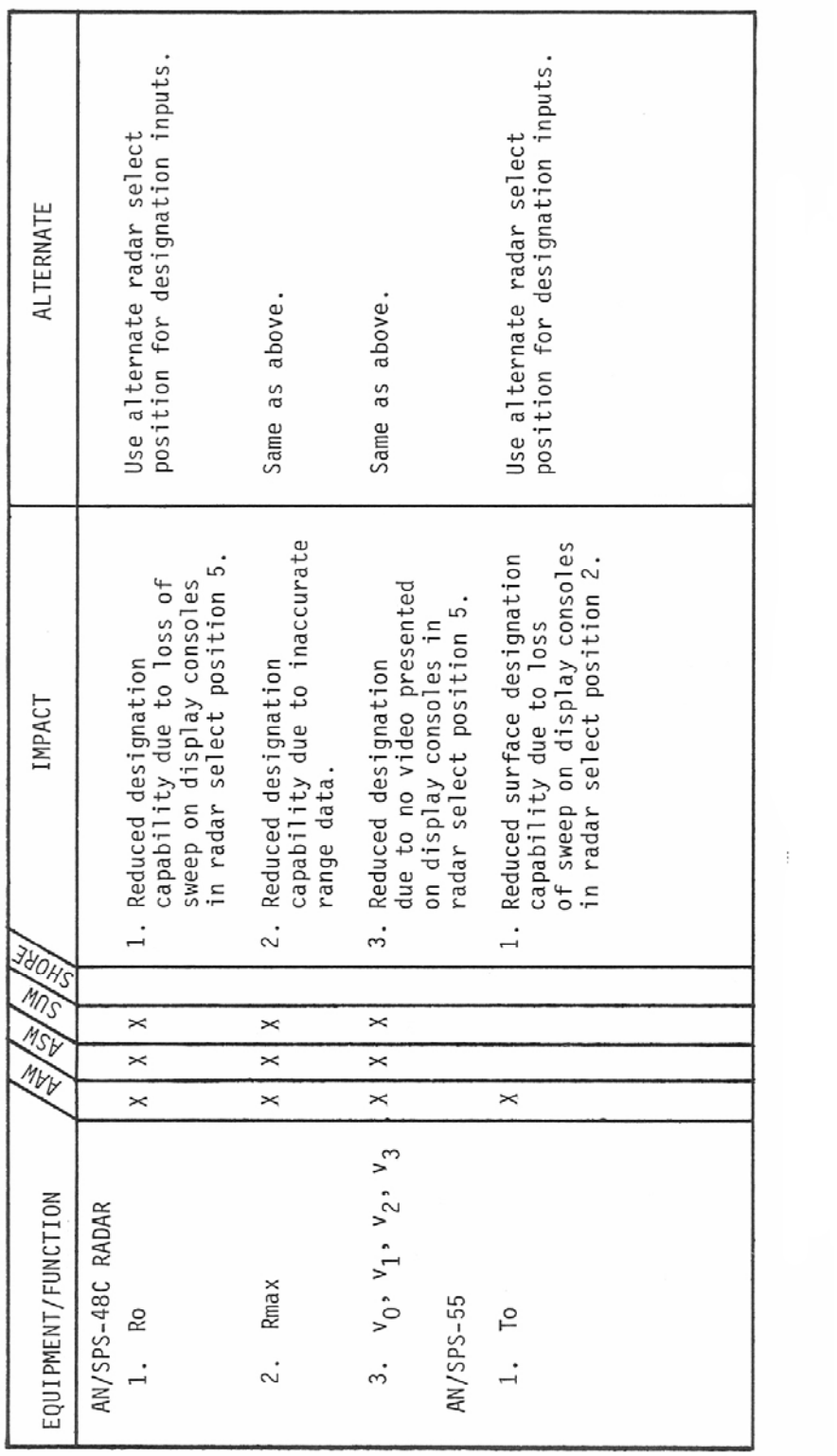
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 38. Readiness assessment diagram (RAD).

Fault Symptom	Operational reference				Fault isolation reference						
Note:* F = Figure	*	OSN Vol 2. F4-1.1	OSN Vol 3. F4-1.2	NSO967-LP-014-1160	RAD. F5-5.8	NSO967-441-9010	NSO967-238-7010				
SPS-48C: DETECTOR TRACKER											
No radar video displayed in RADAR 5 positions.	X		X		X		X				
SPS-48-C: DETECTOR TRACKER											
No symbology displayed when new track is entered.	X		X		X		X				
SPS-40B: DETECTOR TRACKER											
No radar video displeyed in RADAR 4 positions.		X	X		X	X	X				
SPS-40B: DETECTOR TRACKER											
No symbology displayed when new track is entered.		X	X		X	X					
TRACK SUPERVISOR											
No radar video displayed in RADAR 5 positions.	X		X		X	X					
TRACK SUPERVISOR											
No symbology displayed when new track is entered.	X	X	X		X						
SPS-48C: RADAR SET CONSOLE											
Track not on SPS-48C RSC sequence list.	X				X						
TRACK SUPERVISOR											
No late detect alert on a late detect target.	X	X	X		X	X					

