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ELECTRONICS

INSTALLATION

AND

MAINTENANCE BOOK

TEST METHODS

AND PRACTICES

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(1) The number listed in this column indicates that this handbook issue incorporates information from EIB issues up to and including the one shown. In addition to this column entry, a source reference code is inserted immediately following the last line of copy of pertinent articles picked up in EIMB handbooks. The following examples show the coding method used to identify origin of material used:

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*Only articles which have been revised to omit classified data but retain information of value and lasting interest.

(2) This change reserved for Tab Separator Package.

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PREFACE

POLICY AND PURPOSE

The Electronics Installation and Maintenance Book (EIMB) was established as the medium for collecting, publishing, and distributing, in one convenient source document, those subordinate maintenance and repair policies, installation practices, and overall electronic equipment and material-handling procedures required to implement the major policies set forth in Chapter 400 of the Naval Ships' Technical Manual. All data contained within the EIMB derive their authority from Chapter 400 of the Naval Ships' Technical Manual, as established in accordance with Article 1201, U. S. Navy Regulations.

Since its inception the EIMB has been expanded to include selected information of general interest to electronic installation and maintenance personnel. These items are such as would generally be contained in textbooks, periodicals, or technical papers, and form (along with the information cited above) a comprehensive reference document. In application, the EIMB is to be used for information and guidance by all military and civilian personnel involved in the installation, maintenance, and repair of electronic equipment under cognizance, or technical control, of the Naval Sea Systems Command (NAVSEA). The information, instructions, and procedures, in the EIMB supplement instructions and data supplied in equipment technical manuals and other approved maintenance publications.

INFORMATION SOURCES

Periodic revisions are made to provide the best current data in the EIMB and keep abreast of new developments. In doing this, many source documents are researched to obtain pertinent information. Some of these sources include the Electronics Information Bulletin (EIB), the NAVSEA Journal, electronics and other textbooks, industry magazines and periodicals, and various military installation and maintenance-related publications. In certain cases, NAVSEA publications have been incorporated into the EIMB in their entirety and, as a result, have been cancelled. A list of the documents which have been superseded by the EIMB and are no longer available is given in Section 1 of the General Handbook.

ORGANIZATION

The EIMB is organized into a series of handbooks to afford maximum flexibility and ease in handling. The handbooks are stocked and issued as separate items so that individual handbooks may be obtained as needed.

The handbooks fall within two categories: general information handbooks, and equipment-oriented handbooks. The general information handbooks contain data which are of interest to all personnel involved in installation and maintenance, regardless of their equipment specialty. The titles of the various general information handbooks give an overall idea of their data content; the General Handbook includes more complete descriptions of each handbook.

The equipment handbooks are devoted to information about particular classes of equipment. They include general test procedures, adjustments, general servicing information, and field change identification data.

All handbooks of the series are listed below with their NAVSEA numbers. The NAVSEA numbers serve also as the stock numbers to be used on any requisitions submitted.

HANDBOOK TITLE	NAVSEA NUMBER
EIMB General Information Handbooks	
General	0967-LP-000-0100
Installation Standards	0967-LP-000-0110
Electronic Circuits	0967-LP-000-0120
Test Methods & Practices	0967-LP-000-0130
Reference Data	0967-LP-000-0140
EMI Reduction	0967-LP-000-0150
General Maintenance	0967-LP-000-0160
EIMB Equipment-Oriented Handbooks	
Communications	0967-LP-000-0010
Radar	0967-LP-000-0020
Sonar	0967-LP-000-0030
Test Equipment	0967-LP-000-0040
Radiac	0967-LP-000-0050
Countermeasures	0967-LP-000-0070

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Initial Set: An "AF" Restriction Code has been assigned to NAVSEA 0967-LP-000-0000 to control the over-requisitioning of the EIMB Series. Fleet and shore activities requiring an initial set of the

PREFACE

EIMB Series (13 handbooks with all changes and heavy-duty binders) should submit their requisition (DD Form 1348 with written justification) through their Supply Officer or area, for issue approval to:

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SUGGESTIONS/CORRECTIONS

NAVSEA recognizes that users of the EIMB will have occasion to offer corrections or suggestions. To encourage more active participation, a pre-addressed comment sheet is provided in the back of each handbook change. Complete information should be given when preparing suggestions. Suggestors are encouraged to include their names and addresses so that clarifying correspondence can be initiated when necessary. Such correspondence will be by letter directly to the individual concerned.