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

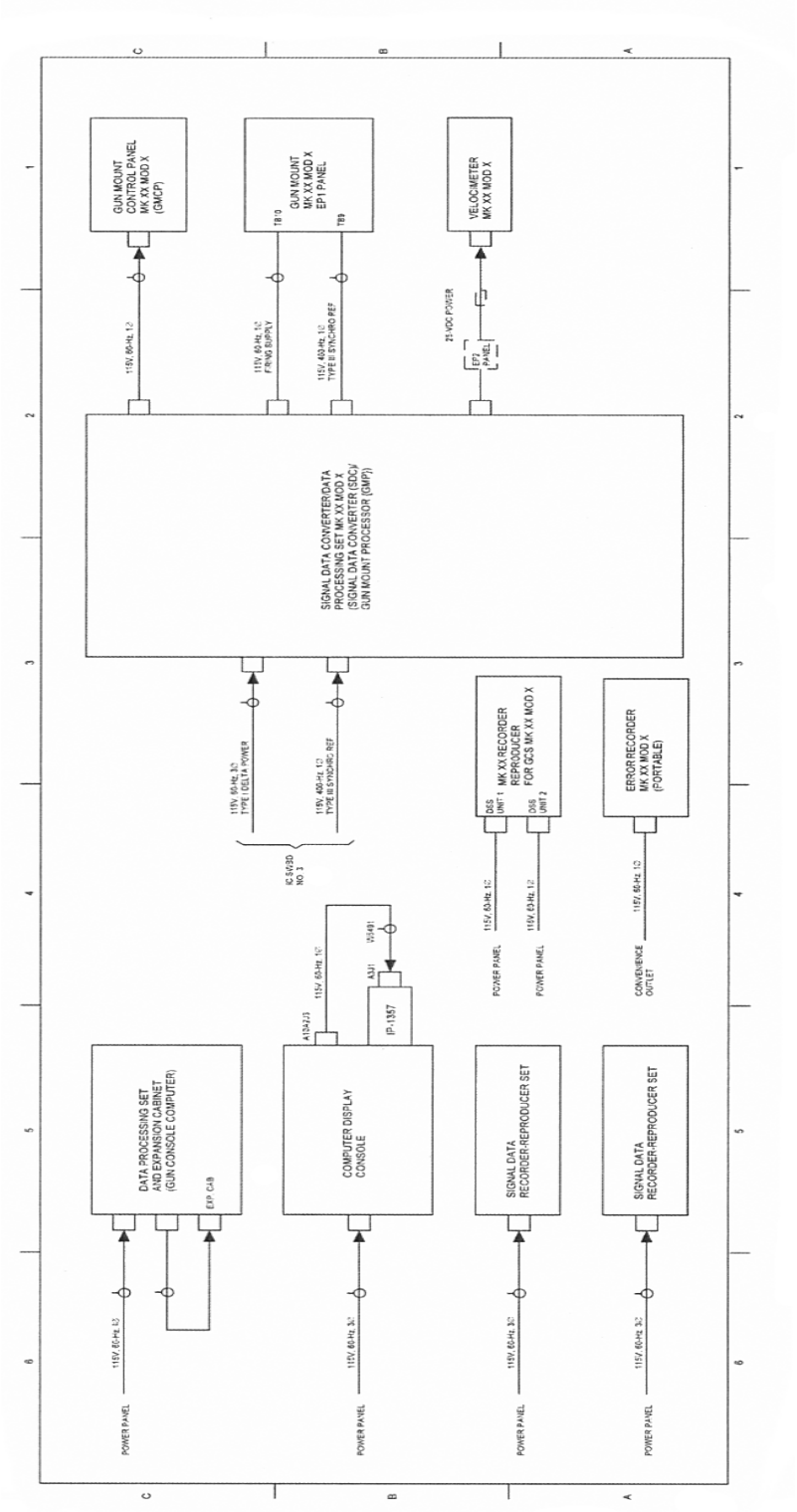
FIGURE 39. Operational fault directory.



EQUIPMENT/FUNCTION	AAW	ASW	SUW	SHORE	IMPACT	ALTERNATE
AN/SPS-48C RADAR						
1. Ro	X	X	X		1. Reduced designation capability due to loss of sweep on display consoles in radar select position 5.	Use alternate radar select position for designation inputs.
2. Rmax	X	X	X		2. Reduced designation capability due to inaccurate range data.	Same as above.
3. v_0, v_1, v_2, v_3	X	X	X		3. Reduced designation due to no video presented on display consoles in radar select position 5.	Same as above.
AN/SPS-55						
1. To	X				1. Reduced surface designation capability due to loss of sweep on display consoles in radar select position 2.	Use alternate radar select position for designation inputs.

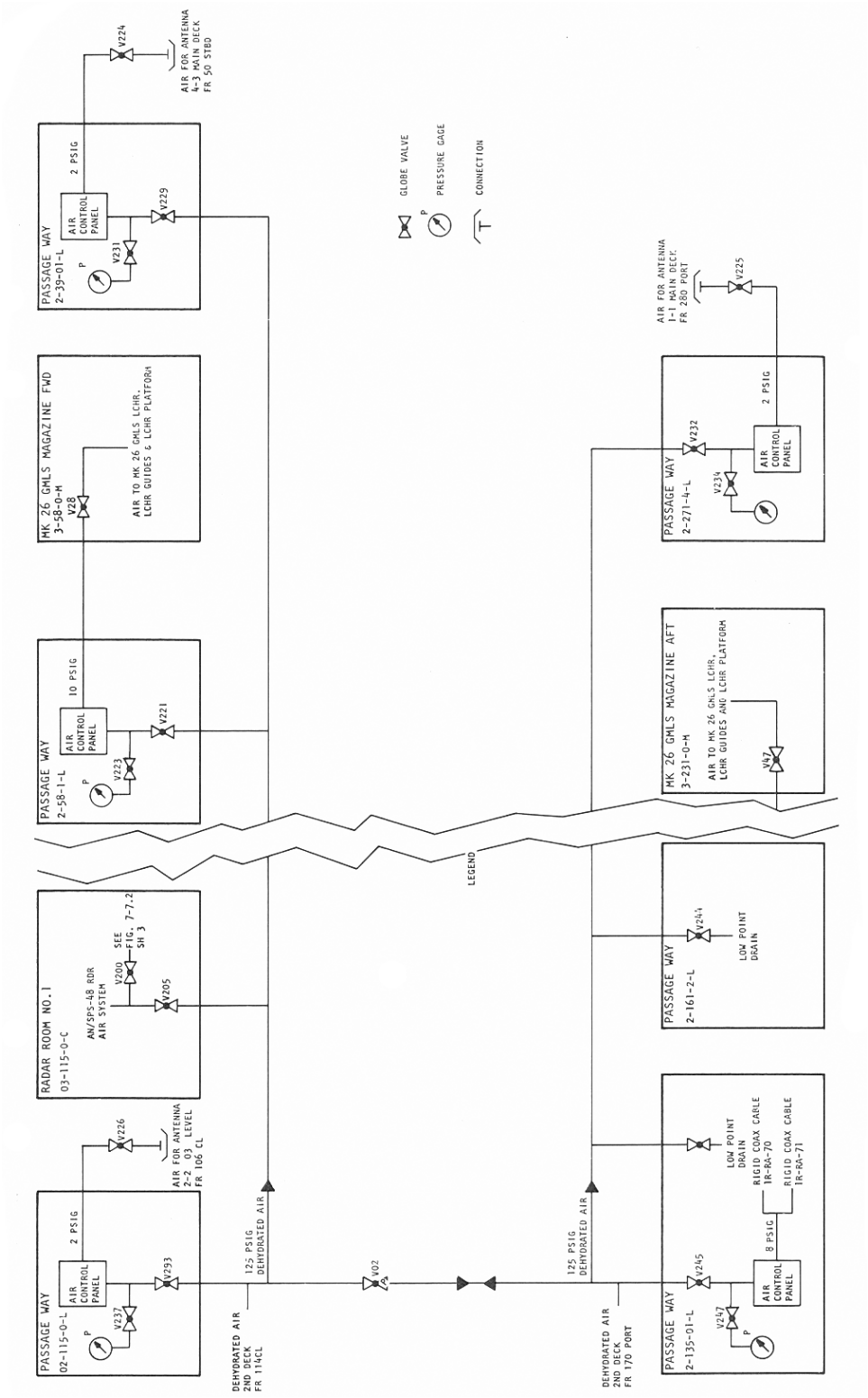
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 40. System impact evaluation table.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 41. Support system electrical power distribution diagram.