If a comment sheet is not available, or if correspondence is lengthy, corrections or suggestions should be directed to the following:

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Washington, D.C. 20362

SECTION 1

GENERAL

1-1 INTRODUCTION

This book provides electronic technicians with reference information on the fundamentals of testing electronic equipment. The function of general-type test equipment available to Navy maintenance personnel is described. Testing techniques and practices are outlined, and the maintenance of test equipment is discussed. Detailed instructions contained in publications for specific equipment are not duplicated by this publication. The importance of testing, functional divisions of testing, and safety precautions are discussed in this section. Basic tests, measurements, and test equipment general functions are discussed in section 2. Section 3 describes electronic testing techniques and practices. The interpretation of waveforms is covered in section 4, with antenna and transmission line measurements being described in section 5. Section 6 of this publication discusses electronic system servicing techniques.

1-2 IMPORTANCE OF TESTING

Naval forces have become dependent upon electrical and electronic equipment in performing their missions. The effectiveness of nontactical, as well as tactical forces, is dependent to large extent upon the reliability of communication, detection, control, computing, and many other types of electronic devices. In turn, the reliability of such equipment is determined by many factors, such as the quality of the equipment in use, the amount of standby equipment available, the ability of operating personnel to perform their tasks, and adequate maintenance facilities. Maintenance is definable as work done to correct, reduce and counteract wear and damage to equipment. Maintenance of Navy electronic equipment is divided into two main categories: preventive (routine) maintenance, and corrective maintenance. Preventive maintenance consists of making checks to determine whether equipment is functioning properly, and includes lubrication procedures and visual inspection of cabling and equipment for evidence of damage. Corrective maintenance is performed to isolate equipment troubles (by means of test techniques), to replace defective parts, and to realign and readjust equipment or otherwise bring the equipment up to proper performance. Testing, considered in its broad sense, includes trouble-shooting, and is that portion of maintenance which requires the greatest skill on the part of the technician. Figure 1-1 shows the functional relationship that exists between testing and other necessary services that enter into the general shipboard (technical) maintenance of electronic equipment. Testing procedures are referred to as measurements, tests, and checks. All three of these terms may overlap in meaning, depending upon their usage and the results obtained. For instance, a power output measurement and a frequency check constitute a typical test of the operation of a radio transmitter.

1-3 FUNCTIONAL DIVISIONS OF TESTING

The functional divisions of testing, as discussed in section 2 of this book, provide a logical approach to testing and to the study of test equipment circuit theory. These constitute the fundamental test methods necessary to facilitate the operation and maintenance of electronic equipment. The functional divisions of testing may be categorized as follows:

1. Basic measurements consisting of
   a. Voltage
   b. Current
   c. Resistance
   d. Capacitance
   e. Inductance
2. Power measurements
3. Frequency measurements
4. Waveform measurements
5. Modulation measurements
6. Impedance measurements
7. Standing Wave measurements
8. Field Intensity and Noise measurements
9. Alignment
10. Tube testing
11. Semi-conductor testing
12. Integrated circuit testing
13. System testing and monitoring

1-4 SAFETY PRECAUTIONS

Every person who works with electronic equipment should be constantly alert to the hazards of this equipment to which he may be exposed, and should also be capable of rendering first aid to injured personnel. The hazards which are considered in this paragraph are: electric shock, rf-energy burns, X-rays produced by high-voltage tubes, radioactive material contained in radar switching tubes, cathode-ray-tube implosion, lightning, and fire.