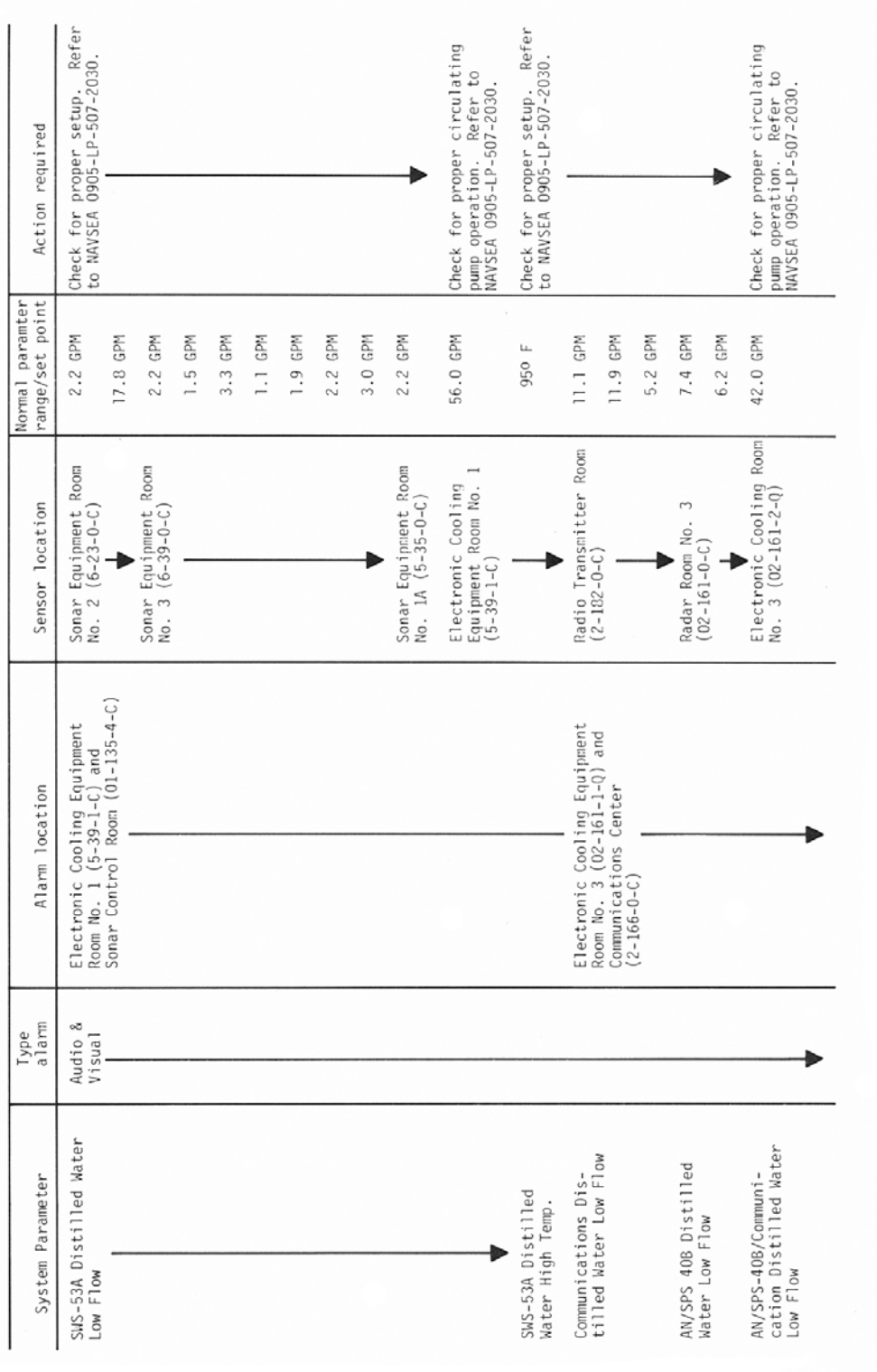
Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 42. Support system dry air system distribution diagram.

Fault cause \ Fault symptom	Pressure relief valve opens	High inlet pressure	Low inlet pressure	High outlet pressure	Low outlet pressure	Dew point alarm ON	High flow rate	Low flow rate	Pressure alarm ON
Panel outlet pressure too high	X								
Relief valve maladjustments	X								
Defective relief valve	X								
Excessive air main pressure		X							
Failure priority valves			X						X
Air leaks			X		X	X	X		X
Unauthorized uses on line			X			X			X
Pressure drop in dehydrator			X						X
Line valve partially closed			X						X
Bypass valve not closed				X					
Internal RS maladjustment				X	X				X
RS component failure				X	X				X
Excessive Moisture						X			
Improper sensor setting						X			X
Defective sensor						X			X
Line blockage							X		X

Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 43. Support system symptom/cause fault directory.



Note: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 44. Table of audio-visual alarms.

Custodian:
Navy – SH

Review Activity:
Navy – EC

Preparing Activity:
Navy – SH
(Project TMSS-N255-000)

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