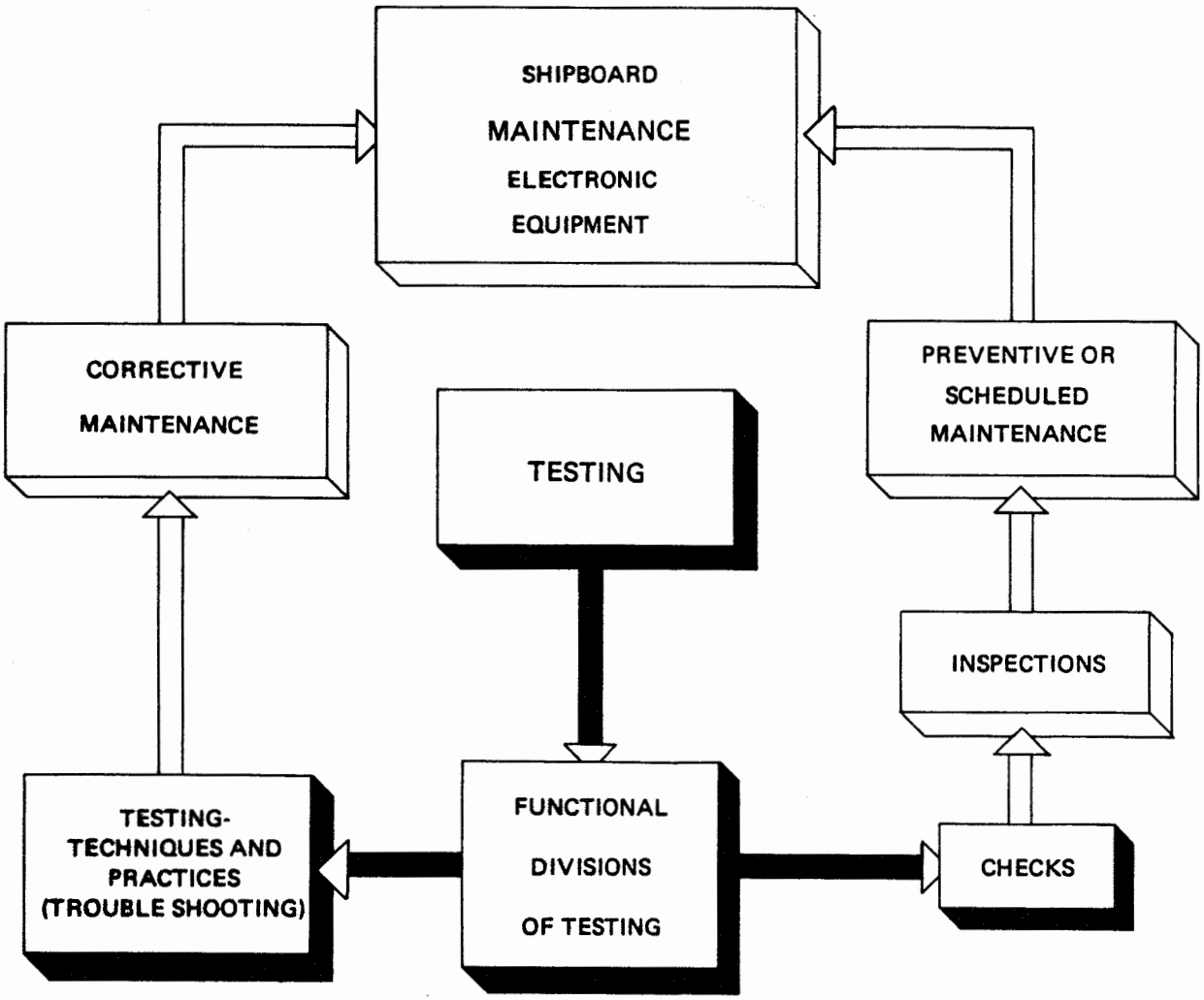

Figure 1-1. Electronic Maintenance, Functional Diagram

Safety must be a major responsibility of all electronics personnel. The installation, maintenance, and operation of electronic equipment enforces a stern safety code. Carelessness on the part of the electronics technician or operator can result in serious injury or death due to electrical shock, falls, burns, flying objects, etc. After an accident has occured, investigation almost invariably shows that it could have been prevented by the exercise of simple safety precautions and procedures that must be observed at all times. Each person concerned with electronic equipment is responsible to read and become thoroughly familiar with the safety practices and procedures contained in the Electronic Installation and Maintenance Book (General) NAVSEA 0967-LP-000-0100 and in equipment technical manuals, before performing work on electrical or electronic equipment. It is a personal responsibility to identify and eliminate unsafe conditions and unsafe acts which cause accidents. It must be borne in mind that de-energizing main supply circuits by opening supply switches will not necessarily "kill" all circuits in a given piece of equipment. A source of danger that has often been neglected or ignored, sometimes with tragic results, is the input to electronic equipment from other sources, such as synchros, remote control circuits, etc. For example, turning off the antenna safety switches will disable the antenna, but may not turn off the antenna synchro voltages from the ship's compass or stable elements. Moreover, the rescue of a victim shocked by the power input from a remote source is often hampered because of the time required to determine the source of power and turn it off. Therefore, turn off ALL power inputs before working on equipment. Take time to be safe when working on electronic circuits and equipment. Carefully study the schematics and wiring diagrams of the entire system, noting what circuits must be de-energized in addition to the main power supply. Remember--electronics equipments usually have more than one source of power. Be certain that ALL power sources are de-energized before servicing the equipment. Do not service any equipment with the power ON unless absolutely necessary. Remember that the 115-volt power supply voltage is not a low, relatively harmless voltage, but is the voltage that has caused more deaths in the Navy than any other medium.

1-5 SAFETY PRACTICES

The following is a listing of common-sense safety precautions that must be observed at all times:

1. Do NOT work with high-voltage by yourself; have another person (safety observer), qualified in first aid for electrical shock, present at all times. The person stationed nearby should also know which circuits and switches control the equipment, and should be given instructions to pull the switch immediately if anything unforeseen happens.

2. Always be aware of the nearness of high-voltage lines or circuits. Use rubber gloves where applicable, and stand on approved rubber matting (MIL-M-15562). Not all so-called rubber mats are good insulators.

3. Inform remote stations as to the circuit on which work is being performed.

4. Keep clothing, hands, and feet dry if at all possible. When necessary to work in wet or damp locations, use a dry platform or wooden stool to sit or stand on, and place a rubber mat or other non-conductive material on top of the wood. Use insulated tools and insulated flashlights of the molded type when required to work on exposed parts.

5. Do NOT work on energized circuits unless absolutely necessary. Be sure to take time to lock out (or block out) the associated switch and tag it. Locks for this purpose should be readily available; if such a lock cannot be obtained, remove the fuse and tag the holder.

6. Use only one hand when turning power switches ON or OFF. Keep the doors to switch and fuse boxes closed, except when working inside or replacing fuses. Use a fuse puller to remove cartridge fuses, after first making certain that the circuit is dead.

7. All power supply switches or cutout switches from which power could possibly be fed shall be secured in the OPEN (safety) position and tagged. The tag shall read "THIS CIRCUIT WAS ORDERED OPEN FOR REPAIRS AND SHALL NOT BE CLOSED EXCEPT BY DIRECT ORDER OF" (the person either making or directly in charge of the repairs).

8. Never short out, tamper with, or block open an interlock switch.

9. Keep clear of exposed equipment; when it is absolutely necessary to work on it, use only one hand as much as possible.

10. Avoid reaching into enclosures except when absolutely necessary. When reaching into an enclosure, use rubber blankets to prevent accidental contact with the enclosure.

11. Do not use bare hands to remove hot vacuum tubes from their sockets. Wear protective gloves or use a tube puller.

12. Use a shorting stick to discharge all high-voltage capacitors.

13. Make certain that the equipment is properly grounded. Ground all test equipment to the equipment under test.

14. Turn off the power before connecting alligator clips to any circuit.

15. When measuring circuits over 300 volts, do not hold the test prods.